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"HYPERSPACE OF OBJECTS (IoT) & MICRO CONTROLLERS"

(HBM-2018)

on

25-01-2018

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Department of Computer Science & Department of Physics
In Association with IQAC
AG & SG SIDDHARTHA COLLEGE OF ARTS AND SCIENCES (Autonomous)
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ABOUT THE COLLEGE

By considering the educational requirements of the local aspiring students, the farmers of Vuyyuru area approached the K.C.P. Sugar and Industrial Corporation Ltd. Management requesting for the establishment of a degree college. Already there was the "Adusumilli Gopalakrishnaiah Technological Institution" managing an Industrial training centre and a polytechnic college from 1947 to 1958. The society was revived by the K.C.P Ltd., with the help of local philanthropists and sugarcane growers and the college was born with the name of Adusumilli Gopalakrishnaiah and Sugarcane Growers College on 12th August 1975 and was inaugurated by the Hon'ble Chief Minister Sri. J. Vengala Rao. In May 2001, the Management of K.C.P.S & I.C Ltd. handed over the management of the college to the Siddhartha Academy of General & Technical Education, Vijayawada which had ample experience in running many educational institutions for better maintenance. The Academy rechristened the college as A.G & S.G Siddhartha College of Arts and Science. Today, under the dynamic and visionary leadership of the Siddhartha Academy, the college is forging ahead catering to the growing needs of education of the local communities of the area, laboring hard to achieve excellence in imparting integrated education. Due to the hard work of the teachers and the administration UGC granted autonomy in 2012 subsequently to newly born Krishna University.

ABOUT THE SEMINAR

On the behalf of organizing committee, we cordially invite you to pleasant place Vuyyuru for one day UGC sponsored "National Seminar on Hyperspace of objects (IoT) & Microcontrollers",(HBM-2018).

Research regarding the Hyperspace is a term that describes the total number of individual locations and all of their interconnections in hypertext environment. World-wide network of interconnected heterogeneous objects (sensors, actuators, smart devices, smart objects, RFID, embedded computers, etc) uniquely addressable, based on standard communication protocols. At this point, it must be seen as a vision where "things", especially everyday objects, such as home appliances furniture, clothes, vehicles, roads and smart materials, which are readable, recognizable, locatable, addressable and/or controllable via Internet. This will provide the basis for many new applications, such as energy monitoring, transport safety systems or building security and control various appliances. The Microcontrollers and other programmable digital devices have become "Universal Components". They are used in all things from cell phone to car, TV to Oven etc. anything that has a human interface that uses microcontrollers. Anyone working in a traditionally analog specialty does not have a working acquaintance with microcontrollers they may find their job and career options limited. This seminar provides an Introduction to world of microcontrollers and embedded systems development. The goal of this seminar is to prepare the attendee to start studying and learning about the world of microcontrollers applications without constantly stumbling over basic concept and vocabulary.

This seminar acquaints the attendee with the various types of devices and their principal characteristics. It also enables the attendee to choose appropriate software and hardware tools for their project. This seminar is introductory in nature and no previous experience with microcontrollers or programming is needed.

The main objective of the seminar is to bring scientists, engineers, technologists and researchers from various corners of India at one forum and share their views, exchange of ideas, concepts and techniques in terms of presentations or deliberations. The deliberations are categorized as plenary lectures, Invited talks, from reputed resource persons on major topics and contributory oral talks for the participants. For the benefit of both faculty and student community.

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LIGHT CONVERTING INORGANIC PHOSPHORS FOR WHITE LIGHT EMITTING DIODES: AN OVER VIEW

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Abstract

The present paper reports the White light-emitting diodes (WLEDs) have matched the emission efficiency of florescent lights and will rapidly spread as light source for homes and offices in the next 5 to 10 years. WLEDs provide a light element having a semiconductor light emitting layer (blue or near-ultraviolet (nUV) LEDs) and photoluminescence phosphors. These solid state LED lamps, rather than organic light emitting diode (OLED) or polymer light emitting diode (PLED), have a number of advantages over conventional incandescent bulbs and halogen lamps, such as high efficiency to convert electrical energy into light, reliability and long operating lifetime. To meet with the further requirement of high color rendering index, warm light with low color temperature, high thermal stability and higher energy efficiency for WLEDs, new phosphors that can absorb excitation energy from blue or nUV LEDs and generate visible emissions efficiently are desired. The criteria of choosing the best phosphors, for blue (450–480 nm) and nUV (380–400 nm) LEDs, strongly depends on the absorption and emission of the phosphors. Moreover, the balance of light between the emission from blue - nUV LEDs and the emissions from phosphors (such as yellow from $Y_3Al_5O_{12}:Ce^{3+}$) is important to obtain white light with proper color rendering index and color temperature. Here, we will review the status of phosphors for LEDs and prospect the future development.

Keywords: light-emitting diode (LED); phosphors; luminescence efficiency; color rendering index (Ra); thermal stability

1. Introduction

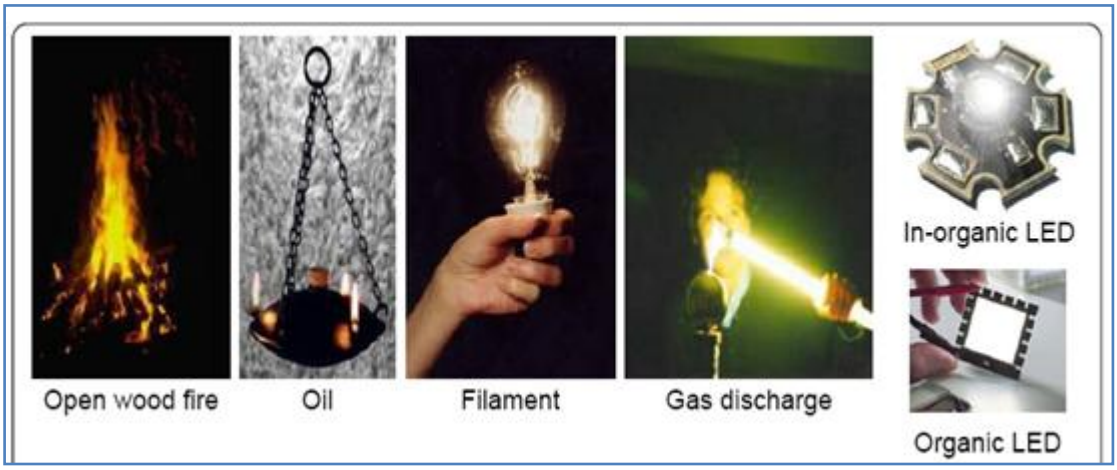
1.1 Brief history of light sources

The first revolution is everything that is related with open fire, i.e. burning of wood, kerosene, candles, etc. This is rather inefficient way since only a small part of energy is converted into the light and the rest is dissipated as heat. However, this was the longest period when such light sources were used. On the other hand, burning wood or kerosene is still the only way to produce artificial light in many developing countries where electricity is in a short supply.

The second generation of light sources has started when the incandescent light bulb was discovered by T. A. Edison in 1879. The era of incandescent light bulb dates till now, however, it seems that quite soon it might be over, since the EU, USA and Australia decided to ban them in the nearest future in order to save electrical power.

The third revolution of light sources began with the introduction of fluorescent tubes by General Electrics (GE) in 1939 (even though the patent was filled by Meyer et al. already in 1927). It employs the UV radiation emitted by the low pressure mercury plasma to excite the phosphor layer inside of the tube. The fluorescent tubes at present are the most efficient white light sources for general lighting applications.

The fourth evolution of light sources starts with the invention of the blue emitting InGaN-based LED by S.Nakamura in 1991. With years the scientists were able to produce more and more efficient blue LEDs, which became the basis for white LEDs. In other words, the invention of blue LED has started the era of solid state lighting. The white LEDs inevitably will replace incandescent light bulbs and, with enough time, the fluorescent tubes. Moreover, white LEDs are already a dominant technology for backlighting units of LCD displays in mobile phones, handled devices, computer monitors, and TVs.



Inorganic luminescent materials = phosphors

Host Lattice: Generally large band gap and stiff

e.g. silicates, phosphates, fluorides etc.

Activator: Luminescent center, Suitable energy levels, Crystal field effects

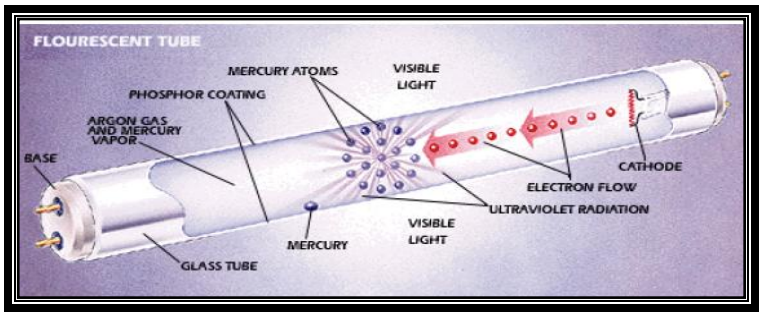
e.g. rare earths - narrow band

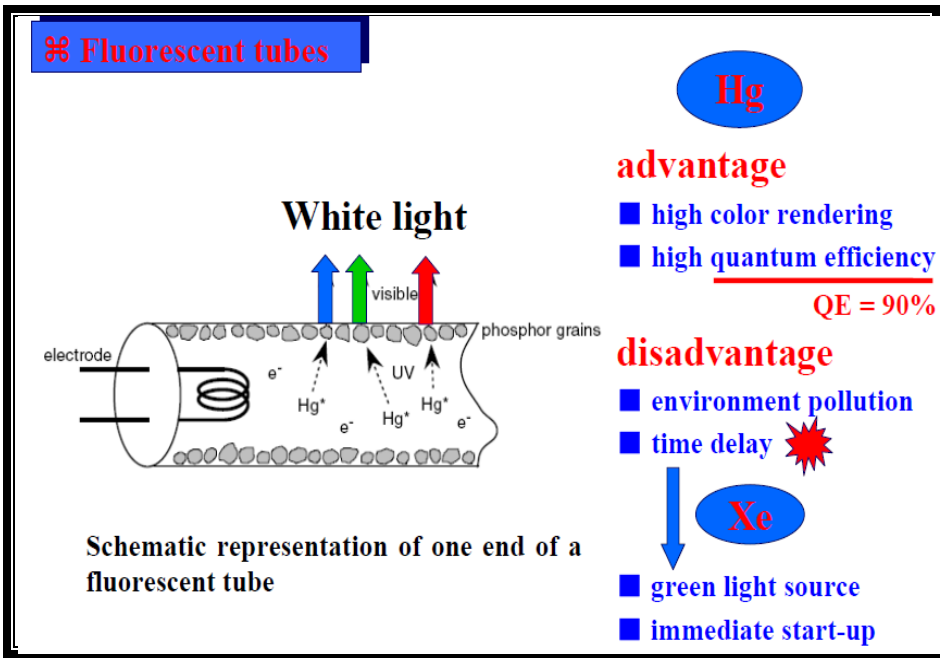
transition metals – broad band

Sensitizer: Sensitizes activator emission

e.g. Ce^{3+}, Sb^{3+}

Light generation – Hg Low-pressure Discharges





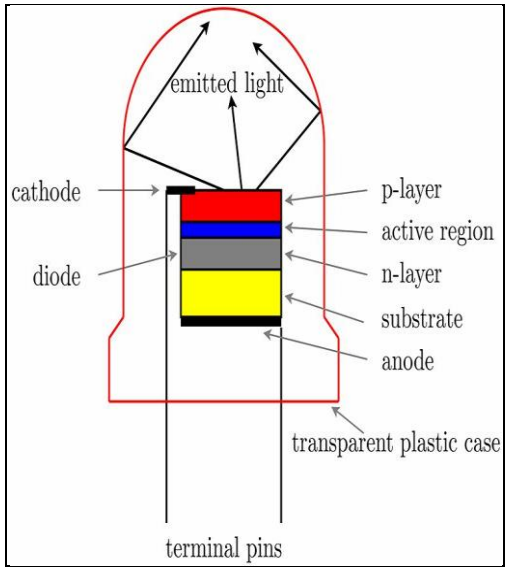
Light Source	Electrical Input power [w]	Luminous flux [lm]	Luminous efficacy [lm/W]
Incandescnet	10 – 1000	80 – 15000	8 – 15
Halogen	20 – 2000	300 – 60000	15 – 30
Low-pressure Hg discharge	7 – 150	350 – 15000	50 – 70 (compact) 100 (straight)
High – pressure Hg discharge	50 – 1000	2000 – 60000	40 – 60
Metal-halide discharge	20 – 2000	1600 – 24000	80 – 120
Low-pressure Na discharge	20 – 200	2000 – 40000	100 – 200
High-pressure Na discharge	40 -1000	1600 – 14000	40 -140
Medium-pressure Xe discharge	Up to 1000	Uo to 40000	35-45 (lamps) 4-5 (PDPs)
White dichromatic Inorganic LEDs	1 -5	20 – 150	30 – 50 > 100 [published]
White trichromatic Inorganic LEDs	1	20 – 25	20 – 30
Organic LED (at 1000 cd/m^2)	15mW (per cm^2)	0.25 (per cm^2)	15 – 25 > 50 (published)

Solid-state semiconductor lighting technology can be traced as far back as 1962 to the first semiconductor diode laser announced by Hall [1] at General Electric Research Labs in Schenectady, New York, but there was almost no application besides used in numeric displays or indicator lights in past, because the wavelengths produced by semiconductor lasers have generally been longer than 0.7 µm [1].

Phosphors – Fluorescent Lamps

Rare earth ion	s^2- or TM ion activated
Ce^{3+}	Pb^{2+}
$LaPO_4$:Ce	$Sr_2MgSi_2O_7$:Pb
YPO_4:Ce	$BaSi_2O_5$:Pb
Eu^{2+}	Sb^{3+}
$Sr_5(PO_4)_3(F,Cl)$:Eu	$Ca_5(PO_4)_3(F,Cl)$:Sb
$BaMgAl_{10}O_{17}$:Eu	
Tb^{3+}	Mn^{2+}
$LaPO_4$:Ce,Tb	$BaMgAl_{10}O_{17}$:Eu,Mn
$CeMgAl_{11}O_{19}$:Tb	Zn_2SiO_4:Mn
$LaMgB_5O_{10}$:Ce,Tb	$Ca_5(PO_4)_3(F,Cl)$:Sb,Mn
	$LaMgB_5O_{10}$:Ce,Tb,Mn
Eu^{3+}	Mn^{4+}
Y_2O_3:Eu	$Mg_4GeO_{5.5}F$:Mn
$(Y,Gd)(V,P)O_4$:Eu	

LED inner structure



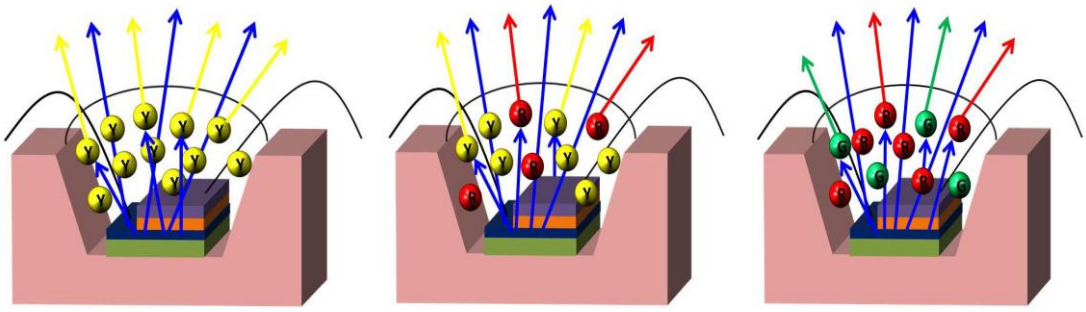
However, this situation was completely changed with Shuji Nakamura's invention, who successfully fabricated double-hetero structure InGaN/GaN blue LED chips for the first time in 1993 and later in 1994 succeeded in producing l-cd-brightness high-power blue InGaN/AlGaN LEDs suitable for commercial applications [2–6]. Since the first commercially available white light-emitting diode (LED) was produced by Nichia Corporation in 1996,

tremendous progress has been achieved in development of solid-state lighting based on InGaN semiconductors [6, 7]. The operation of LEDs is based on spontaneous light emission in semiconductors, which is due to the radiative recombination of excess electrons and holes that are produced by the injection of current.

Therefore, LEDs are not limited by the fundamental factors that still existed in conventional incandescent lamp and compact fluorescent lamp [8]. As a result, LED light sources have superior efficiency, lifetime, reliability, which makes it more energy-saving and environmental-friendly for less thermal radiation and no mercury. The organic light emitting diode (OLED) or polymer light-emitting diode (PLED) has a similar principle of operation with LED, but whose application is restricted by the effect of circumstance on organics. Here, we focus on LEDs. Currently, the application of LEDs has been extended from signal indicators initially to automobile light, traffic light, street lighting, landscape decoration, backlight of liquid crystal display (LCD) for TV sets, computers and mobile telephones, et al. Converting phosphors are essential components for LEDs.

2. Principle of White Light Generating in LEDs

The first commercially available white LED produced by Nichia Corporation was prepared by combining the blue emission of InGaN diode chip with the yellow luminescence from $Y_3Al_5O_{12}:Ce^{3+}$ (YAG: Ce^{3+}) phosphor [6]. The chief drawbacks to this YAG based WLEDs are poor color rendering and seriously thermal quenching luminescence. As an alternative, combining red, green, and blue phosphors and near-ultraviolet/ultraviolet (nUV/UV) InGaN diode chips to produce white light is highly favored [9]. From the view point of industrialization, most commercially available white LEDs are prepared by pre-coating phosphors onto blue diode chips, because the luminous efficiency of blue chip based white LEDs is far higher than that of nUV/UV type. According to the phosphors adopted in LEDs, the methods of generating white light can be summarized in three different types. The first is realized by mixing blue emission from a LED diode chip and the yellow luminescence from phosphor particles, as shown in Figure 1(a), whose typical character is highly efficient but with poor color rendering index (Ra). The second is by adding proper red phosphor into the first type, as shown in Figure 1(b), through which the Ra can be improved and luminous efficiency is appropriate. The third one is prepared by combining a blue LED diode chip with red and green phosphors, as shown in Figure 1(c), whose typical character is high Ra but with low efficiency. The thermal stability of LED luminescence depends significantly on phosphors, because heat is produced continuously during LEDs operating. Presently, the phosphors that can be adopted for commercial white LEDs are summarized as following.



(a) (b) (c)

Figure 1 Different ways of generating white light with blue LED and phosphors
(a) A blue LED + Yellow phosphors (b) A blue LED + Yellow phosphors + Red phosphors (c) A blue LED + Green phosphors + Red phosphors

3. Converting Phosphors for LEDs

Table I. Key parameters for selected phosphor-converted white LEDs (phosphor composition, color temperature and color rendering Estimated values are denoted by *.

$\lambda_{max,LED}$ (nm)	Phosphor(s)	CCT (K)	CRI
460	$Y_3Al_5O_{12}:Ce^{3+}$	5600	71
460*	$Y_3Al_5O_{12}:Ce^{3+}$, CaS:Eu^{2+}	5500	92
460	$Y_3Al_5O_{12}:Ce^{3+}$, $Sr_2Si_5N_8:Eu^{2+}$	2900	80
460	$Sr_2GaS_4:Eu^{2+}$, SrS:Eu^{2+}	3600	82
460	$Sr_2GaS_4:Eu^{2+}$, (Ca,Sr)S:Eu^{2+}	4800	92
450	$Ca_3Sc_2Si_3O_{12}:Ce^{3+}$, $CaAlSiN_3:Eu^{2+}$	6500*	92
450	$SrSi_2O_2N_2:Eu^{2+}$, $Sr_2Si_5N_8:Eu^{2+}$	3200	89
455	$SrSi_2O_2N_2:Eu^{2+}$, $CaSiN_2:Ce^{3+}$	5200	91
450	$(Sr,Ca)_3(Al,Si)O_4(O,F):Ce^{3+}$, $K_2TiF_6:Mn^{4+}$	3200	90
455	$BaSi_2O_2N_2:Eu^{2+}$, β-SiAlON:Eu^{2+}, Ca-α-SiAlON:Eu^{2+}, $CaAlSiN_3:Eu^{2+}$	6400	96
455	$BaSi_2O_2N_2:Eu^{2+}$, β-SiAlON:Eu^{2+}, Ca-α-SiAlON:Eu^{2+}, $CaAlSiN_3:Eu^{2+}$	2900	98
365	$BaMgAl_{10}O_{17}:Eu^{2+}$, $Ca_9La(PO_4)_7:Eu^{2+}$, Mn^{2+}	4500	92

4. Conclusions

In conclusion, the strategies for generating white light by combining light-emitting diodes with converting phosphors and the phosphors that are available for producing white light with different luminescence efficiency and color rendering index properties are summarized in this paper. To get white light with high efficiency but with low coloring index, yellow phosphors (such as YAG:Ce^{3+} or (Sr,Ba)$SiO_4:Eu^{2+}$) combining with blue LEDs are a good choice, which is suitable for the place that requires high brightness but without high requirement of color rendering; to obtain white light with high color rendering index but with low efficiency, green (such as LuAG:Ce^{3+} or (Ba,Sr)$SiO_4:Eu^{2+}$) and red phosphors (such as $(Sr,Ba)_2Si_5N_8:Eu^{2+}$ or (Sr,Ca)$SiAlN_3:Eu^{2+}$) combining with blue LEDs are a perfect choice, which is suitable for the place that requires high color rendering but without high requirement of efficiency; to achieve white light with appropriate color rendering index and moderate luminescence efficiency, blue LEDs and yellow phosphor (such as YAG:Ce^{3+} or (Sr,Ba)$SiO_4:Eu^{2+}$) by adding proper red phosphors (such as $(Sr,Ba)_2Si_5N_8:Eu^{2+}$ or (Sr,Ca)$SiAlN_3:Eu^{2+}$) are a perfect choice, which is suitable for the circumstance where both the effects of color rendering index and efficiency should be taken into account. Additionally, the white light with high color rendering index and low efficiency can also be produced by combining nUV LEDs with tri-color phosphors, but the luminescence efficiency is very lower comparing with blue LEDs. Up to now, however, the converting phosphors that are convenient to combine with blue LEDs to produce white light with high color rendering index and high luminance have not been found. Therefore, the researches on LED phosphors in future will focus on this point.

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ULTRASONIC SENSORS

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Abstract
Paper deals with ultrasonic sensors used for distance measurement. Selected ultrasonic sensor has been tested and results of experiments are shown in the paper. Uncertainty analysis also has been realized.
Keywords: ultrasonic, distance measurement, sensor, uncertainty

Introduction

An **Ultrasonic sensor** is a device that can measure the distance to an object by using sound waves. It measures distance by sending out a sound wave at a specific frequency and listening for that sound wave to bounce back. ... It is important to understand that some objects might not be detected by **ultrasonic sensor**

Today we are investigating another sensor—the ultrasonic sensor. Have you heard of an ultrasonic sensor? This sensor is able to estimate objects in front of it using reflected sound. Does this process sound similar to any other process you know of? (Listen to student ideas. They may mention bats, echolocation, radar or sonar). This process is similar to how bats locate objects in their paths.

This includes two mini-activities to help us get familiar with the LEGO EV3 ultrasonic sensor. Then in the next class, we will conduct a more-involved activity that gives you the opportunity to program your LEGO robots to move about freely without bumping into LEGO people. To do that, you'll use a LEGO EV3 ultrasonic sensor to detect whether anything is in the way.

Principle:

Ultrasonic sensors emit short, high-frequency sound pulses at regular intervals. ... If they strike an object, then they are reflected back as echo signals to the **sensor**, which itself computes the distance.

Types of Ultrasonic Sensors:

There are two types of ultrasonic sensors

Proximity Detection: An object passing within the preset range will be detected and generate an output signal. The detect point is independent of target size, material or reflectivity.

Ranging Measurement: Precise distance(s) of an object moving to and from the sensor are measured via time intervals between transmitted and reflected bursts of ultrasonic sound. Distance change is continuously calculated and outputted.

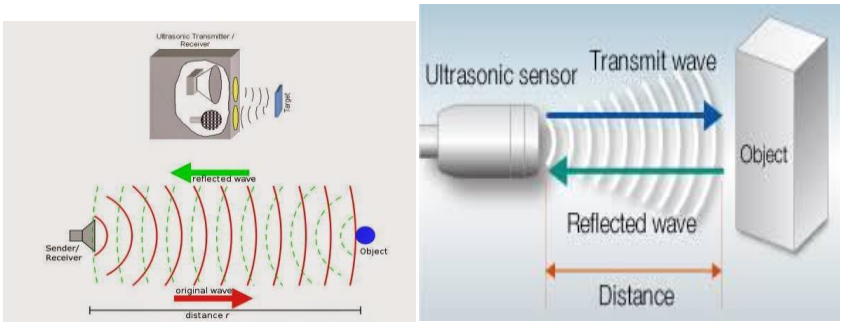
Working of Ultrasonic Sensors:

We learn about how ultrasonic sensors work, reinforcing the connection between this sensor and how humans, bats and dolphins estimate distance. They learn the echolocation process—sound waves transmitted, bounced back and received, with the time difference used to calculate the distance of objects. Two mini-

activities, which use LEGO® MINDSTORMS® EV3 robots and ultrasonic **sensors, give students a chance to experiment with ultrasonic sensors in** preparation for the associated activity.

Ultrasonic sensors are devices that use electrical–mechanical energy transformation to measure distance from the sensor to the target object. Ultrasonic waves are longitudinal mechanical waves which travel as a sequence of compressions and rarefactions along the direction of wave propagation through the medium. Apart from distance measurement, they are also used in ultrasonic material testing (to detect cracks, air bubbles, and other flaws in the products), Object detection, position detection, ultrasonic mouse, etc.

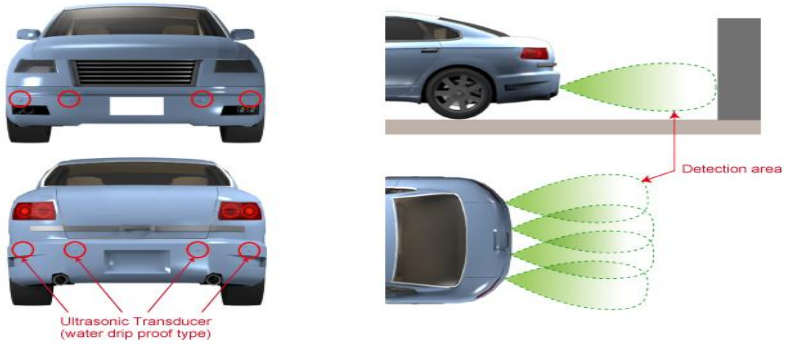
These sensors are categorized in two types according to their working phenomenon – piezoelectric sensors and electrostatic sensors. Here we are discussing the **ultrasonic sensor using the piezoelectric principle. Piezoelectric ultrasonic sensors** use a piezoelectric material to generate the ultrasonic waves. **An ultrasonic sensor** consists of a transmitter and receiver which are available as separate units or embedded together as single unit. The above image shows the ultrasonic transmitter and receiver.



An ultrasonic sensor is as sensor which measures the distance of respective object by sending the sound wave of specific frequency. This sound wave is reflected after the collision with respective object and this wave is received by the ultra-sonic receiver. Distance is measured by calculating sending and receiving time of this sound wave. you may also like to read **distance measurement** using ultrasonic sensor and arduino. Basic operational diagram of ultrasonic sensor is shown in fig

Applications of ultrasonic sensors:

Today, sophisticated instruments and algorithms used for process control allow the efficient production of substances with the quality guaranteed to the customer. However, production and management techniques are changing. This article aims to analyze trends resulting from those



Parking sensors make reversing into tricky spaces easier and help prevent minor damage to your car Parking Distance Warning System.
Ultrasonic sensors in the bumpers trigger a warning tone to alert you to obstacles close to your car.

changes from the point of view of ultrasonic sensors. The focus will be on plant asset management. One part of plant asset management is maintenance management. Its goal is cost saving by avoiding unexpected shutdowns of single components or the complete plant. However, new maintenance concepts like condition-based or predictive maintenance require reliable methods of condition monitoring. This article will discuss these new applications for ultrasonic sensors. A new ultrasonic measurement based on acoustic emission analyses for condition monitoring of high pressure process pumps is introduced and economic benefits for the user are discuss Ultrasonic Range Detector With Arduino Using The SR04 Ultrasonic Sensor.

15 Applications Using Migatron Ultrasonic Sensors:ss

Loop control
Roll diameter, tension control, winding and unwind
Liquid level control
Thru beam detection for high-speed counting
Full detection
Thread or wire break detection
Robotic sensing
Stacking height control
45° Deflection; inkwell level detection; hard to get at places
People detection for counting
Contouring or profiling using ultrasonic systems
Vehicle detection for car wash and automotive assembly
Irregular parts detection for hoppers and feeder bowls
Presence detection
Box sorting using multi-transducer ultrasonic monitoring system

Conclusion

Ultrasonic sensors have variety application as distance measurement, obstacle avoiding and anti-collision detection, robot navigation, measurement in automotive parking assistance systems, measurement of air flow velocity - anemometer, medical ultrasonography, non-destructive testing, piezoelectric transducers, level measurement, pallet detection on forklifts, vehicle detection in barrier systems etc.

Ultrasonic sensors are non-intrusive in that they do not require physical contact with their target, and can detect certain clear or shiny targets otherwise obscured to some vision-based sensors. On the other hand, their measurements are very sensitive to temperature and to the angle of the target. Temperature and humidity affect the speed of sound in air. Therefore, range finders may need to be recalibrated to make accurate measurements in a new environment. Temperature variations and air currents can create invisible boundaries that will reflect ultrasonic waves, so care must be taken to avoid these. For the transmitted wave to echo back to the receiver, the target surface must be perpendicular to the transmitter. Round objects are therefore most easily sensed since they always show some perpendicular face. When targeting a flat object, care must be taken to ensure that its angle with respect to the sensor does not exceed a particular range.

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CONVERSION OF AEOLIPILE / HERON ENGINE TO IC ENGINE

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Abstract

In this manuscript, proposed research on Aeolipile internal combustion engine is discussed (Theoretical only). The objective of this project is to develop new IC based on the principle of Aeolipile. Torque is produced by steam jets in the existing aeolipile but in IC model torque is produced by exhaust gases from multiple nozzles. The development of this model results in, low emissions which lead to establishing a path for renewable hydrogen based fuel utilization. It can operate on many hydrogen-containing fuels. It allows specific markets to utilize hydrogen economically and painlessly.

Introduction

The word "engine" derives from Old French engine, from the Latin ingenium–the root of the word ingenious. Pre-industrial weapons of war, such as catapults, trebuchets and battering rams, were called "siege engines", and knowledge of how to construct them were often treated as military secrets. The word "gin", as in "cotton gin", is short for "engine". Most mechanical devices invented during the industrial revolution were described as engine - the steam engine being a notable example.

In modern usage, the term engine typically describes devices, like steam engines and internal combustion engines, that burn or otherwise consume fuel to perform mechanical work by exerting a torque or linear force (usually in the form of thrust). Examples of engines which exert a torque include the familiar automobile gasoline and diesel engines, as well as turbo shafts. Examples of engines which produce thrust include turbofans and rockets.

In 250BC, Greek compressed air engineer Ctesibius ("father of pneumatics") is attributed to have invented the steam spinning device; which is often assigned as being the world's first prototype steam engine.

In the 1st century AD by Heron of Alexandria and described in his Pneumatica. The aeolipile was a hollow sphere mounted so that it could turn on a pair of hollow tubes that provided steam to the sphere from a cauldron. The steam escaped from the sphere from one or more bent tubes projecting from its equator,

causing the sphere to revolve. The aeolipile is the first known device to transform steam into rotary motion. Like many other machines of the time that demonstrated basic mechanical principles, it was simply regarded as a curiosity or a toy and was not used for any practical purpose.

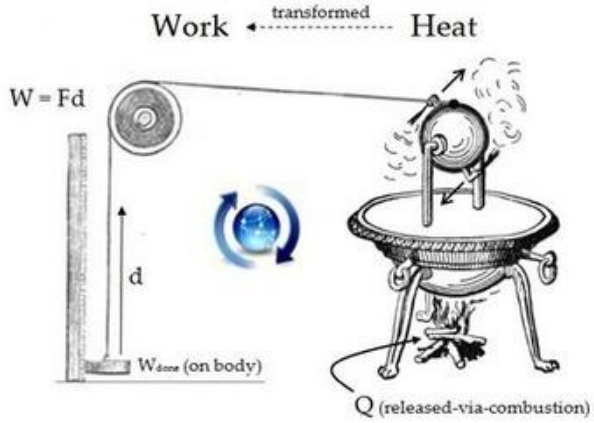
The name – derived from the Greek words "aeolos" and "pila" – translates to "the ball of Aeolus"; Aeolus being the Greek god of the wind.

His machine consisted of a water reservoir with a heat source located underneath, and copper tubing extended upwards from this, acting as the pivot for a rotating sphere. To the outside of the sphere, two nozzles were created from tubing bent out from the surface of this sphere, making an L-shape.

The principle behind the machine relied upon steam from the heated water rising through the copper tubing into the sphere. This steam escaped through the nozzles at high speed, generating thrust according to Newton's 2nd and 3rd laws of motion (This experiment shows one on the basic principles of physics, that for every action, there must be an equal and opposite action, and this simple principle lies at the root of modern society. Combustion engines, turbines, lawn sprinklers, and rockets are just some of the machines relying upon the principles shown by Heron.), causing the sphere to rotate on its axis.

Simpler versions of Heron's aeolipile dispensed with the boiler and simply heated the water in the sphere (a new invention that depended more on the mechanical interaction of heat and water); this was much easier to build but would not operate for long before the water boiled away.

When the nozzles, pointing in different directions, produce forces along different lines of action perpendicular to the axis of the bearings, the thrusts combine to result in a rotational moment (mechanical couple), or torque, causing the vessel to spin about its axis. Aerodynamic drag and frictional forces in the bearings build up quickly with increasing rotational speed (rpm) and consume the accelerating torque, eventually canceling it and achieving a steady state speed.



Drawbacks

Because it was really, just a toy of curiosity. So there were no businessmen waiting for the next big idea with which to take the world by storm. In fact, that concept didn't exist, as hard as that may be to believe.

The state of metallurgy also would have restricted the maximum pressure that could be built up.

The aeolipile obviously contributed to these developments - but it had to wait for subsidiary developments (eg: valves or high-energy fuel and safe ways of using it) to come along.

1. The Aeolipile sucked, useless as a source of energy. It just spun around for a short period and would have been impossible to run say factory.
2. The very idea of self powered machines is far more complex than it seems, it involves a revolution in thinking about the nature of reality and Rome was not there yet. For them power had to come from nature, animals or men.
3. Rome had plenty of slaves to provide cheap power for manufacture. (There was no need for "automation" to eliminate labor, because with slave labour cheap and readily available).

4. Roman view of power involved the exploitation of other humans and animals, not only did they not develop steam power; they tended not to use water or wind power. Even their ships, which would use wind power, allow used oars men. We tend to think of power coming from machines, we have developed a concept of power over the world via technology; Rome did not have that idea.
5. After Heron's death, the device was long forgotten but in 1577 it was reinvented by Taqu al-Din who was an engineer, astronomer and a philosopher but remained unnoticed.
6. A replica of Heron's steam engine was later produced and with an extremely low pressure of 1.8 pounds per square inch, it managed to rotate 1500 rounds a minute.

History

C.30–70AD–Hero of Alexandria describes the first documented steam-powered device, aeolipile.

1769 – James Watt patents his first improved steam engine.

1877 – Nikolaus Otto patents a four-stroke internal combustion engine

1892 – Rudolf Diesel patents the Diesel engine

1954 – Felix Wankel creates the first working Wankel engine.

Description

Modern Aeolipile consists of a hollow cylinder (Fig. 1) with nozzles (nozzles were made from tubing bent out from the surface of this cylinder, making an L-shape.) fitted on its outer curved surface. The bottom of the hollow cylinder is closed. The upper surface of the cylinder is fitted with a bearing for free rotation of the cylinder. The cylinder and the bearing are fixed by a cap with a large hole at the centre of the cap to accommodate another cylinder which acts as an arm to hold entire structure to a supporting frame.

The second cylinder is also made hollow, but the bottom surface is left without drilling, with some thickness and its diameter (bottom of the second cylinder) is larger than the diameter of the second cylinder.

Three holes are drilled in the bottom surface (Fig.2) of the second cylinder one is for fuel inlet, second is for high pressure air inlet and third is for spark plug. If this second cylinder, outer curved surface is grooved then this entire structure can be attached to any frame by a suitable size nut.

Working

When air and fuel (gas or liquid spray) are pumped into the first cylinder, they are mixed inside the cylinder. Gasoline is ignited within this enclosed chamber by the spark plug. The gas inside the chamber expands and gushes out through the multiple nozzles producing a Torque which rotates the cylinder.

Torque is the force being exerted on the nozzle by backward thrust .This is expressed by the formula:

$$\tau = |\mathbf{r} \times \mathbf{F}| = rF\sin(\mathbf{r}, \mathbf{F})$$

Where r is the length between the opposite nozzles across the cylinder, F is the Thrust applied on it, and r×F is the vector cross product. Torque is measured typically either in newton-metres (N•m, SI units) or in foot-pounds (ft•lb, imperial units).The angle between r and F is 900.

So, τ = r*F

Pressure

If P is the pressure inside the ignition chamber, V is the volume of the ignition chamber

P.V = (F/A). (V)

= (F/A)(A*L)

= F*L

= W

= E

Where P = Force / Area

F = force

A = circular area of the cylindrical ignition chamber

V = volume of the cylindrical ignition chamber

L = length of the cylindrical ignition chamber

W = work done

E = energy produced inside the chamber

P = E/V

From the above formula, pressure inside the chamber can be calculated.

Thrust

F = m*ve + (Pe - Po)*Ae

Here product of rate of change of mass and exit velocity can be neglected because rate of change of mass is negligible.

Combustion Chamber

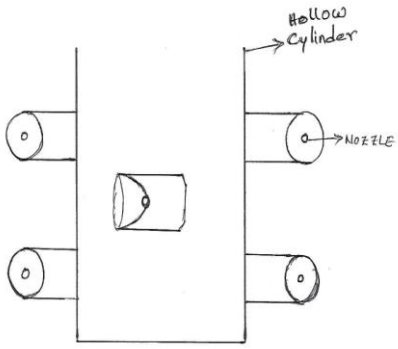


Fig. 1

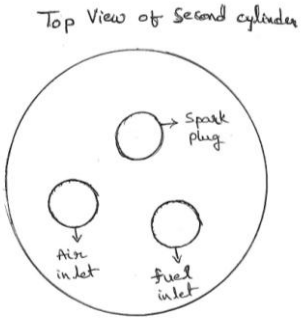


Fig. 2

Blow up view of Aeolipile IC engine

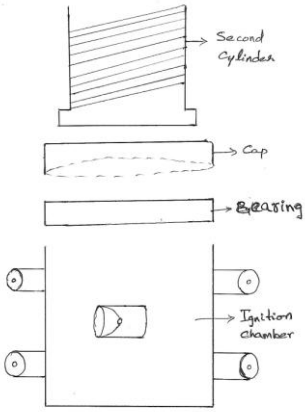


Fig. 3

Conclusion

In this palimpsest, proposed research on Aeolipile internal combustion engine is discussed theoretically. The objective of this project to develop new IC based on the principle of Aeolipile is achieved theoretically. It is understood that, torque is produced by steam jets in the existing aeolipile but in IC model torque is produced by exhaust gases from multiple nozzles. The development of this model results in, low emissions which lead to establishing a path for renewable hydrogen based fuel utilization. It can operate on many hydrogen-containing fuels. It allows specific markets to utilize hydrogen economically and painlessly. Practical application of this model needs to be explored.

Obviously, modifications of the old model are possible in the light of the above discussed design.

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GYROSCOPE SENSORS

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Abstract:
Micro electromechanical systems (MEMS) in consumer electronics are growing faster each year, with increasing demands from the mobile market, which is dominating the growth for this emerging technology. MEMS sensors are, in fact, becoming the key elements in designing differentiating products for consumer and mobile markets like game consoles, smart phones, and tablets. MEMS give the user a new way to interface with their smart device. This paper is an overview of MEMS: the principle of their operation, the sensing mechanism, and a variety of potential applications.

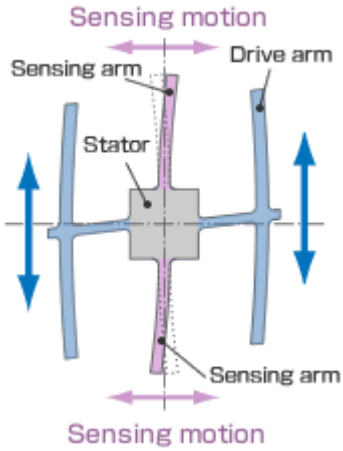
Introduction:

Micro electromechanical systems (MEMS) combine mechanical and electrical components into small structures in the micrometer scale. They are formed by a combination of semiconductor and micro fabrication technologies using micro machine processing to integrate all the electronics, sensors, and mechanical elements onto a common silicon substrate. Major components in any MEMS system are the mechanical elements, sensing mechanism, and the ASIC or a microcontroller. This article presents an overview of MEMS accelerometer sensors and gyroscopes. We discuss the principles of their operation, their sensing mechanism, the growing variety of applications for them, and the profound impact they are already having on our daily lives.

Gyro sensors, also known as angular rate sensors or angular velocity sensors, are devices that sense angular velocity. Angular velocity. In simple terms, angular velocity is the change in rotational angle per unit of time. Angular velocity is generally expressed in .

Principle of gyroscope:

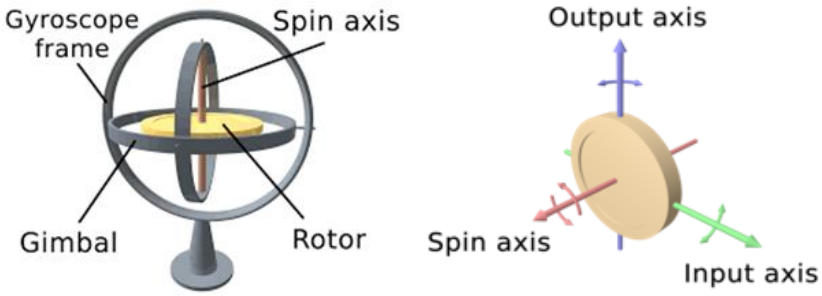
The rotor keeps swiveling. This rotation of the axis is what is known as precession. The angular momentum keeps following the torque and thus its rotational axis precesses. This is the gyroscopic principle.



A gyroscope is a device used for measuring or maintaining orientation and angular velocity.It is a spinning wheel or disc in which the axis of rotation is free to assume any orientation by itself. When rotating, the orientation of this axis is unaffected by tilting or rotation of the mounting, according to the conservation of angular momentum.

Gyroscopes based on other operating principles also exist, such as the microchip-packaged MEMS gyroscopes found in electronic devices, solid-statering lasers, fibre optic gyroscopes, and the extremely sensitive quantum gyroscope.

Diagram of a gyro wheel. Reaction arrows about the output axis (blue) correspond to forces applied about the input axis (green), and vice versa.



A gyroscope is a wheel mounted in two or three gimbals, which are pivoted supports that allow the rotation of the wheel about a single axis. A set of three gimbals, one mounted on the other with orthogonal pivot axes, may be used to allow a wheel mounted on the innermost gimbal to have an orientation remaining independent of the orientation, in space, of its support. In the case of a gyroscope with two gimbals, the outer gimbal, which is the gyroscope frame, is mounted so as to pivot about an axis in its own plane determined by the support. This outer gimbal possesses one degree of rotational freedom and its axis possesses none. The inner gimbal is mounted in the gyroscope frame (outer gimbal) so as to pivot about an axis in its own plane that is always perpendicular to the pivotal axis of the gyroscope frame (outer gimbal). This inner gimbal has two degrees of rotational freedom.

Basic Accelerometer Operation:

Newton's Second law of motion says that the acceleration (m/s^2) of a body is directly proportional to, and in the same direction as, the net force (Newton) acting on the body, and inversely proportional to its mass (gram).

Mass (Kilogram) * Acceleration (m/s^2) = Force (Newton)

It is important to note that acceleration creates a force that is captured by the force-detection mechanism of the accelerometer. So the accelerometer really measures force, not acceleration; it basically measures acceleration indirectly through a force applied to one of the accelerometer's axes.

An accelerometer is also an electromechanical device, including holes, cavities, springs, and channels, that is machined using microfabrication technology. Accelerometers are fabricated in a multilayer wafer process, measuring acceleration forces by detecting the displacement of the mass relative to fixed electrodes.

Application of gyroscope sensor:

The gyroscope, or gyro for short, adds an additional dimension to the information supplied by the accelerometer by tracking rotation or twist. An accelerometer measures linear acceleration of movement, while a gyro on the other hand measures the angular rotational velocity.

Applications of gyroscopes include inertial navigation systems, such as in the Hubble telescope, or inside the steel hull of a submerged submarine. Due to their precision, gyroscopes are also used in gyrotheodolites to maintain direction in tunnel mining. Gyroscopes can be used toconstruct gyrocompasses, which complement or replace magnetic compasses (in ships, aircraft and spacecraft, vehicles in general), to assist in stability (bicycles, motorcycles, and ships) or be used as part of an inertial guidance system.

Implementations of Gyroscope Sense in Mobile App Development:

- Availability to trigger a number of preset events based on different set of motions by the user e.g. shaking the phone to lock
- A Camera App for picture and video capturing eradicating the effect of vibrations
- Auto rotation of the view when the Phone is rotated
- Angular motion in a Mobile Game by 3D motion of the device
- Smooth rotations and functional execution of various commands in the game by 3D Motion

CONCLUSION

MEMS accelerometer sensors and gyroscopes have long been used for a wide range of applications in shipping, space, industrial robotics, and automobiles. At present they may be in self driving cars/auto cars, which is the need of the day. But their application versatility has now spread to smart phones where they give us a new way to interface for motion and gestures with our smart device. Understanding MEMS behavior and the characteristics of an accelerometer or gyroscope allows designers to design more efficient and low-cost products for high-volume applications. These MEMS devices also allow us to create new applications that are profoundly changing how our movements, body motion, and gestures impact the way we live.

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HUMIDITY SENSORS

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Abstract:

In the broadest definition, a sensor is a device, module, or subsystem whose purpose is to detect events or changes in its environment and send the information to other electronics, frequently a computer processor. A sensor is always used with other electronics, whether as simple as a light or as complex as a computer**.**

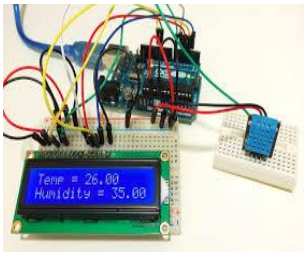
Sensors are used in everyday objects such as touch-sensitive elevator buttons (tactile sensor) and lamps which dim or brighten by touching the base, besides innumerable applications of which most people are never aware. With advances in micro machinery and easy-to-use microcontroller platforms, the uses of sensors have expanded beyond the traditional fields of temperature, pressure or flow measurement for example into MARG sensors. Moreover, analog sensors such as potentiometers and force-sensing resistors are still widely used. Applications include manufacturing and machinery, airplanes and aerospace, cars, medicine, robotics and many other aspects of our day-to-day life.

A sensor's sensitivity indicates how much the sensor's output changes when the input quantity being measured changes. For instance, if the mercury in a thermometer moves 1 cm when the temperature changes by 1 °C, the sensitivity is 1 cm/°C . Some sensors can also affect what they measure; for instance, a room temperature thermometer inserted into a hot cup of liquid cools the liquid while the liquid heats the thermometer. Sensors are usually designed to have a small effect on what is measured; making the sensor smaller often improves this and may introduce other advantages.[2] Technological progress allows more and more sensors to be manufactured on a microscopic scale as micro sensors using MEMS technology. In most cases, a micro sensor reaches a significantly higher speed and sensitivity compared with macroscopic approaches.

HUMIDITY SENSORS

Humidity Sensor is one of the most important devices that has been widely in consumer, industrial, biomedical, and environmental etc. applications for measuring and monitoring Humidity.

Humidity is defined as the amount of water present in the surrounding air. This water content in the air is a key factor in the wellness of mankind. For example, we will feel comfortable even if the temperature is 00C with less humidity i.e. the air is dry.

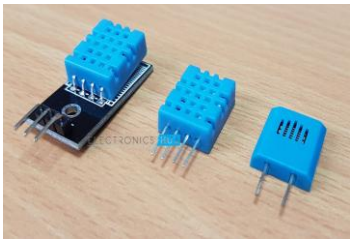


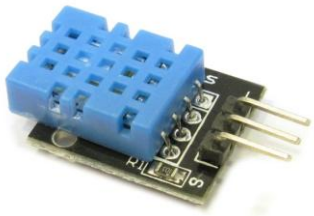
But if the temperature is 100C and the humidity is high i.e. the water content of air is high, then we will feel quite uncomfortable. Humidity is also a major factor for operating sensitive equipment like electronics, industrial equipment, electrostatic sensitive devices and high voltage devices etc. Such sensitive equipment must be operated in a humidity environment that is suitable for the device.

Moisture: Generally, the term Moisture means water content of any material or substance. But practically, the term Moisture refers to the water content in solids and liquids. The term Humidity refers to the water content in gases (air).

Absolute Humidity: Absolute Humidity (AH) is the ratio of mass of the water vapour to the volume of the air. If m is the mass of the water vapour and V is the total volume i.e. volume of air and water vapour mixture, then Absolute Humidity AH is given by

AH = m/V





Hence, sensing, measuring, monitoring and controlling humidity is a very important task. Some of the important areas of application for sensing, measuring and controlling Humidity are mentioned below.

WORKING:

Humidity sensors work by detecting changes that alter electrical currents or temperature in the air. There are three basic types of humidity sensors: capacitive, resistive and thermal. All three types of sensors monitor minute changes in the atmosphere in order to calculate the humidity in the air.

Capacitive: A capacitive humidity sensor measures relative humidity by placing a thin strip of metal oxide between two electrodes. The metal oxide's electrical capacity changes with the atmosphere's relative humidity. Weather, commercial and industries are the major application areas

Resistive: Resistive humidity sensors utilize ions in salts to measure the electrical impedance of atoms. As humidity changes, so does the resistance of the electrodes on either side of the salt medium.

APPLICATIONS IN VARIOUS FIELDS:

Domestic: Sensing and controlling humidity in our homes and offices is important as higher humidity conditions will affect the blood flow. Other areas include cooking, indoor plantation etc.

Industrial: In industries like refineries, chemical, metal, or other industries where furnaces are used, high humidity will reduce the amount of oxygen in the air and hence reduces the firing rate. Other industries like food processing, textile, paper etc. also need control of humidity.

Agriculture: Irrigation techniques like drip irrigation need accurate moisture content for plants. Also, the moisture in the soil plays an important role in the proper growth of the plant. Other areas where humidity control is required is indoor vegetation.

Electronics and Semiconductor: Almost all electronic devices are rated with a range of humidity values in which they work as expected. Generally, this value will be something like 10% – 50% Humidity. Semiconductor Fabs (Fabrication Plants) should maintain very precise temperature and humidity values as even minute difference can show a huge impact in the production.

Medical: Medical equipment like ventilators, incubators, sterilizers etc. need humidity control. It is also used in pharmaceutical plants and biological processes. All the above mentioned and many other applications need sensing of Humidity and is done using Humidity Sensors. Before discussing about Humidity Sensors, its types and working principle, we will first see some important terms and definitions related to Humidity.

CONCLUSION:

Tips on Humidity Sensor working

- Coulo metric: An electrolyte is formed by absorption of water resulting in a current level which is proportional to the moisture content in the air.
- Gravimetric: A drying agent is exposed to moist air, resulting in weight gain by the drying agent. The increased weight corresponds to the amount of moisture.
- Microwave/Infrared: A transmitted signal varies as the humidity increases. The attenuation is an indication of the moisture content in the medium.

- Humidity sensors may be used in steam bath kits, so that it human skin tolerable amount of steam may be maintained in the enclosure.

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ANTIMONY BORATE GLASS SYSTEM – AN OVER VIEW

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Abstract

The present paper reports an over view of antimony borate glass system collected from the available literature which is helpful for the upcoming researchers those who wants to synthesise this binary glass system (may be doped with transition metal ions or rare-earth ions) for various applications.

1. Introduction

Glass has been used by humans since the Stone Age. Obsidian a natural glass formed from the cooling of silica-rich lava can be fractured like flint to form extremely sharp edges, a property that was exploited for use in arrowheads and simple cutting tools. The earliest known man-made glasses originated in Egypt and Eastern Mesopotamia circa 3500 B.C. in the form of glass beads (possibly an unintended by product of other industry) and by c. 1500 B.C. craftsmen were able to produce glass pots and other vessels. The Romans later spread glass making technology throughout Western Europe and around the Mediterranean, and the use of glass for practical, artistic and architectural purposes grew and developed during the middle Ages and the Renaissance. It was not until the late 19th century, however, that scientific studies to relate the properties of a glass to its composition began in earnest; the effects of certain additives such as oxides of magnesium, calcium and lead had been known of for centuries, but were discovered empirically. Modern scientific interest in glass includes its applications in the field of laser optics and in the storage of nuclear waste.

1.1 Definition and properties

Silica, in the form of sand, is commonly regarded as a prerequisite for glass-making and many SiO_2 based glasses do exist; it is not, however, an essential component of a glass. In fact, a diverse array of chemical substances can be vitrified; materials are instead characterized as a glass based on their properties, rather than their composition. A solid is generally classed as a glass if it meets two criteria: it has no long-range order in its atomic arrangement, and it experiences a 'glass transformation region' (a time-dependent behaviour over a temperature range). Consider a liquid at a temperature above its melting point (Fig. 1). As the temperature is lowered, the enthalpy of the substance will gradually decrease and its atomic arrangement will slowly change, being at any point characteristic of the temperature of the melt. When the liquid is cooled below its melting point Tm it will usually experience an abrupt shift to a crystalline solid (with long-range atomic order) with a correspondingly sharp decrease in enthalpy. However, if the liquid can be cooled below the melting point without crystallization ('super-cooled') it will continue to exhibit a gradual decrease in enthalpy with temperature.

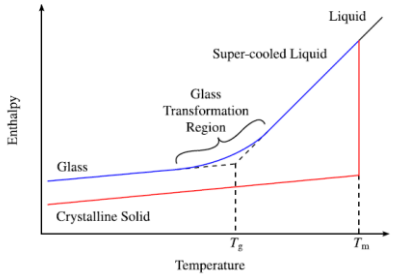

Figure 1 Thermodynamic diagram showing the changes in enthalpy of a glass-forming melt with temperature (blue line), as opposed to that of a normal liquid-solid transition (red line)

As cooling progresses, the viscosity of the liquid will increase; at some point the viscosity will be such that the atomic structure of the liquid will be unable to realign to the equilibrium arrangement for its temperature in the time available. This will cause the enthalpy of the system to lag from the equilibrium line until the point is reached where the viscosity prevents any further atomic rearrangement. In essence, the liquid has become an amorphous solid with no long-range order one of the conditions necessary for a material to be considered as a glass. In addition, the process of super-cooling has also fulfilled the second requirement: the temperature region that lies between the enthalpy being that of the equilibrium liquid and that of the frozen liquid is what is known as the glass transformation region.

1.2 An Introduction to Glass

As indicated in Figure 1, the glass transformation region exists over a range of temperatures. However, it is often useful to define a single glass transition temperature, T_g, as an indication of the onset of the glass transformation region upon heating the glass. This is defined empirically, and the value obtained for a given glass is dependent on several factors, including the rate at which the melt was originally cooled, the experimental method used to determine T_g and the heating rate applied. Hence, T_g should not be considered a true thermodynamic property, but is a useful indicator of when the transition between glass and super cooled liquid occurs. Another temperature often quoted is the crystallization temperature, T_c, which occurs after T_g and indicates the onset of crystallization of the devitrified material. The deference in magnitude between T_g and T_c can also be used as an indicator of the stability of the glass.

Finally, it should be noted that, whilst cooling of a melt is the most common method of glass-making, it is by no means the only way of doing so: chemical vapour deposition and sol-gel processing are examples of other such techniques.

1.3 Glass forming oxides

Silica (SiO_2) is one of a series of oxides known as glass formers (or network formers) that will readily form glasses in isolation other examples are B_2O_3, GeO_2 and P_2O_5. The cations in these oxides tend to form highly covalent bonds with oxygen, which has been shown to be a common property of glass formers. Oxides with cations whose oxygen bonding is more ionic in nature such as SeO_2, WO_3 and Al_2O_3 will not form a glass individually, but will do so when melted with a suitable quantity of a second oxide; these are termed intermediates or conditional glass formers. Finally, oxides with highly ionic bonds never form a glass, but can be used to affect the glass structure created from other glass formers these oxides are known as modifiers.

1.4 Simple structural theories of glass formation

Different chemical systems require specific cooling rates to be met or exceeded in order to form glasses. This fact has led to several attempts to produce a complete atomic theory of glass formation based on the nature of the chemical bonds and the shape of the structural units involved. Whilst it may seem strange to propose structural theories for a substance that is defined as having 'no long-range, periodic atomic ordering', it has been found to be possible to form reproducibly the same glass from a nominal starting composition, implying that there is some short-range ordering that is sufficient to control the overall properties.

1.5 Multi-component glasses

Whilst some substances form vitreous systems with relative ease (e.g. B_2O_3, P_2O_5), other, poorer glass formers (e.g. As_2O_3) require more extreme cooling rates for this to occur. As detailed above, glass structural theories require the formation of a continuous random network of atoms, as opposed to the ordered, repeating atomic arrangement in a crystal lattice this can be made to occur more readily in poor glass formers by adding a small amount of a contaminant. In terms of enthalpy, glasses are thermodynamically less favourable than the available crystalline modifications; however, their random structures are more entropic. The tradeoff between reducing the enthalpy and decreasing the entropy during crystallization is prevented by kinetic factors: once a super cooled liquid drops below T_g the activation energy necessary to re-form the structure is no longer present, and the atoms become locked in an amorphous arrangement. The ease with which a melt forms a crystal lattice is also affected by kinetics, since crystals form by a process of nucleation and growth.

The introduction of a contaminant increases the overall entropy of the system making it somewhat less thermodynamically favourable to form a crystal structure and hinders the kinetic realignment by providing more bonds to break and atoms to rearrange, frustrating crystal formation. Thus, the presence of a contaminant in a melt can substantially improve the glass-forming ability of a system. However, such impurities can also play a significant role in the properties of the glass formed. This is an important factor since not all contamination is intentional: for example, a melt may react with a certain crucible material and thus introduce impurities to the resultant glass. Another common contaminant is water which is difficult to regulate between preparations and can form hydroxyl groups in the glass structure.

Glass melts are cooled by a variety of techniques, depending on the glass to be formed and its stability; less stable glasses require more extreme cooling techniques. Splat-quenching (pressing the melt between two cooled metal plates), roller-quenching (pouring the melt between two counter-rotating cylinders) and melt-spinning (forcing a thin stream of melt onto a roller to quench, with the aid of high-pressure gas) are some examples, and other cooling rates of the order of 10^3, 10^5 and 10^8 $^{o}C\ s^{-1}$, respectively.

1.6 Lone-pair cations in glasses

Cations with a lone-pair of electrons that is, a pair of valence electrons that are more strongly bound to the nucleus and as such do not bond as easily with other atoms have been associated with non-linear optical properties in glasses. Lone-pairs have a strong steric influence that can alter the long range structure of a material, resulting in voids due to the volume excluded by the electron pair. However, the relationship between the effects of the lone-pair on the medium-range structure and the non-linear optical properties observed in the glass are not well understood. The lone pair influences the spatial arrangement of atoms in a molecule in a similar manner to a bonding-pair of electrons, although a model where the two are treated equivalently, such as that of Sidgwick and Powell, does not account for the bond angles observed in many lone-pair molecules, such as H_2O. Gillespie and Nyholm instead proposed a different model, where two bonding-pairs repelled each other less than a lone-pair and a bonding-pair, which in turn experienced less repulsion than two lone-pairs. This theory resulted in more accurate predictions of molecular bond angles, and with further refinement resulted in the Valence Shell Electron Pair Repulsion (VSEPR) model.

A glass can be considered as the result of lowering the temperature of a super cooled liquid to the point at which it becomes too viscous to reach an equilibrium state for its temperature; in other words, at the point where the energy of the system is insufficient to allow a thermodynamically favourable drop in enthalpy to occur kinetically. The resulting amorphous structure can be modelled as a continuous random network, with no long-range periodic ordering, although short range atomic alignments characteristic of the material still exist and regulate the properties of the glass. The ability of a substance to form a glass, either in isolation or when mixed with another compound, allows it to be classified as a glass-former, intermediate or modifier. The ease with which a glass-former can be used to create a vitreous system can be improved by the addition of one or more modifiers (or contaminants), although this can also affect the properties of the resultant glass. The lone-pair of electrons on certain cations can exert a strong steric influence that affects the structure of a material and, in the case of a glass, can lead to interesting properties. Antimony trioxide contains such lone-pair cations and has been reported to readily form a glass in combination with another oxide. This work will use neutron diffraction and other methods to investigate several Sb_2O_3 based glasses, with the aim of characterizing the behaviour of Sb_2O_3 in a glass network.

2. Antimony glass

Antimony oxide exists in several forms, including antimony trioxide (Sb_2O_3), antimony tetroxide (Sb_2O_4) and antimony pentoxide (Sb_2O_5). Of these, Sb_2O_3 occurs as cubic and orthorhombic polymorphs (senarmontite and valentinite, respectively), with the latter being the stable form at higher temperatures, whilst Sb_2O_4 can be monoclinic (clinocervantite) or, more commonly, orthorhombic (cervantite), and Sb_2O_5 has only been reported to have a single, monoclinic structure. Antimony tetroxide is a mixed valency compound, containing both Sb^{3+} and Sb^{5+} ions in equal proportions in its crystal lattice. It is worth noting that the 'molecular' structure of senarmontite (Fig.2) does not appear to lend itself to glass formation when compared with the 'double-chain'

structure of valentinite (Fig.3) which can be expected to form the 'continuous random network outlined by Zachariasen with greater ease. Antimony trioxide (Sb_2O_3) was predicted to be a glass-former by Zachariasen and contains the lone-pair cation Sb^{3+} (antimony can also occur in the oxidation state Sb^{5+}).

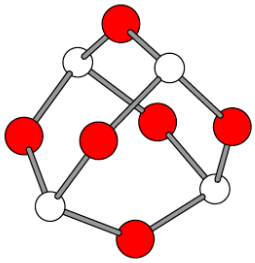

Fig.2

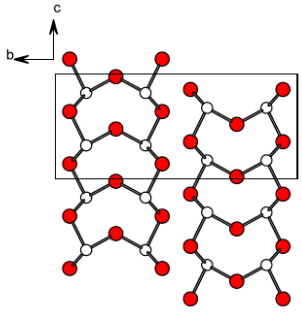

Fig.3

3. Antimony borate glasses

The antimony borate glass system has been the subject of several studies in the literature, with x Sb_2O_3 (1- x) B_2O_3 glasses reported to form across the entire compositional range. This makes the system a desirable one to exploit for non-linear optical applications. Numerous authors have reported methods of preparing antimony borate glasses: these typically involve melting at 800 ^{o}C in silica or platinum crucibles for ~20 minutes before splat-quenching between steel or copper plates; some authors report using higher temperatures, or less extreme quenching methods. Youngman et al. report SiO_2 contamination which they attribute to the silica crucibles used for the melt it seems likely that this is also the case for the other authors who reported SiO_2 content or who used such crucibles.

There is a general consistency in the densities that have been reported for the various antimony borate glasses (Fig. 4) the only notable exceptions are some of the values reported by Terashima et al. In that work, only the nominal batch compositions are listed for the samples, and so the discrepancies may be due to the quenched glasses having slightly different compositions.

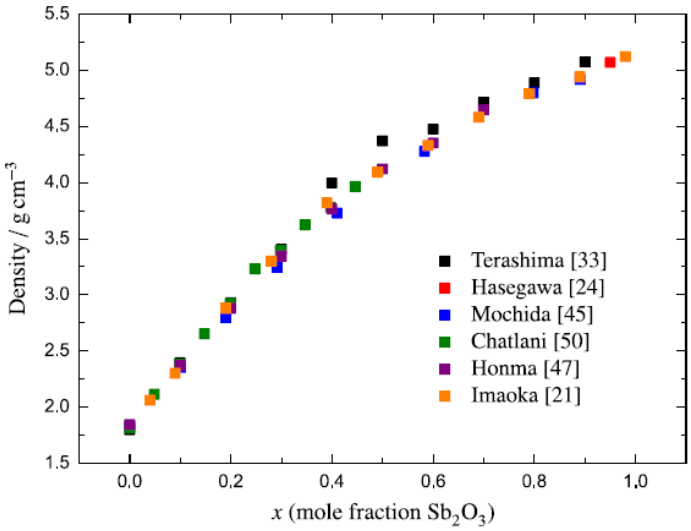

Figure 4 The densities reported for the antimony borate glass system by various authors [12, 13, 14, 15, 16, 21]

The glass transformation temperatures exhibit much greater disagreement (Fig. 5). From the majority of the results reported, there appears to be a maximum T_g at x = 0:3, although the data of Holland et al. appears to indicate that a value at significantly higher x would be appropriate. Nevertheless, the error range reported

would include a curve of similar shape to the other authors, suggesting that the data is insufficiently accurate to draw conclusions as to a maximum in T_g. The value of T_g for x = 0:7 reported by Holland et al. remains anomalous however, as do the lower values of T_g (by 15 °C to 20 °C) reported by Honma et al.

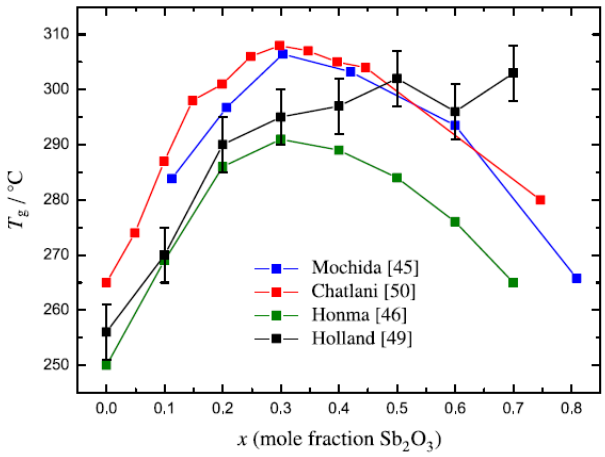

Figure 5 Values of T_g for the antimony borate glass system,
as measured by various authors [15, 17, 20, 21]

Several authors have reported 11B magic angle spinning nuclear magnetic resonance (MAS NMR) data, which they used to estimate the fraction of four coordinated boron, N4, that was present in the glass samples. These estimates (Fig. 6) show a good agreement, with the small discrepancies probably attributable to differences in sample preparation, as noted by Holland et al.

In a much earlier paper, Mochida and Takahashi had observed from the analysis of Raman spectra that there was evidence of an increase in boron coordination with increasing Sb_2O_3 content, but that this effect was relatively small compared with that in the bismuth borate system also studied (the Raman technique was not able to provide quantitative information): this is consistent with the observation of Holland et al. that the values of N_4 for the antimony borate system are unusually low for a binary borate glass. The consensus in the literature is that the short-range structure of the glass is based on the chains of trigonal [SbO_3] pyramids found in valentinite. Common justifications are the low viscosity of the glass melt, suggesting a layer or chain like structure, and the Sb-O bond length of ~1.97 together with a coordination of 3 or slightly higher (from X-ray diffraction or EXAFS, implying the basic structural unit to be the [SbO_3] trigonal pyramid.

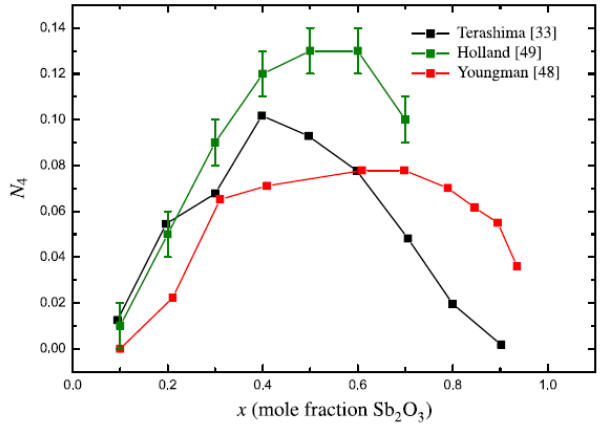

Figure 6 Values of N_4 reported in the literature for the
antimony borate system [14, 19, 20]

Authors have also published infra-red and Raman data supporting a chain-like structure, as well as reporting the glass crystallizing to valentinite, and observing quadrupole splitting in Mossbauer spectra that suggests that the [SbO_3] trigonal pyramid is the basic structural unit. Hasegawa et al. also compared the correlation function that they obtained to various models and concluded that the disorder in the structure probably arose from a small number of [SbO_3] pyramids turned over irregularly within the chains. In addition to the aforementioned EXAFS work, Youngman et al. also conducted a Raman study that showed evidence of a number of boroxol rings that decreased with increasing x, appearing to reach zero at x = 0:6, together with a small amount of four co-ordinated boron (although note that Raman spectroscopy is not quantitative). They concluded that the structure is predominantly a corner-sharing network of [SbO_3] trigonal pyramids and [BO3] planar triangles the formation of [BO_4] species then requires the presence of three-fold coordinated oxygen, as noted by Terashima et al. However, Holland et al. associated the formation of [BO_4] with the presence of Sb^{5+}, with experimental data showing good agreement with the amount of the latter present in the samples, at least up to x = 0:5.

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MICROCONTROLLER BASED SEQUENTIAL TIMER FOR DC MOTOR CONTROL.

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ABSTRACT
In most of the manufacturing industries, it is required to rotate DC motor forward and reverse alternatively for desired time. First motor rotates forward (clockwise) for some time (say few minutes or even seconds). Then it stops for some time. Again it rotates reverse (anticlockwise) for some time and stops. This process continues. For example, in automated bottle filling plant, the bottles are moving on conveyor belt. When it comes under filler, the filler comes down (that means motor attached with mechanism rotates forward) then it fills the bottle (that means motor stops) again it goes up (motor rotates reverse) and stops until next bottle arrives. For moving filler up and down the time of rotating motor forward and reverse is calibrated and fixed. Also the motor stop time is calibrated based on time required to fill the bottle and the next bottle arrives.
Dc motor is controlled by sequential timer. Sequential timer circuit operates different processes one after another - means one process ends and it triggers next. The last process triggers first process when it ends. And thus the cycle continues. These sequence timers are micro controller based multi-functional and programmable. So operation time of each process can be programmed.
Key Words : micro controller , programmable.

INTRODUCTION :

A **microcontroller** is a small computer on a single integrated circuit. Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, toys and other embedded systems. By reducing the size and cost compared to a design that uses a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to digitally control even more devices and processes. Mixed signal microcontrollers are common, integrating analog components needed to control non-digital electronic systems.

DESCRIPTION OF 89S52:

The 89S52 has 4 different ports, each one having 8 Input/output lines providing a total of 32 I/O lines. Those ports can be used to output DATA and orders do other devices, or to read the state of a sensor, or a switch. Most of the ports of the 89S52 have 'dual function' meaning that they can be used for two different functions. The first one is to perform input/output operations and the second one is used to implement special features of the microcontroller like counting external pulses, interrupting the execution of the program according to external events, performing serial data transfer or connecting the chip to a computer to update the software. Each port has 8 pins, and will be treated from the software point of view as an 8-bit variable called 'register', each bit being connected to a different Input/Output pin.

- **Micro-controller 89S52:** It controls entire system by performing following tasks
- Accepts user inputs from push buttons to program DC motor running and stop timings
- Runs DC motor forward and reverse through driver circuit
- Shows different indication on indicators
- Displays different messages on LCD for time setting. It also displays remaining time for ongoing process

LED Indicators: They indicates motor is running forward or reverse, motor is stop etc

LCD Panel:

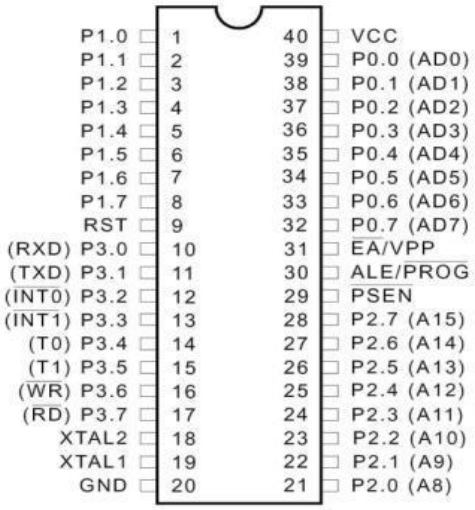
It is used to display text, messages, time settings, time countdown etc

LED interfacing is the first thing, one would try to do while getting started with any microcontroller. So here in this tutorial we are going to **interface a LED with 8051 microcontroller**, and will write a C Program

to blink the LED. We have used a very popular **microcontroller AT89S52**, of 8051 family, by ATMEL.

PIN CONFIGURATION:

Before going in to the details,we should get some brief idea about microcontroller AT89S52 .it is 40 pin microcontroller and has 4 ports(P0,P1,P2,P3) and each port have 8 pins.we can consider each port as 8 bit registers,from the software point of view.Each pin having one input/output line ,means every pin can be used as input/output line.i.e. to read data from some devices like sensors or to provide its output to some output device.some pin has dualfunctionality,which has been mentioned in pin diagram.as seem below



VCC Supply voltage.

GND Ground.

Port 0: Port 0 is an 8-bit open drain bidirectional I/O port. As an output port, each pin can sink eight TTL inputs. When 1s are written to port 0 pins, the pins can be used as highimpedance inputs. Port 0 can also be configured to be the multiplexed loworder address/data bus during accesses to external program and data memory. In this mode, P0 has internal pullups. Port 0 also receives the code bytes during Flash programming and outputs the code bytes during program verification. External pullups are required during program verification.

Port 1: Port 1 is an 8-bit bidirectional I/O port with internal pullups. The Port 1 output buffers can sink/source four TTL inputs. When 1s are written to Port 1 pins, they are pulled high by the internal pullups and can be used as inputs. As inputs, Port 1 pins that are externally being pulled low will source current (IIL) because of the internal pullups. In addition, P1.0 and P1.1 can be configured to be the timer/counter 2 external count input (P1.0/T2) and the timer/counter 2 trigger input (P1.1/T2EX), respectively, as shown in the following table. Port 1 also receives the low-order address bytes during Flash programming and verification. ddress during accesses to external memory. ALE is emitted at a constt rate of 1/6 of the oscillator frequency, for external timing or clo

Port Pin	Alternate Functions
P1.0	T2 (external count input to Timer/Counter 2), clock-out
P1.1	T2EX (Timer/Counter 2 capture/reload trigger and direction control)
P1.5	MOSI (used for In-System Programming)
P1.6	MISO (used for In-System Programming)
P1.7	SCK (used for In-System Programming)

Port 2: Port 2 is an 8-bit bidirectional I/O port with internal pullups. The Port 2 output buffers can sink/source four TTL inputs. When 1s are written to Port 2 pins, they are pulled high by the internal pullups and can be used as inputs. As inputs, Port 2 pins that are externally being pulled low will source current (IIL) because of the internal pullups. Port 2 emits the high-order address byte during fetches from external program memory and during accesses toexternal data memory that use 16-bit addresses (MOVX @ DPTR). In this application, Port 2 uses strong internal pullups when emitting 1s. During accesses to external data memory that use 8-bit addresses (MOVX @ RI), Port 2 emits the contents of the P2 Special Function Register. Port 2 also receives the high-order address bits and some control signals during Flash programming and verification

Port 3

Port 3 is an 8-bit bidirectional I/O port with internal pullups. The Port 3 output buffers can sink/source four TTL inputs. When 1s are written to Port 3 pins, they are pulled high by the internal pullups and can be used as inputs. As inputs, Port 3 pins that are externally being pulled low will source current (IIL) because of the pullups. Port 3 also serves the functions of various special features of the AT89S52, as shown in the following table. Port 3 also receives some control signals for Flash programming and verification.**:** Program Store Enable is t not activated when the device is executing out of internal Program

Port Pin	Alternate Functions
P3.0	RXD (serial input port)
P3.1	TXD (serial output port)
P3.2	INT0 (external interrupt 0)
P3.3	INT1 (external interrupt 1)
P3.4	T0 (timer 0 external input)
P3.5	T1 (timer 1 external input)
P3.6	WR (external data memory write strobe)
P3.7	RD (external data memory read strobe)

Memory

ERST:

Reset input. A high on this pin for two machine cycles while the oscillator is running resets the device. This pin drives High for 96 oscillator periods after the Watchdog times out. The DISRTO bit in SFR AUXR (address 8EH) can be used to disable this feature. In the default state of bit DISRTO, the RESET HIGH out feature is enabled.**/VPP:** When EA is held high the CPU executes out of internal Program Memory (unless the **ALE/PROG8** Address Latch Enable (ALE) is an output pulse for latching the low byte of the address during accesses to external memory. This pin is also the program pulse input (PROG) during Flash programming. In normal operation, ALE is emitted at a constant rate of 1/6 the oscillator frequency and may be used for external timing or clocking purposes. Note, however, that one ALE pulse is skipped during each access to

external data memory. If desired, ALE operation can be disabled by setting bit 0 of SFR location 8EH. With the bit set, ALE is active only during a MOVX or MOVC instruction. Otherwise, the pin istweakly pulled high. Setting the ALE-disable bit has no effect if the microcontroller is in external execution mode.i

PSENr

Program Store Enable (PSEN) is the read strobe to external program memory. When the AT89S52 is executing code from external program memory, PSEN is activated twice each machine cycle, except that two PSEN activations are skipped during each access to external data memory.

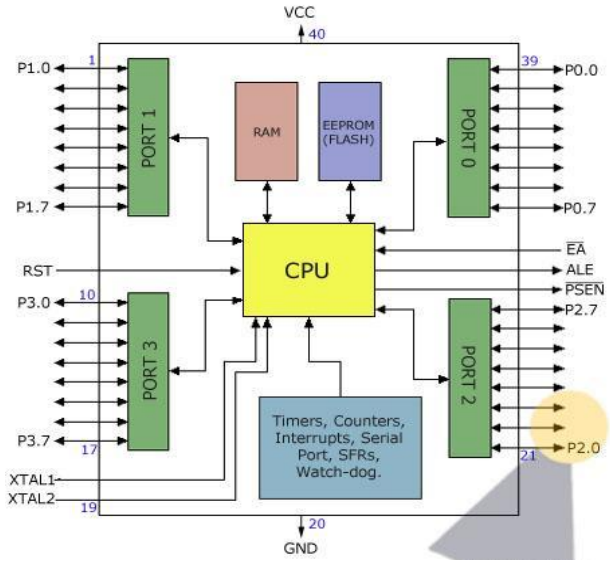
EA/VPP

External Access Enable. EA must be strapped to GND in order to enable the device to fetch code from external program memory locations starting at 0000H up to FFFFH .Note, however, that if lock bit 1 is programmed, EA will be internally latched on reset. EA should be strapped to VCC for internal program executions. This pin also receives the 12-volt programming enable voltage (VPP) during Flash programming

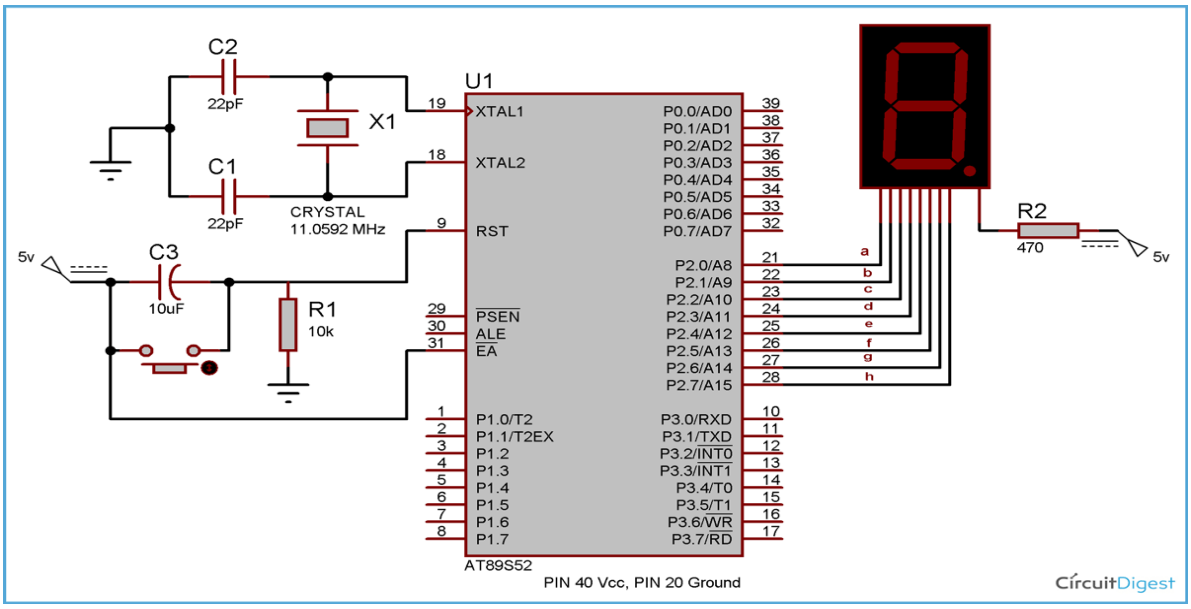
XTAL1: Input to the inverting oscillator amplifier and input to the internal clock operating circuit**.**

XTAL2: Output from the inverting oscillator amplifier.

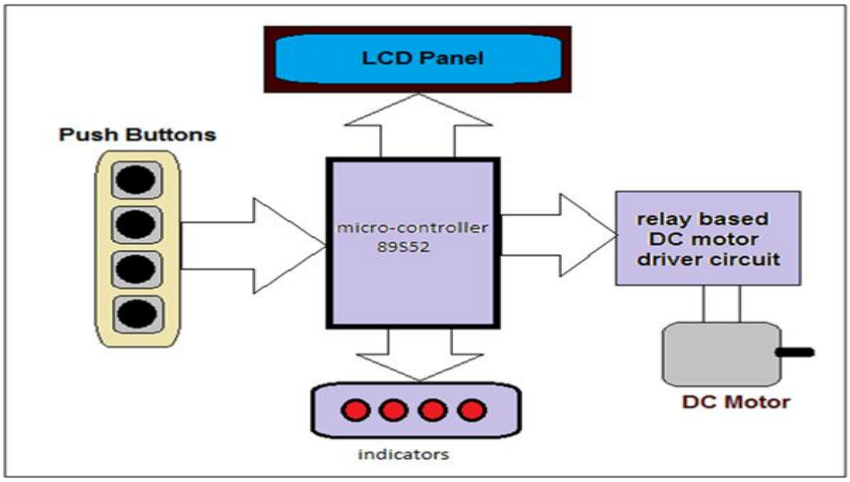
BLOCK DIAGRAM:



.Circuit Diagram



Relay based motor driving circuit: The motor runs – stops and it is rotated forward and reverse through relays. The relay contact connections are made such a way that as they switched ON/OFF the motor runs or stops and even alters its direction.



Push buttons: - the circuit requires only 4 push buttons for different settings and user inputs

S no	Button name	Function
1	start	To start rotating motor
2	Increase time	Increase time set by 1 sec – up to 60 sec
3	Decrease time	Decrease time set by 1 sec – up to 1 sec

SEQUENTIALTIMER:

Such motion of motor is controlled by sequential timer. Sequential timer circuit operates different processes one after another - means one process ends and it triggers next. The last process triggers first process when it ends. And thus the cycle continues. These sequence timers are micro controller based multi-functional and programmable. So operation time of each process can be programmed.

Some of the features of this project are

- 8-bit micro controller based fully programmable
- Process time can be set from 0 to 60 seconds
- LCD panel for display
- Timings can be set for 4 different process
- Can control 24 V DC motor or 230 V AC motor
- Push buttons for user interface
- User selectable single cycle or continuous operation
- LEDs for indications

CONCLUSION

The Dc motor sequential timer are used in industrial and agriculture purpose. Sequence timers are micro controller based multi-functional and programmable. this is may be one of the application of speed controller.

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8051- STEPPER MOTOR

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Abstract

A precision stepper motor controller capable of both independent and synchronized control of a multiple number of stepper motors is discussed. The controller is built around a 16-bit microprocessor to provide fast and reliable control operations. In addition, micro stepping techniques are used to achieve high resolution electronically and to suppress mechanical resonance. The controller also includes two output ports. Such a controller has wide applications in manufacturing. For instance, it can be used to control a robot having multiple degrees of freedom.

The controller was tested with a simultaneous control (synchronous) of two stepper motors for precision trajectory control applications. Stepper motors are being used more often these days for various applications because they are economical and easy to control. They have become easy to control because of the emergence of various low cost microcontrollers which can be programmed to control them. This has enabled stepper motors to be controlled with more flexibility and versatility for various applications. The reason stepper motors are becoming more prevalent is because of their ease of interfacing with digital components.

A stepper motor moves one step for every pulse given to it. This enables open loop control of the position of the stepper motor. Unlike in other AC or DC motors, stepper motors do not need closed loop systems for position control. Also, since a stepper motor requires digital control pulses, there is no need for analog to digital conversion circuitry usually required for AC and DC motors. This makes Stepper Motors very economical and easy to control. The objective of the project is to design and develop microcontroller based Stepper Motor controller for speed and position control, that will smoothly control the rotation of a stepper motor, taking into account the physical constraints on the maximum operating speed of the motor.

Introduction to Stepper Motor

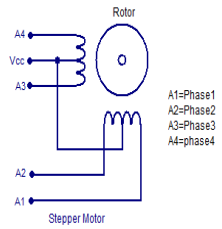
An Automatic railway gate control at unmanned level crossings replacing the gates operated by gate keepers and also the semi automatically operated. It deals with two things.

Firstly deals with the reduction of time for which the gate being kept closed.

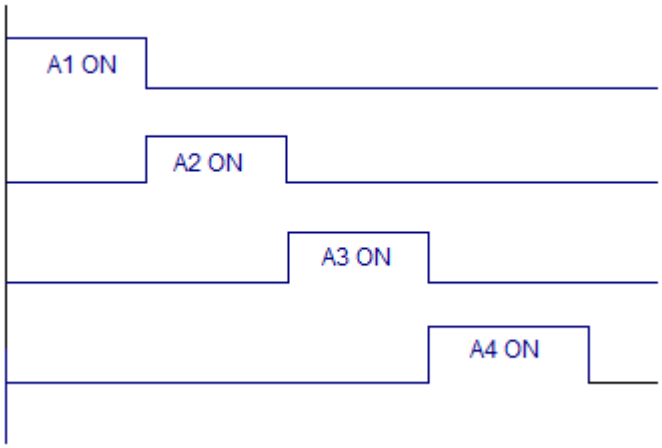
And, secondly to provide safety road users by reducing the accidents that usually occur due to carelessness of road users and at times error made by the gate keepers.

Stepper motor is a brush less motor which converts electrical pulses into mechanical rotation. As the name indicates it rotates in steps according to the input pulses. A stepper motor usually have a number of field coils (phases) and a toothed rotor. The step size of the motor is determined by the number of phases and the number of teeth on the rotor. Step size is the angular displacement of the rotor in one step. If a stepper motor has 4 phases and 50 teeth, it takes 50×4=200 steps to make one complete rotation. So step angle will be 360/200=1.8°.

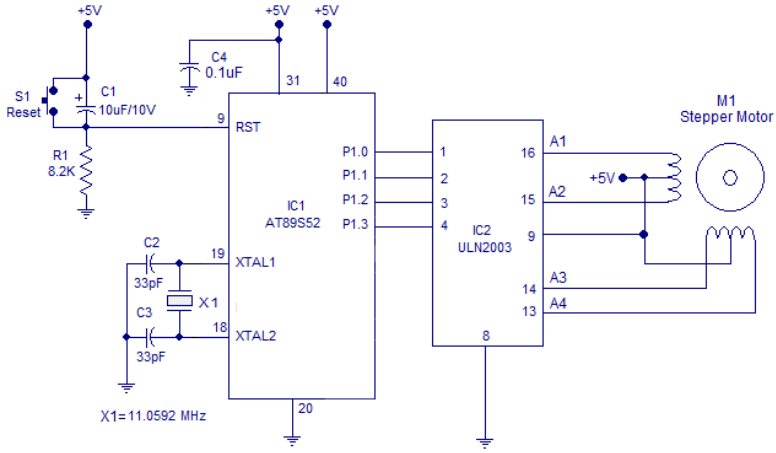
The stepper motor we are using has 4 poles and a 1/64 reduction gear mechanism for increasing torque. The step angle of the motor is 5.64°. But when considering the reduction gear, the step angle of the output shaft is 5.64/64°. The internal schematic of the stepper motor is given below.



The stepper motor is rotated by switching individual phases ON for a given time one by one. The sequence is given in the graph below.



Circuit diagram.



The circuit diagram for interfacing stepper motor to 8051 is shown above. P1.0, P1.1, P1.2 and P1.3 pins are used for controlling the phases A1, A2, A3 and A4 of the stepper motor respectively. ULN2003 is used for driving the individual phases of the stepper motor. ULN2003 is a Darlington transistor array used for driving high current loads such as relays and motors. ULN2003 has 8 individual channels each with 1A capacity. The channels can be paralleled to increase the current capacity. Each channels are fitted with individual freewheeling diodes. The ULN2003 is operated in current sinking mode. Each channel is activated by giving a logic LOW at the corresponding input.

A stepper motor is an electromechanical device it converts electrical power into mechanical power. Also it is a brushless, synchronous electric motor that can divide a full rotation into an expansive number of steps. The motor's position can be controlled accurately without any feedback mechanism, as long as the motor is carefully sized to the application. Stepper motors are similar to switched reluctance motors.

The stepper motor uses the theory of operation for magnets to make the motor shaft turn a precise distance when a pulse of electricity is provided. The stator has eight poles, and the rotor has six poles. The rotor will require 24 pulses of electricity to move the 24 steps to make one complete revolution. Another way to say this is that the rotor will move precisely 15° for each pulse of electricity that the motor receives.

Types of Stepper Motor:

There are three main types of stepper motors, they are:

Permanent magnet stepper

Hybrid synchronous stepper

Variable reluctance stepper

Permanent Magnet Stepper Motor:

Permanent magnet motors use a permanent magnet (PM) in the rotor and operate on the attraction or repulsion between the rotor PM and the stator electromagnets.

Hybrid Synchronous Stepper Motor:

Hybrid stepper motors are named because they use a combination of permanent magnet (PM) and variable reluctance (VR) techniques to achieve maximum power in a small package size.

Variable Reluctance Stepper Motor:

Variable reluctance (VR) motors have a plain iron rotor and operate based on the principle that minimum reluctance occurs with minimum gap, hence the rotor points are attracted toward the stator magnet poles.

Advantages of Stepper Motor:

- The rotation angle of the motor is proportional to the input pulse.
- The motor has full torque at standstill.
- Precise positioning and repeatability of movement since good stepper motors have an accuracy of 3 – 5% of a step and this error is non cumulative from one step to the next.
- Excellent response to starting, stopping and reversing.
- Very reliable since there are no contact brushes in the motor. Therefore the life of the motor is simply dependant on the life of the bearing.
- The motors response to digital input pulses provides open-loop control, making the motor simpler and less costly to control.
- It is possible to achieve very low speed synchronous rotation with a load that is directly coupled to the shaft.
- A wide range of rotational speeds can be realized as the speed is proportional to the frequency of the input pulses.

Applications:

- Industrial Machines – Stepper motors are used in automotive gauges and machine tooling automated production equipments.
- Security – new surveillance products for the security industry.
- Medical – Stepper motors are used inside medical scanners, samplers, and also found inside digital dental photography, fluid pumps, respirators and blood analysis machinery.
- Consumer Electronics – Stepper motors in cameras for automatic digital camera focus and zoom functions.
- And also have business machines applications, computer peripherals applications.

Operation of Stepper Motor:

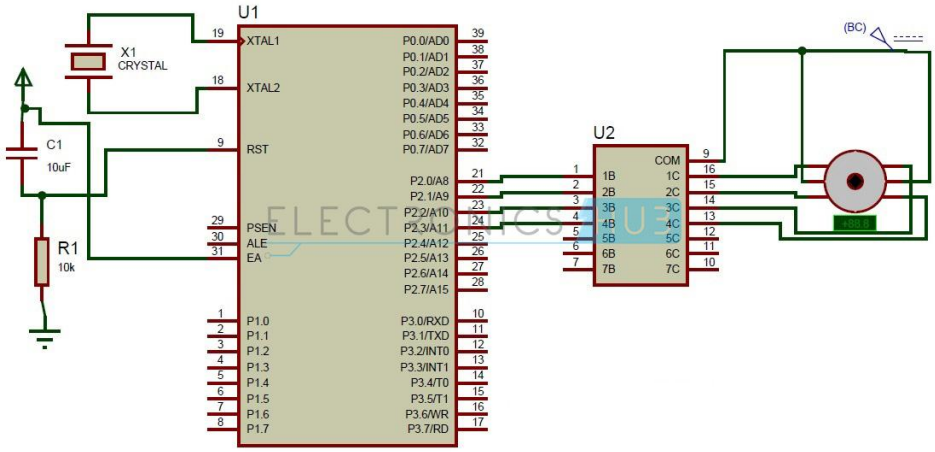
Stepper motors operate differently from DC brush motors, which rotate when voltage is applied to their terminals. Stepper motors, on the other hand, effectively have multiple toothed electromagnets arranged

around a central gear-shaped piece of iron. The electromagnets are energized by an external control circuit, for example a microcontroller.

Stepper Motor Control using 8051 Microcontroller Circuit Diagram:

Circuit Diagram of Stepper Motor Control using 8051 Microcontroller

To make the motor shaft turn, first one electromagnet is given power, which makes the gear's teeth magnetically attracted to the electromagnet's teeth. The point when the gear's teeth are thus aligned to the first electromagnet, they are slightly offset from the next electromagnet. So when the next electromagnet is turned ON and the first is turned OFF, the gear rotates slightly to align with the next one and from there the process is repeated. Each of those slight rotations is called a step, with an integer number of steps making a full rotation. In that way, the motor can be turned by a precise. Stepper motor doesn't rotate continuously, they rotate in steps. There are 4 coils with 90o angle between each other fixed on the stator. The stepper motor connections are determined by the way the coils are interconnected.



In stepper motor, the coils are not connected together. The motor has 90o rotation step with the coils being energized in a cyclic order, determining the shaft rotation direction. The working of this motor is shown by operating the switch. The coils are activated in series in 1 sec intervals. The shaft rotates 90o each time the next coil is activated. Its low speed torque will vary directly with current.

Stepper Motor using ULN2003 and 8051 Microcontroller

ULN2003 is high voltage, high current Darlington arrays each containing seven open collector Darlington pairs with common emitters. Here it is used as a current driving IC. This IC is required because stepper motor require more than 60mA current and since controller doesn't work at this current rating so this IC provides high current to the stepper motor.

In the circuit port P2 as output port which provide input sequence to four input pins of ULN3003 and output of ULN2003 drives the motor.

Input sequences are same as in previous project which are

Simplest sequence

0001

0010

0100

1000

And for half step size

0001

0011

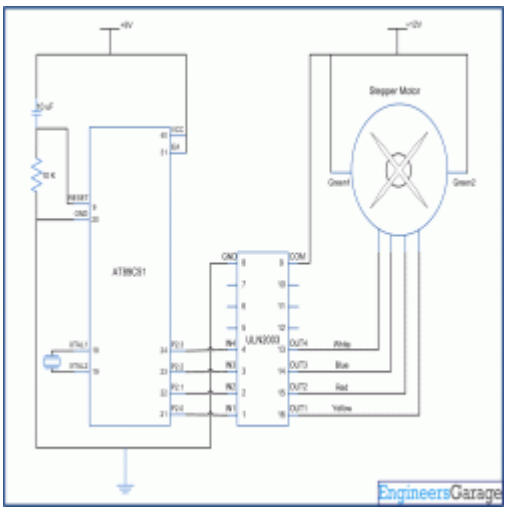
0010

0110

0100

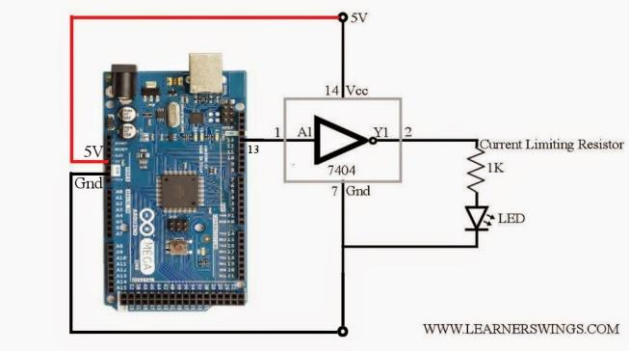
1100
1000
1001

Circuit Diagram for ULN 2003



SN7404 Microcontroller

Controlling 7404 using Adriano is more simple. Circuit is done as shown in the following diagram. An Adriano mega is used to control 7404. 5V for IC is supplied from the 5V pin of Arduino Mega. Ground is given to the, GND pin of Adriano. Output is connected to an LED through a current limiting resistor to protect LED from over current. Pull down resistor is not needed in this circuit because, when the Adriano digital pin outputs LOW, voltage level at this digital pin will be less than 2V which will give LOW voltage at the NOT gate input. But in switch controlling of 7404 , must be connected.

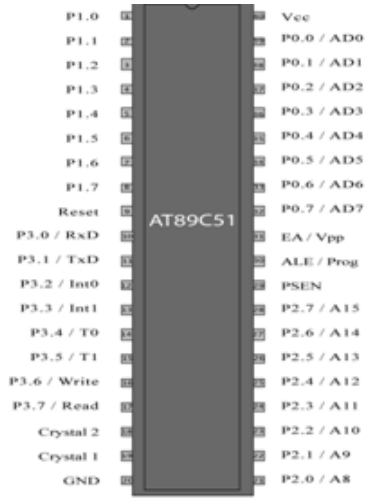


ATMEL 89C51 AN 8051 Family Controller

40 Pin AT89C51, there are four ports designated as P1, P2, P3 and P0. All these ports are 8-bit bi-directional ports, i.e., they can be used as both input and output ports. Except P0 which needs external pull-ups, rest of the ports have internal pull-ups. When 1s are written to these port pins, they are pulled high by the internal pull-ups and can be used as inputs. These ports are also bit addressable and so their bits can also be accessed individually.

Port P0 and P2 are also used to provide low byte and high byte addresses, respectively, when connected to an external memory. Port 3 has multiplexed pins for special functions like serial communication, hardware interrupts, timer inputs and read/write operation from external memory. AT89C51 has an inbuilt UART for serial communication. It can be programmed to operate at different baud rates. Including two timers & hardware interrupts, it has a total of six interrupts.

Pin Diagram:



Pin Description:

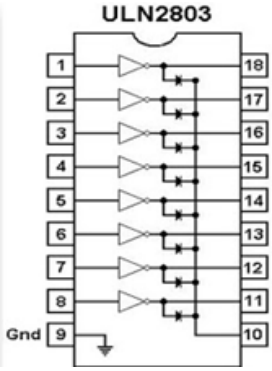
Pin No	Function			Name
1	8 bit input/output port (P1) pins			P1.0
2				P1.1
3				P1.2
4				P1.3
5				P1.4
6				P1.5
7				P1.6
8				P1.7
9	Reset pin; Active high			Reset
10	Input (receiver) for serial communication	RxD	8 bit input/output port (P3) pins	P3.0
11	Output (transmitter) for serial communication	TxD		P3.1
12	External interrupt 1	Int0		P3.2
13	External interrupt 2	Int1		P3.3
14	Timer1 external input	T0		P3.4
15	Timer2 external input	T1		P3.5
16	Write to external data memory	Write		P3.6
17	Read from external data memory	Read		P3.7
18	Quartz crystal oscillator (up to 24 MHz)			Crystal 2
19				Crystal 1
20	Ground (0V)			Ground
21	8 bit input/output port (P2) pins High-order address bits when interfacing with external memory			P2.0/ A8
22				P2.1/ A9
23				P2.2/ A10
24				P2.3/ A11
25				P2.4/ A12
26				P2.5/ A13
27				P2.6/ A14
28				P2.7/ A15

29	Program store enable; Read from external program memory	PSEN
30	Address Latch Enable	ALE
	Program pulse input during Flash programming	Prog
31	External Access Enable; Vcc for internal program executions	EA
	Programming enable voltage; 12V (during Flash programming)	Vpp
32	8 bit input/output port (P0) pins Low-order address bits when interfacing with external memory	P0.7/ AD7
33		P0.6/ AD6
34		P0.5/ AD5
35		P0.4/ AD4
36		P0.3/ AD3
37		P0.2/ AD2
38		P0.1/ AD1
39		P0.0/ AD0
40	Supply voltage; 5V (up to 6.6V)	Vcc

ULN 2803 for Driving Stepper Motor

ULN 2803 to control 2 stepper motors, and the input to the IC is directly from an I/O port on an 8051 microcontroller.

The stepper motors are 24V, and "apparently" need 800mA each to operate. Also, the circuits I have seen use a Zener diode on the power input to the uln2803, usually slightly higher voltage than the motors require. Apparently this protects back emf. Also, the circuits I have seen use a Zener diode on the power input to the uln2803, usually slightly higher voltage than the motors require. Apparently this protects back emf. Basically I have a 27V, 1.3W zener diode, and i do not want to blow the IC up with too large a current or something.



Conclusion:

- Hence the unmanned railway gates operate according to data input from sensors to microcontroller.
- First an alam is triggered and then the gate is operated.

Specifications:

- ❖ Mechanical gate arrangement
- ❖ Atmel 89C51 an 8051 family microcontroller
- ❖ SN 7404 for microcontroller interfacing
- ❖ IR sensors for sensing train
- ❖ Stepper motor to operate gates
- ❖ ULN 2803 for driving Stepper motor.

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DIFFERENT TYPES OF SENSORS

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Abstract:

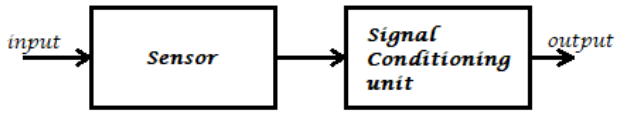
An up-to-date review paper on sensors is presented. Attention is focused on sensors used in production of automatic systems. The primary sensor technologies in use today are home appliances, industry and scientific research. This subject is extensive. In brief, there are six types of rotational motion sensors, four types of pressure sensors, five types of position sensors, and three types of temperature sensors. Additionally, two types of mass air flow sensors, five types of exhaust gas oxygen sensors, four types of linear acceleration sensors, four types of angular-rate sensors, four types of occupant comfort/convenience sensors, two types of near-distance obstacle detection sensors, four types of far-distance obstacle detection sensors, and ten types of sensors are emerging every day.

Introduction

The era of automation has begun already. Most of the things that we use now can be automated. To design automated devices first we need to know about the sensors, these are the modules/devices which are helpful in making things done without human intervention. Even the mobiles or smart phones which we daily use will have some sensors like hall sensor, proximity sensor, accelerometer, touch screen, microphone etc. These sensor acts as eyes, ears, nose of any electrical equipment which senses the parameters in outside world and give readings to devices or Microcontroller.

What is a sensor?

The sensor may be defined as a device which can be used to sense/detect the physical quantity like force, pressure, strain, light etc and then it can be converted it into desired electrical signal to measure the applied physical quantity. In few cases, a sensor alone may not be sufficient to analyze the obtained signal. In those cases, a signal conditioning unit is used in order to maintain sensor's output voltage levels in the desired range with respect to the end device that we use.



In signal conditioning unit, the output of the sensor may be amplified, filtered or modified to the desired output voltage. For example, if we consider a microphone it detects the audio signal and converts to the output voltage (in millivolts) which becomes hard to drive an output circuit. So, a signal conditioning unit (an amplifier) is used to increase the signal strength. But the signal conditioning may not be necessary for all the sensors like photodiode, LDR etc.

Most of the sensors can't work independently. So, sufficient input voltage should be applied to it. Various sensors have different operating ranges which should be considered while working with it else the sensor may get damaged permanently.

Types of Sensors: There are different types of sensors available in the market. Their functionality, working, applications etc are briefly studied in the present paper.

Light Sensor

IR Sensor (IR Transmitter / IR LED)

Photodiode (IR Receiver)

Light Dependent Resistor

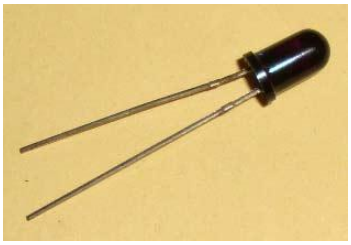
Temperature Sensor
Thermistor
Thermocouple
Pressure/Force/Weight Sensor
Strain Gauge (Pressure Sensor)
Load Cells (Weight Sensor)
Position Sensor
Potentiometer
Encoder
Hall Sensor (Detect Magnetic Field)
Flex Sensor
Sound Sensor
Microphone
Ultrasonic Sensor
Touch Sensor
PIR Sensor
Tilt Sensor
Accelerometer
Gas Sensor

We have to select the desired sensor based on our project or application. In order to make them work, proper voltage should be applied based on their specifications.

IR LED: It is also called as IR Transmitter. It is used to emit Infrared rays. The range of these frequencies are greater than the microwave frequencies (i.e. >300GHz to few hundreds of THz). The rays generated by an infrared LED can be sensed by Photodiode. The pair of IR LED and photodiode is called IR Sensor.

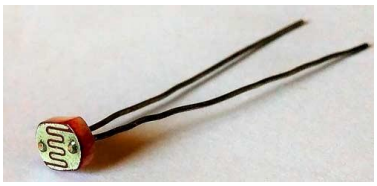
Photo Diode (Light Sensor): It is a semiconductor device which is used to detect the light rays and mostly used as IR Receiver. Its construction is similar to the normal PN junction diode but the working principle differs from it. As we know a PN junction allows small leakage currents when it is reverse biased so, this property is used to detect the light rays. A photodiode is constructed such that light rays should fall on the PN junction which makes the leakage current increase based on the intensity of the light that we have applied. So, in this way, a photodiode can be used to sense the light rays and maintain the current through the circuit.

Using a photodiode we can build a basic automatic street lamp which glows when the sunlight intensity decreases. But the photodiode works even if a small amount of light falls on it so, care should be taken.

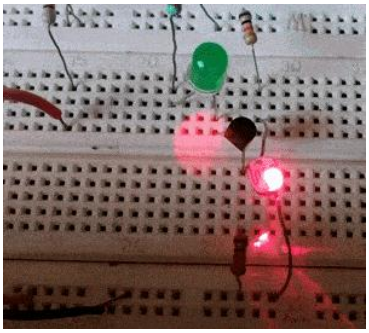


LDR (Light Dependent Resistor): As the name itself specifies that the resistor that depends upon the light intensity. It works on the principle of photoconductivity which means the conduction due to the light. It is generally made up of Cadmium sulfide. When light falls on the LDR, its resistance decreases and acts similar to

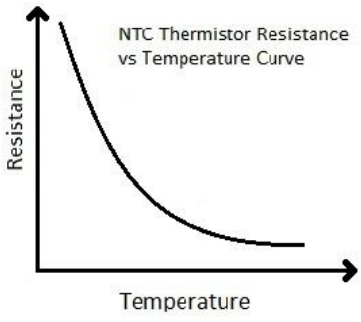
a conductor and when no light falls on it, its resistance is almost in the range of MΩ or ideally it acts as an open circuit. One note should be considered with LDR is that it won't respond if the light is not exactly focused on its surface.



With a proper circuitry using a transistor it can be used to detect the availability of light. A voltage divider biased transistor with R2 (resistor between base and emitter) replaced with an LDR can work as a light detector.



Thermistor (Temperature Sensor):A thermistor can be used to detect the variation in temperature. It has a negative temperature coefficient that means when the temperature increases the resistance decreases. So, the thermistor's resistance can be varied with the rise in temperature which causes more current flow through it. This change in current flow can be used to determine the amount of change in temperature. An application for thermistor is, it is used to detect the rise in temperature and control the leakage current in a transistor circuit which helps in maintaining its stability.



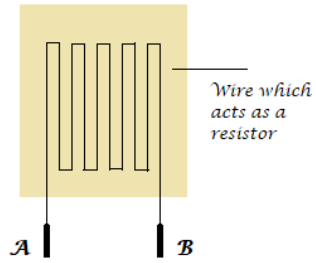
Thermocouple (Temperature Sensor): Another component that can detect the variation in temperature is a thermocouple. In its construction, two different metals are joined together to form a junction. Its main principle is when the junction of two different metals are heated or exposed to high temperatures a potential across their terminals varies. So, the varying potential can be further used to measure the amount of change in temperature.

Strain Gauge (Pressure/Force Sensor):

A strain gauge is used to detect pressure when a load is applied. It works on the principle of resistance, we know that the resistance is directly proportional to the length of the wire and is inversely proportional to its cross-sectional area (R=ρl/a). The same principle can be used here to measure the load. On a flexible board, a wire is arranged in a zig-zag manner as shown in the figure . So, when the pressure is applied to that particular board, it bends in a direction causing the change in overall length and cross-sectional area of the wire. This leads to change in resistance of the wire. The resistance thus obtained is very minute (few ohms) which can be

determined with the help of the Wheatstone bridge. The strain gauge is placed in one of the four arms in a bridge with the remaining values unchanged. Therefore, when the pressure is applied to it as the resistance changes the current passing through the bridge varies and pressure can be calculated.

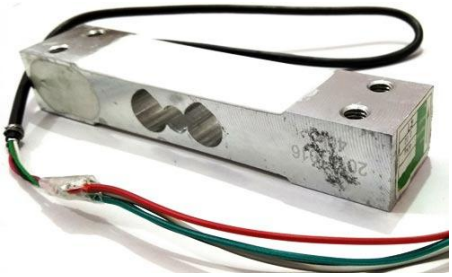
Strain gauges are majorly used to calculate the amount of pressure that an airplane wing can withstand and it is also used to measure the number of vehicles allowable on a particular road etc.



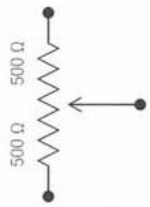
Strain Gauge

Load Cell (Weight Sensor):

Load cells are similar to strain gauges which measure the physical quantity like force and give the output in form of electrical signals. When some tension is applied on the load cell it structure varies causing the change in resistance and finally, its value can be calibrated using a Wheatstone bridge.



Potentiometer: A potentiometer is used to detect the position. It generally has various ranges of resistors connected to different poles of the switch. A potentiometer can be either rotary or linear type. In rotary type, a wiper is connected to a long shaft which can be rotated. When the shaft has rotated the position of the wiper alters such that the resultant resistance varies causing the change in the output voltage. Thus the output can be calibrated to detect the change in its position.



Potentiometer

Encoder: To detect the change in the position an encoder can also be used. It has a circular rotatable disk-like structure with specific openings in between such that when the IR rays or light rays pass through it only a few light rays get detected. Further, these rays are encoded into a digital data (in terms of binary) which represents the specific position.

Hall Sensor:

The name itself states that it is the sensor which works on the Hall Effect. It can be defined as when a magnetic field is brought close to the current carrying conductor (perpendicular to the direction of the electric field) then a potential difference is developed across the given conductor. Using this property a Hall sensor is used to detect the magnetic field and gives output in terms of voltage. Care should be taken that the Hall sensor can detect only one pole of the magnet. This is used in maglev vehicles.

The hall sensor is used in few smartphones which are helpful in turning off the screen when the flap cover (which has a magnet in it) is closed onto the screen. Here is one practical application of Hall Effect sensor in Door Alarm.

Flex Sensor:

A FLEX sensor is a transducer which changes its resistance when its shape is changed or when it is bent. A FLEX sensor is 2.2 inches long or of finger length. Simply speaking the sensor terminal resistance increases when it's bent. This change in resistance can do no good unless we can read them. The controller can only read the changes in voltage and nothing less, for this, we are going to use voltage divider circuit, with that we can derive the resistance change as a voltage change.

Flex Sensor

Microphone (Sound Sensor):

Microphone can be seen on all the smartphones or mobiles. It can detect the audio signal and convert them into small voltage (mV) electrical signals. A microphone can be of many types like condenser microphone, crystal microphone, carbon microphone etc. each type of microphone work on the properties like capacitance, piezoelectric effect, resistance respectively. A crystal microphone works on the piezoelectric effect. A bimorph crystal is used which under pressure or vibrations produces proportional alternating voltage. A diaphragm is connected to the crystal through a drive pin such that when the sound signal hits the diaphragm it moves to and fro, this movement changes the position of the drive pin which causes vibrations in the crystal thus an alternating voltage generated with respect to the applied sound signal. The obtained voltage is fed to an amplifier in order to increase the overall strength of the signal.

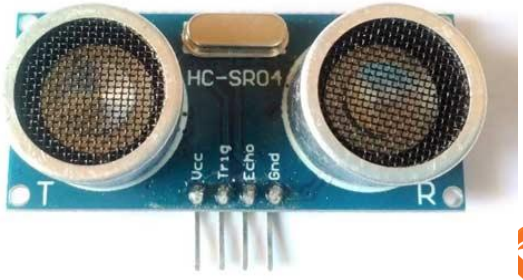
Ultrasonic sensor: Ultrasonic means nothing but the range of the sound frequencies. Its range is greater than audible range (>20 kHz) so even it is switched on we can't sense these sound signals. Only specific speakers and receivers can sense those ultrasonic waves. This ultrasonic sensor is used to calculate the distance between the ultrasonic transmitter and the target and also used to measure the velocity of the target.

Ultrasonic sensor HC-SR04 can be used to measure distance in the range of 2cm-400cm with an accuracy of 3mm. The HCSR04 module generates a sound vibration in ultrasonic range when we make the 'Trigger' pin high for about 10us which will send an 8 cycle sonic burst at the speed of sound and after striking the object, it will be received by the Echo pin. Depending on the time taken by sound vibration to get back, it provides the appropriate pulse output. We can calculate the distance (based on the formula distance = velocity * time) of the object based on the time taken by the ultrasonic wave to return back to the sensor.

There are many applications with the ultrasonic sensor. We can make use of it avoid obstacles for the automated cars, moving robots etc. The same principle will be used in the RADAR for detecting the intruder missiles and airplanes. A mosquito can sense the ultrasonic sounds. So, ultrasonic waves can be used as mosquito repellent.

Touch Sensor:

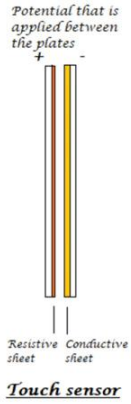
In this generation, we can say that almost all are using smartphones which have widescreen that too a screen which can sense our touch and also calibration. Basically, there are two types of touch sensors resistive based and a capacitive based touch screens.



The resistive touch screen has a resistive sheet at the base and a conductive sheet under the screen both of these are

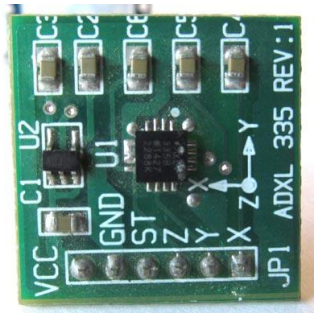
separated by an air gap with a small voltage applied to the sheets. When we press or touch the screen the conductive sheet touches the resistive sheet at that point causing current flow at that particular point, the software senses the location and relevant action is performed.Whereas capacitive touch works on the electrostatic charge that is available on our body. The screen is already charged with the electric field. When we touch the screen a closed circuit forms due to electrostatic charge that flow through our body. Further, software decides the location and the action to be performed. We can observe that capacitive touch screen won't work when we wear and gloves because there won't be conduction between the finger(s) and the screen.

PIR sensor: PIR sensor stands for Passive Infrared sensor. These are used to detect the motion of humans, animals or things. We know that infrared rays have a property of reflection. When an infrared ray hits an object, depending upon the temperature of the target the infrared ray properties changes, this received signal determines the motion of the objects or the living beings. Even if the shape of the object alters, the properties of the reflected infrared rays can differentiate the objects precisely.



Touch sensor

Accelerometer (Tilt Sensor): An accelerometer sensor can sense the tilt or movement of it in a particular direction. It works based on the acceleration force caused due to the earth's gravity. The tiny internal parts of it are such sensitive that those will react to a small external change in position. It has a piezoelectric crystal when tilted causes disturbance in the crystal and generates potential which determines the exact position with respect to X, Y and Z axis.



These are commonly seen in mobiles and laptops in order to avoid breakage of processors leads. When the device falls the accelerometer detects the falling condition and does respective action based on the software there are many projects using Accelerometer principle.

Gas sensor: In industrial applications gas sensors plays a major role in detecting the gas leakage. If no such device is installed in such areas it ultimately leads to an unbelievable disaster. These gas sensors are classified into various types based on the type of gas that to be

detected. Different gases react to different materials. Let's see how this sensor works. Underneath a metal sheet there exists a sensing element which is connected to the terminals where a current is applied to it. When the gas particles hit the sensing element, it leads to a chemical reaction such that the resistance of the elements varies and current through it also alters which finally can detect the gas.

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SERVO MOTOR WITH MICROCONTROLLER

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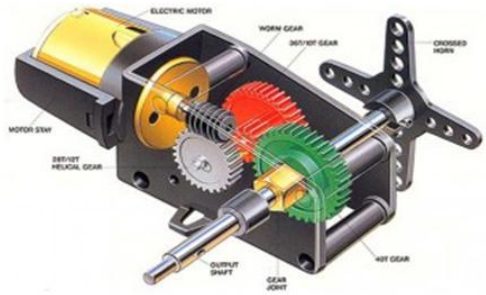
Abstract
Automatic control of servo motor in terms of rotation angle has played a vital role in the advance Electromechanical Engineering. Nowadays, the automatic process of motor control using a Personal Computer (PC) is commonly used. The controllers are designed to interface between a Computer and Motor. This paper presents the implementation of PIC Microcontroller with Graphical User Interface (GUI) in Matlab to track the rotational angle of servo motor. The movement of slider on GUI will act as an input signal into the Microcontroller to change the rotation angle. A simulation on the performance of the system has been carried out using Proteus software interfaced with Matlab and the controller was tested on real-time application. Results show that the use of PIC Microcontroller and GUI in Matlab is an advantage solution to control the rotational angle.
Keywords : Interfacing, microcontroller, software, motor, servo.

INTRODUCTON

The servo motor is most commonly used for high technology devices in the industrial application like automation technology. It is a self contained electrical device, that rotate parts of a machine with high efficiency and great precision. The output shaft of this motor can be moved to a particular angle. Servo motors are mainly used in home electronics, toys, cars.



Software Interfacing of Servo Motor with Microcontroller

Introduction

Servo Motors become an important device in a wide range of industrial applications that require high dynamics on position control such as numerically controlled machinery, robotics, automation and other mechanism where the starting and stopping functions are quickly and accurately.These applications require a high-speed control accuracy and good dynamic respond. In robotic applications, servo motors are used to move the robotic arm to a relevant position by means of controllers in the automated manufacturing lines of industries . The rotor construction of servo motors made of special material with less weight to decrease the inertia of armature but capable to produce the necessary magnetic flux. Low rotor inertia increases the capability of immediately starting and stopping during the on-off conditions. The high cost of servo motor becomes a major issue. Therefore, the small-scale manufacturers or users cannot afford to use this type of DC Motor. DC Servo Motors have a large market share in the Industry Automation & Drive Technologies. The common problems in controlling the servo motor with specific speed and position is the tuning of the parameters. Many different techniques have been proposed in order to cope with the tuning problems. Fuzzy Logic is one of the implemented techniques that have been used to sort out with these problems. The nonlinearity of the servo motor is one of the difficulties in controlling the servo motor. Since the load pressure varies over a wide range under internal parameter variations and external disturbances (load torque variations), these two factors tend to induce a higher degree of nonlinearity. Along with the rapid

development of digital and computer control technology, embedded hardware interfacing with the technology of simulink software is undergoing tremendous change. Currently, there are several commercially available embedded hardware interfacing, including advanced RISC machine (ARM), digital signal processing (DSP), application-specific integrated circuit (ASIC), and field programmable gate array (FPGA). Among them, FPGA have a number of programmable logic resources that make it possible to integrate with microprocessors to form a complete embedded system and perform complex computations in hardware. Many researchers have investigated servo system simulation focusing on principle teaching and maintain training, an integrated Matlab/Simulink with neural network and LabVIEW was designed to develop a SCADA real-time AC servo motor monitoring control system. Another simulink testing system is introduced in for intelligent robot control using Matlab environment and Turbo C software. Both systems are an effective solution to simplify the data processing with a high performance servo motor tracking scheme. The traditional test system can no longer meet the rapid development of modern servo system. Therefore, a new kind of automatic testing systems incorporating monitoring software are needed. discusses the development of simulation software models for two axis servo platform based on the National Instruments LabVIEW. The system is used to evaluate and test an advanced servo control algorithms before being implemented into the actual system. An overall network structure of a developed system in layers was designed in. The system consists of advanced test instruments, user-friendly virtual interface, database server, LAN clients and web server. The connection between LabVIEW and database is realized by using the Database Connectivity Toolkit. To simplify the program, Virtual Instruments Software Architecture was applied with written commands to the buffer, instead of considering any specific communication protocols. This paper presents the implementation of computer interfacing control for servo motor based on Matlab coding imbedded in microcontroller. Proteus software was used to simulate the hardware and verify the Matlab coding for real time application. In this work, some of the components can be changed easily to upgrade the performance of the system. The work is organized as such that, section 1 gives a brief introduction of DC servo motor with the existing software. A literature review on DC motors and control methods are presented in Section 2. Section 3 presents the principle operation of DC servo motor control. The methodology, software simulation and hardware implementation are outlined in Sections 4 and 5 respectively. The results are discussed in Section 6, while Section 7 drafts the conclusion.

A review on dc servo motor control

According to the variety of DC motor, different techniques are designed to control the DC motor and overcome the volatility characteristics of the physical DC motor system itself. The types of DC motor are permanent magnet, winding, stepper and servo, etc. Permanent magnet DC motor has a small size and compact compare to other types of DC motor but the magnetic field strength cannot be varied. Winding DC motors which are shunt-wound, series-wound and compound provide a very high range speed and torque. However, the stepper motor has a higher precise speed control and large torque at low speed but in terms of cost, this type is expensive. Alternatively, servo motor is an important for the application at the industries due to its ability of quick response and precise positioning but motor is expensive. A servo motor is an electromechanical device in which the electrical input determines the position of motor armature. It is actually an assembly of four things: a norm motor, a gear reduction unit, a position-sensing device and a control circuit. Servo motors are used extensively in robotics industry and radio-controlled cars. The implemented types in modern servo systems are AC servo motors based on induction motor designs, DC servo motors based on DC motor designs, DC brushless motors and AC brushless servo motors based on synchronous motor designs. These motors are working in a closed loop control systems where the programmed position of motion and velocity feedback controllers are required. Different studies and researches have been conducted on the servo motor control. Currently, the conventional method of servo motor control is based on proportional integral derivative. Other suggested methods such as artificial intelligence and fuzzy logic were mentione. Usually the control method of fuzzy with a fixed set of quantizing factor and scaling factor is often used in the fuzzy control. However, the variations of quantizing factor, scaling factor and control rule in the fuzzy look up table may significantly affect the speed of DC Motor. In addition, with the same set of fuzzy control rule, quantizing

factor and scaling factor, the variation of membership function will also affect the control performance of fuzzy control So far, several approaches for robust control have been proposed and considerable progress was made in this area. The popular techniques primarily intended for linear systems such as linear Quadratic Gaussian control design with loop transfer recovery (LQG/LTR) technique and adaptive or self-tuning control. Among the techniques used mainly for nonlinear systems, the sliding-mode control. Recently, Time Delay Control (TDC) has also attracted attention as an excellent robust nonlinear control algorithm. The main purpose of using TDC methods is to assure control performances (such as accuracy, stability, speed, etc) Generally, TDC uses the time-delayed values of control inputs and derivatives of state variables at the previous time step to cancel the nominal nonlinear dynamics and the aforementioned uncertainties. Thus, TDC does not require any real-time computation of nonlinear dynamics, nor does it use the parameter estimations as in adaptive control. Proportional integration (PI) controller is unquestionable as the most common controller in the process control industry. The main reason for using this controller is its relatively simple structure, which can be easily understood and implemented in practice. It also implemented in the sophisticated control strategies, such as model predictive control PI control is math total of integration error and multiplying of error with constant A simplest method to control the rotation speed of a DC motor is to control its driving voltage. The higher the voltage is the higher speed the motor tries to reach. In many applications, a simple voltage regulation would cause lots of power loss on control circuit, thus, a pulse width modulation method (PWM) is used in many DC motor controlling In the basic PWM method, the operating power to the motors is turned ON and OFF to modulate the current to the motor. The The pulses are arranged such that, only one pulse occurs for every period of the system clock. The duty cycle of the pulses determines the speed of the motor. Therefore, the higher the duty cycles the higher the speed.This would give the motor the ability to safely vary the speed from stand still to its maximum speed. For this reason, the PWM method was chosen to be implemented in the motor control design. Sometimes, the rotation direction needs to be changed. In the normal permanent magnet motors, this rotation is changed by changing the polarity of operating power (for example by switching from negative power supply to positive or by interchanging the power terminals going to power supply). This direction changing is typically implemented using relay or a circuit called an H bridge . The main purpose of interfacing motor control is to implement a closed-loop control of servo motor position utilizing a local interconnect network (LIN) to allow a series of similar motors connected together and controlled by master controller. Since the motor is used for steering and driving systems, a single controller can be used for both functions. A microcontroller is applied to produce the PWM signal.

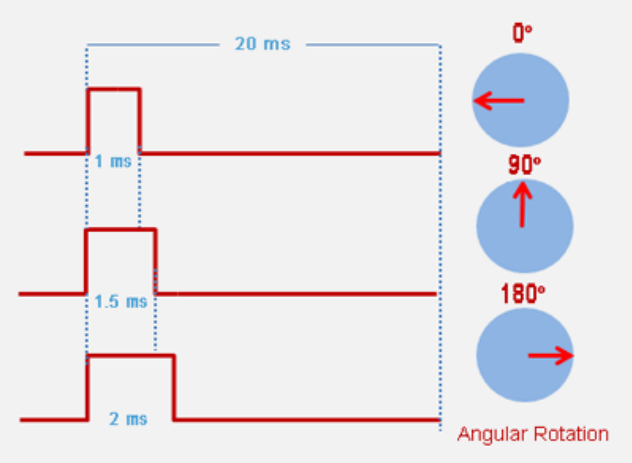
The control programming based on computer interfacing to produce the PWM output would eliminate the need for additional hardware, saving on the overall cost of such a motor drive circuit.

The Complex high-performance controllers such as PID have to be programmed and loaded into the microcontroller by converting it into hex file. Interfacing the motor with computer programming is achieved by the generated PWM signal from microcontroller.

The control system on the hardware uses all the necessary features to meet the requirements of LIN applications.

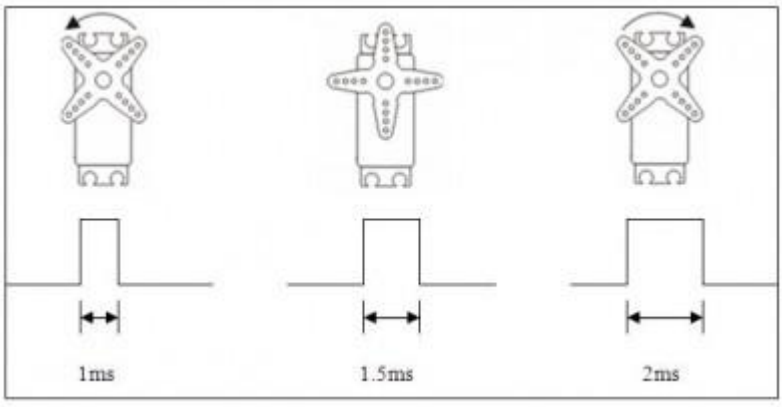
Principle operation of dc servo motor control

Servos are controlled by a pulse of variable width. The sent signal of this input pulse is characterized by a minimum pulse, maximum, and a repetition rate as seen in Figure 1. Given the rotation constraints of the servo, neutral is defined to be the position where the servo has exactly the same amount of potential rotation in a clockwise direction as it is in a counter clockwise direction. The angle is determined by the duration of applied pulse to the signal wire which is called PWM or Pulse Coded Modulation. The servo should detect a pulse every 20 ms. The length of the pulse will determine how far the motor turns. For example, a 1.5 ms pulse will make the motor turn to a 90 degree position (neutral position). The position pulse must be repeated to instruct the servo to stay in position



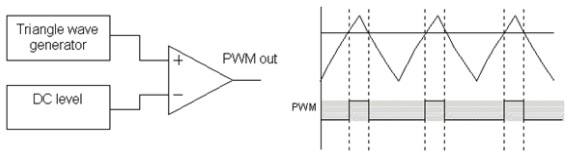
Input pulse of servo motor

When a pulse is sent to a servo that is less than 1.5 ms, the servo rotates to a position and holds its output shaft some number of degrees counter-clockwise from the neutral point. When the pulse is wider than 1.5 ms, the opposite operation is occurred. The minimal width and the maximum width of pulse that will command the servo to turn to a valid position are functions of each servo. Generally the minimum pulse will be about 1 ms wide (some servo is 0.5 ms) and the maximum pulse will be 2 ms wide (some servo is 2.5 ms). The servo motor operates in the range of 5 % to 10 % of duty cycles. Figure 2 shows relationship between pulse and direction of servo motor.



Relationship between pulse and direction of servo motor

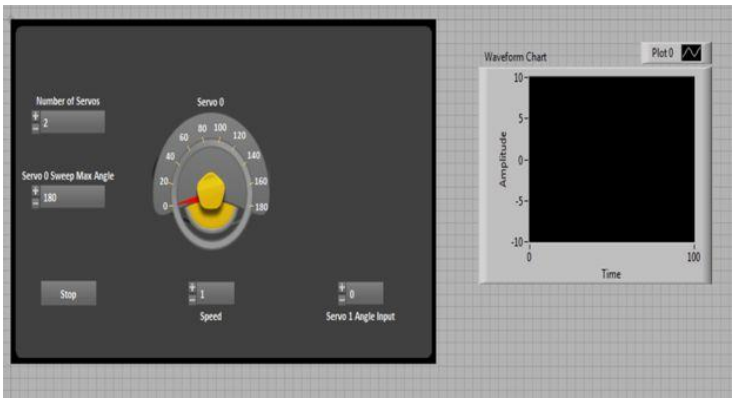
The PWM is a commonly used technique for controlling power into electrical device. The average value of voltage (and current) fed to the load is controlled by turning the switch between supply and load, ON and OFF at a fast pace. The longer the switch is ON compared to the OFF periods, the higher the power supplied to the load is. AC drives required the sinusoidal signal and modulation generator. The triangular signal is the carrier or switching frequency of the inverter. The modulation generator produces a sine wave signal that determines the width of the pulses, and therefore the RMS voltage output of the inverter. For DC drives, the PWM signal is generated by comparing a triangular wave signal with a DC signal as shown in Figure 3. The DC signal can be ranged between the minimum and maximum voltages of the triangle wave. The PWM signal is measured using the percentage of duty cycle where the pulse duration over the pulse.



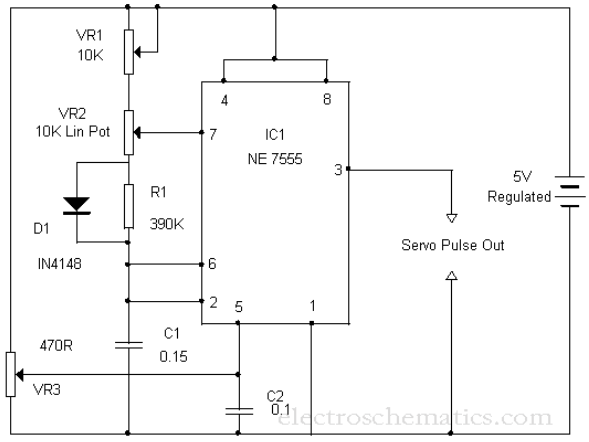
The generation of PWM for DC drives

The mathematical model of DC servo motor can be simplified by mean of the circuit as shown in Figure 4. The electrical part represented by armature and the mechanical part by T and J. As the field excitation is constant, the armature controller only depends on armature voltag.

Software implementation of servo motor control : This section presents the simulation procedures of servo motor control using the Proteus and Matlab software interfaced with Virtual Serial Port. The Proteus design suite is wholly unique in offering the ability to co-simulate both high and low-level microcontroller code in the context of a mixed-mode SPICE circuit simulation. There are over 8000 digital and analog devices model that can be simulated by placing and wired it up. The most exciting and important feature of Proteus is its ability to simulate the interaction between software running on a microcontroller and any analog or digital electronics connected to it. Proteus can work with popular compiler and assembler to simulate the execution of the object code (machine code), just like a real chip. If the program code is written to a port, the logic levels in the circuit will be changed accordingly, and if the circuit changes the state of the processor's pins, this can be seen by the program code, just as in a real life. The application of GUI for system control is widely used in the industries and robotic. In this work, the slider in Matlab GUI contributes to control the servo motor rotation angle as seen in Figure 5. The signal data obtained from the adjusted slider will be sent to the microcontroller and this signal will rotate the servo motor based on the desired angle adjusted by slider. The schematic diagram of servo motor control. The system was built and developed using Proteus software incorporating with Matlab coding. The microcontroller coding are compiled using the Micro Code Studio. Hex file of coding program can be uploaded into the microcontroller to make it ready for real application during hardware implementation. output from microcontroller is measured using the digital oscilloscope provided within Proteus. This measurement is an important to determine the correct output from the microcontroller into a servo motor. The Virtual Serial Port Kit creates virtual serial ports and connects each pair of them via a virtual null-modem cable. Consequently, all the data written to one virtual serial port can be immediately read by the other one, and vice versa.



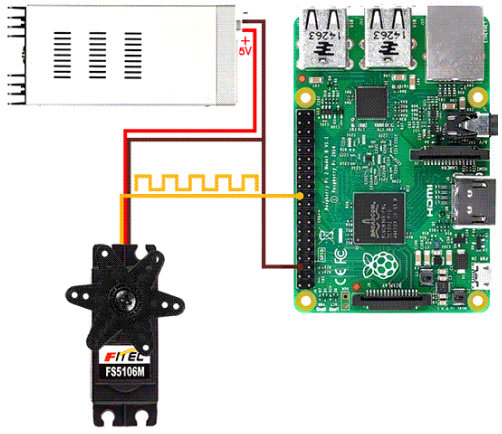
Servo motor control graphical user interface



Referring to the whole controlling system, the servo controller receives position commands through a serial connection which can be provided by using one input/output (I/O) pin of another microcontroller, or a PCs serial port. This pulse signal will cause the shaft to locate itself at the midway position +/-90 degrees. The shaft rotation on a servo motor is limited to approximately 180 degrees (+/-90 degrees from center position). A 1-ms pulse will rotate the shaft all the way to the left, while a 2-ms pulse will turn the shaft all the way to the right. By varying the pulse width between 1 and 2 ms, the servo motor shaft can be rotated to any degree position within its range.

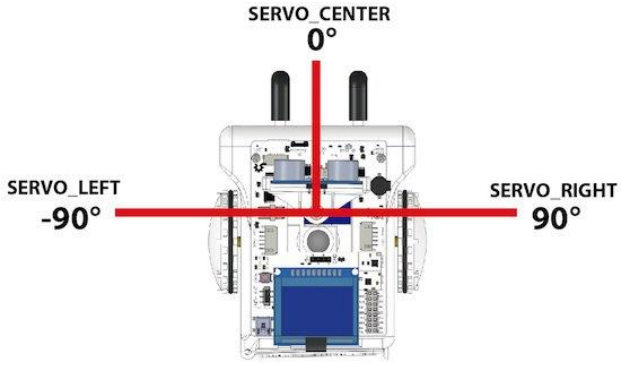
Hardware implementation of servo motor control :

shows the schematic diagram of the controlling system, and the hardware of this system is depicted The application of MAX232 is used to regulate the signal from PC to microcontroller during the interfacing process. The chip receives signals -10V to +10V from PC for logic '0'and '1' and converts them into 0V and 5V in logic '0' and '1' for microcontroller in order to process the sending data. Serial port acts as a medium for sending the data from PC to servo motor control circuit. This controlling system is using the Integrated Circuit (IC) LM 7805 to regulate the 5V voltage supply to entire circuit. A light-emitting diode (LED) is used as an indicator to determine the PWM output generated by microcontroller and sent to the servo motor. The DC servo motor utilized in this hardware is a Cytron RC Servo motor (C40R). The specification of this motor is given.PIC16F628A is the selected microcontroller chip to control the speed of DC servo. RS-232 is a standard for serial binary data signals connected between data terminal equipment and data circuit terminating equipment [32]. According to this standard a logical "0" has a voltage level between -15V and -5V and a logical "1" has a level between +5V and +15V. The microcontrollers use a 5V TTL-level (transistor-transistor logic) to transmit signals. Therefore, the signals should be converted by using MAX232 that only needs a 5V power supply to convert the signal from TTL-level to RS232 level and reverse. RS232 is a serial interface that transfers the data bit by bit and requires only two single wires, one, to send and another, to receive the data. Most of digital logic circuits and processors operate with a "+5" volt. Usually the input circuit is unregulated power supply ranging from 9 volts to 24 volts (DC). For this reason, LM 7805 is placed in the hardware and reacts as a regulator to supply +5 volt .



Schematic diagram of the controlling system

The rotational angle of DC servo motor is measured manually using the protractor. One of the blades will be marked as a reference point. The DC motor is placed at the centre of the protractor and each movement of the slider in GUI Matalb will rotate the servo motor and the angle can be recorded. Figure 13 illustrates the measurement of angle, the maximum and minimum values of angle in the slider are in the range of 0º to 180°. The angle must be limited to 180°. For example, if the slider has a range of 90º to -60°, it means that the measured value by the instrument in the range of maximum and minimum is 150º.



Conclusion

In this paper, microcontroller in Matlab GUI is proposed to control the desired position of rotation angle using the GUI sliders. Based on the regulated values, the sliders control the rotation of the servo motor. In real-time application, the sent data from PC is too small and the microcontrollers are not passing enough signals to produce the actual desired rotations. In order to improve the accuracy for real-time application, there is a need add amplifier for increasing the signals from PC to the microcontroller. The major contribution of this paper is the incorporation of two different softwares coding for real time control of a servo motor rotation angle using GUI in Matlab.

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TEMPERATURE SENSORS

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Abstract

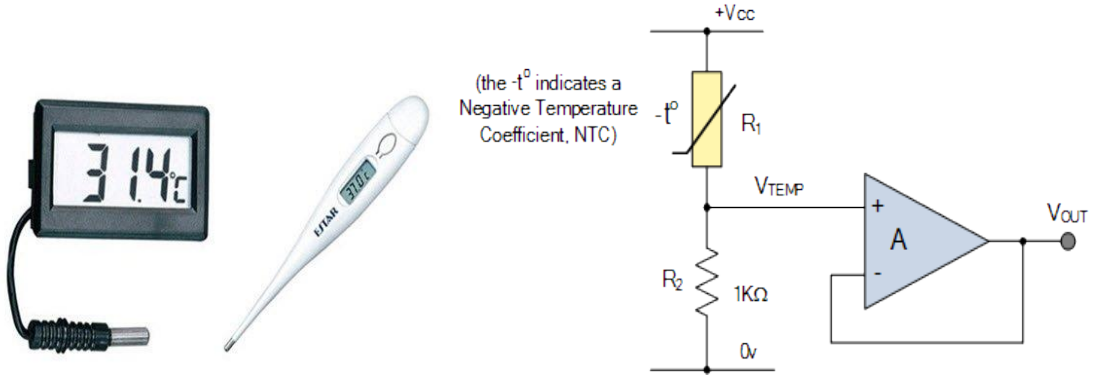
In the broadest definition, a sensor is a device, module, or subsystem whose purpose is to detect events or changes in its environment and send the information to other electronics, frequently a computer processor. A sensor is always used with other electronics, whether as simple as a light or as complex as a computer.

Sensors are used in everyday objects such as touch-sensitive elevator buttons (tactile sensor) and lamps which dim or brighten by touching the base, besides innumerable applications of which most people are never aware. With advances in micromachinery and easy-to-use microcontroller platforms, the uses of sensors have expanded beyond the traditional fields of temperature, pressure or flow measurement,[1] for example into MARG sensors. Moreover, analog sensors such as potentiometers and force-sensing resistors are still widely used. Applications include manufacturing and machinery, airplanes and aerospace, cars, medicine, robotics and many other aspects of our day-to-day life.

A sensor's sensitivity indicates how much the sensor's output changes when the input quantity being measured changes. For instance, if the mercury in a thermometer moves 1 cm when the temperature changes by 1 °C, the sensitivity is 1 cm/°C (it is basically the slope Dy/Dx assuming a linear characteristic). Some sensors can also affect what they measure; for instance, a room temperature thermometer inserted into a hot cup of liquid cools the liquid while the liquid heats the thermometer. Sensors are usually designed to have a small effect on what is measured; making the sensor smaller often improves this and may introduce other advantages. Technological progress allows more and more sensors to be manufactured on a microscopic scale as microsensors using MEMS technology. In most cases, a microsensor reaches a significantly higher speed and sensitivity compared with macroscopic approaches.

Introduction:

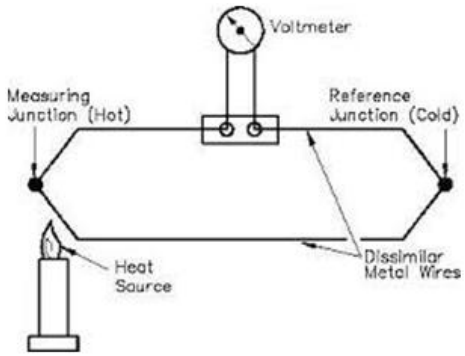
A temperature sensor is a device, typically, a thermocouple or RTD, that provides for temperature measurement through an electrical signal. A thermocouple (T/C) is made from two dissimilar metals that generate electrical voltage in direct proportion to changes in temperature.



Types of Temperature Sensors

Thermocouple: It is a type of temperature sensor, which is made by joining two dissimilar metals at one end. The joined end is referred to as the HOT JUNCTION. The other end of these dissimilar metals is referred to as the COLD END or COLD JUNCTION. The cold junction is actually formed at the last point of thermocouple material. If there is a difference in temperature between the hot junction and cold junction,

a small voltage is created. This voltage is referred to as an EMF (electro-motive force) and can be measured and in turn used to indicate temperature.



Thermocouple

The RTD is a temperature sensing device whose resistance changes with temperature. Typically built from platinum, though devices made from nickel or copper are not uncommon, RTDs can take many different shapes like wire wound, thin film. To measure the resistance across an RTD, apply a constant current, measure the resulting voltage, and determine the RTD resistance. RTDs exhibit fairly linear resistance to temperature curves over their operating regions, and any nonlinearity are highly predictable and repeatable. The PT100 RTD evaluation board uses surface mount RTD to measure temperature. An external 2, 3 or 4-wire PT100 can also be associated with measure temperature in remote areas. The RTDs are biased using a constant current source. So as to reduce self-heat due to power dissipation, the current magnitude is moderately low. The circuit shown in figure is the constant current source uses a reference voltage, one amplifier, and a PNP transistor.

Thermistors: Similar to the RTD, the thermistor is a temperature sensing device whose resistance changes with temperature. Thermistors, however, are made from semiconductor materials. Resistance is determined in the same manner as the RTD, but thermistors exhibit a highly nonlinear resistance vs. temperature curve. Thus, in the thermistors operating range we can see a large resistance change for a very small temperature change. This makes for a highly sensitive device, ideal for set-point applications.

Semiconductor sensors: They are classified into different types like Voltage output, Current output, Digital output, Resistance output silicon and Diode temperature sensors. Modern semiconductor temperature sensors offer high accuracy and high linearity over an operating range of about 55°C to +150°C. Internal amplifiers can scale the output to convenient values, such as 10mV/°C. They are also useful in cold-junction compensation circuits for wide temperature range thermocouples. A brief details about this type of temperature sensor are given below.

Sensor ICs

There are a wide variety of temperature sensor ICs that are available to simplify the broadest possible range of temperature monitoring challenges. These silicon temperature sensors differ significantly from the above mentioned types in a couple of important ways. The first is operating temperature range. A temperature sensor IC can operate over the nominal IC temperature range of -55°C to +150°C. The second major difference is functionality.

A silicon temperature sensor is an integrated circuit, and can therefore include extensive signal processing circuitry within the same package as the sensor. There is no need to add compensation circuits for temperature sensor Ics. Some of these are analogue circuits with either voltage or current output. Others combine analogue-sensing circuits with voltage comparators to provide alert functions. Some other sensor ICs combine analogue-sensing circuitry with digital input/output and control registers, making them an ideal solution for microprocessor-based systems.

Digital output sensor usually contains a temperature sensor, analog-to-digital converter (ADC), a two-wire digital interface and registers for controlling the IC's operation. Temperature is continuously measured and can

be read at any time. If desired, the host processor can instruct the sensor to monitor temperature and take an output pin high (or low) if temperature exceeds a programmed limit. Lower threshold temperature can also be programmed and the host can be notified when temperature has dropped below this threshold. Thus, digital output sensor can be used for reliable temperature monitoring in microprocessor-based systems.

Above temperature sensor has three terminals and required Maximum of 5.5 V supply. This type of sensor consists of a material that performs the operation according to temperature to vary the resistance. This change of resistance is sensed by circuit and it calculates temperature. When the voltage increases then the temperature also rises. We can see this operation by using a diode.

Temperature sensors directly connected to microprocessor input and thus capable of direct and reliable communication with microprocessors. The sensor unit can communicate effectively with low-cost processors without the need of A/D converters.

An example for a temperature sensor is LM35. The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius temperature. The LM35 is operates at -55˚ to +120˚C.

The basic centigrade temperature sensor (+2˚C to +150˚C) is shown in figure below.

Features of LM35 Temperature Sensor:

- Calibrated directly in ˚ Celsius (Centigrade)
- Rated for full l −55˚ to +150˚C range
- Suitable for remote applications
- Low cost due to wafer-level trimming
- Operates from 4 to 30 volts
- Low self-heating,
- ±1/4˚C of typical nonlinearity

Operation of LM35

- The LM35 can be connected easily in the same way as other integrated circuit temperature sensors. It can be stuck or established to a surface and its temperature will be within around the range of 0.01˚C of the surface temperature.
- This presumes that the ambient air temperature is just about the same as the surface temperature; if the air temperature were much higher or lower than the surface temperature, the actual temperature of the LM35 die would be at an intermediate temperature between the surface temperature and the air temperature.

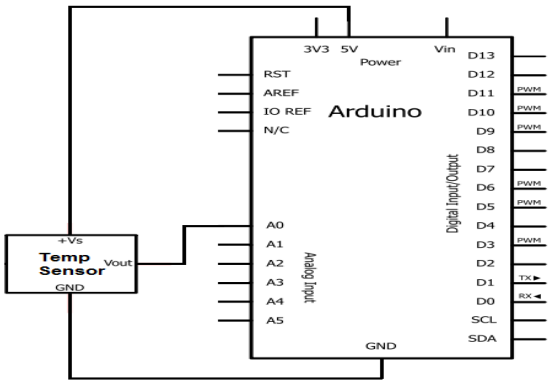
The temperature sensors have well known applications in environmental and process control and also in test, measurement and communications. A digital temperature is a sensor, which provides 9-bit temperature readings. Digital temperature sensors offer excellent precise accuracy, these are designed to read from 0°C to 70°C and it is possible to achieve ±0.5°C accuracy. These sensors completely aligned with digital temperature readings in degree Celsius.

- **Digital Temperature Sensors :** Digital temperature sensors eliminate the necessity for extra components, such as an A/D converter, within the application and there is no need to calibrate components or

the system at specific reference temperatures as needed when utilizing thermistors. Digital temperature sensors deal with everything, empowering the basic system temperature monitoring function to be simplified. The advantages of a digital temperature sensor are principally with its precision output in degrees Celsius. The sensor output is a balanced digital reading. This intends no other components, such as an analogue to digital converter and much simpler to use than, a simple thermistor which provides a non-linear resistance with temperature variation.

An example for a digital temperature sensor is DS1621, which provides a 9 bit temperature reading.

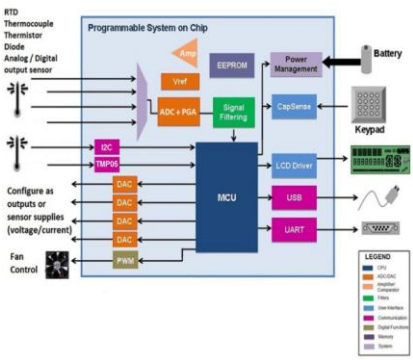
Pin Diagram& Description:



- SDA – 2-Wire Serial Data Input/ Output.
- SCL – 2-Wire Serial Clock.
- GND – Ground.
- TOUT – Thermostat Output Signal.
- A0 – Chip Address Input.
- A1 – Chip Address Input.
- A2 – Chip Address Input.
- VDD – Power Supply Voltage

Features DS1621:

1. No external components are required.
2. Temperature range of -55°C to +125°C in 0.5° intervals is measured.
3. Gives temperature value as a 9-bit reading.
4. Wide power supply range (2.7V to 5.5V).
5. Converts temperature to digital word in less than one second.
6. Thermostatic settings are user definable and Non volatile.
7. It is as 8-pin DIP.



Working of DS1621:

- When the temperature of the device exceeds a user-defined temperature HIGH then the output TOUT is active. The output will remains active until the temperature drops below user defined temperature LOW.
- User defined temperature settings are saved in nonvolatile memory so it may be programmed prior to insertion in a system.
- The temperature reading is provided in a 9-bit, two's complement reading by issuing the READ TEMPERATURE command in the programming.
- A 2 wire serial interface is used for input to the DS16121 for the temperature settings and for output of temperature reading from the DS1621

4 Most Common Types of Temperature Sensor

A temperature sensor plays an important role in many applications. For example, maintaining a specific temperature is essential for equipment used to fabricate medical drugs, heat liquids, or clean other equipment. For applications like these, the responsiveness and accuracy of the **detection circuit** can be critical for quality control.

More frequently, however, **temperature detection is part of preventative reliability**. For example, while an appliance may not actually perform any high temperature activities, the system itself may be at risk to overheating. This risk arises from specific external factors such as a harsh operating environment or internal factors like self-heating of electronics. By detecting when overheating occurs, the system can take preventative action. In these use cases, the temperature detection circuit must be reliable over the expected operating temperature range for the application.

Temperature Sensor Types

Temperature detection is the foundation for all advanced forms of temperature control and compensation. The temperature detection circuit itself monitors ambient temperature. It can then notify the system either of the actual temperature or, if the detection circuit is more intelligent, when a temperature control event occurs. When a specific high temperature threshold is exceeded preventative action can be taken by the system to lower the temperature. An example of this is turning on a fan.

There are four commonly used temperature sensor types:

1. Negative Temperature Coefficient (NTC) thermistor: A thermistor is a thermally sensitive resistor that exhibits a large, predictable, and precise change in resistance correlated to variations in temperature. An NTC thermistor provides a very high resistance at low temperatures. As temperature increases, the resistance drops quickly. Because an NTC thermistor experiences such a large change in resistance per °C, small changes in temperature are reflected very fast and with high accuracy (0.05 to 1.5 °C). Because of its exponential nature, the output of an NTC thermistor requires linearization. The effective operating range is -50 to 250 °C for gas encapsulated thermistors or 150°C for standard.

2. Resistance Temperature Detector (RTD): An RTD, also known as a resistance thermometer, measures temperature by correlating the resistance of the RTD element with temperature. An RTD consists of a film or, for greater accuracy, a wire wrapped around a ceramic or glass core. The most accurate RTDs are made using platinum but lower cost RTDs can be made from nickel or copper. However, nickle and copper are not as stable or repeatable. Platinum RTDs offer a fairly linear output that is highly accurate (0.1 to 1 °C) across -200 to 600 °C. While providing the greatest accuracy, RTDs also tend to be the most expensive of temperature sensors.

3. Thermocouple: This temperature sensor type consists of two wires of different metals connected at two points. The varying voltage between these two points reflects proportional changes in temperature.

Thermocouples are non-linear, requiring conversion when used for temperature control and compensation, typically accomplished using a lookup table. Accuracy is low, from 0.5 to 5 °C. However, they operate across the widest temperature range,from -200 to 1750 °C.

4. Semiconductor-based sensors

A semiconductor-based temperature sensor is placed on **integrated circuits** (ICs). These sensors are effectively two identical diodes with **temperature-sensitive voltage** vs current characteristics that can be used to monitor changes in temperature. They offer a linear response but have the lowest accuracy of the basic sensor types at 1 to 5 °C. They also have the slowest responsiveness (5 to 60 s) across the narrowest temperature range (-70 to 150 °C)

Applications:. **Temperature sensors** are most frequently used for measuring the temperature of **electric motor windings**(sensors with insulation of shrink tube), measuring the temperature **in bearings**, measuring the temperature **of engine oil**, measuring the temperature **in transmissions** and other. Other applications of these temperature sensors can include temperature measurements **in laboratories** and **in testing facilities**, measurements of **temperature of solid, liquid** and **gaseous substances**. Temperature sensors have **high electric strength up to 12 kV**

Temperature sensors are mostly used for:-

- Temperature sensors to electric motor windings
- Temperature sensors for heating system control
- Sensors of temperature, humidity and flow for air conditioning equipment
- Temperature sensors in applications for renewable resources paired temperature sensors-qualified meters
- Temperature sensors for rail vehicles
- Temperature sensors for applications in rubber and plastic industries
- Sensors of temperature, humidity and flow in white goods and medical applications
- Sensors of temperature, humidity and flow in food processing applications

Temperature sensors for machines and equipment:

- **Manufacturer** : IC Manufacturer
- **Part Number** : IC Part Number
- **Output Type** : We can find 3 different Output types : Analog, Digital and Switch
- **Designation** : IC Designation
- **Temperature Range** : Die temperature range where the IC can operate.
- **Accuracy (Typical)** : Typical IC accuracy
- **Accuracy (Max)** : Maximum IC accuracy
- **Linear Temperature Slope** : Linear temperature slope (available for Analog output ICs). Generally expressed in µA/°C or mV/°C Units
- **Input Voltage Range** : Input voltage range where the IC can operate
- **Supply Current** : IC supply current

- **Output Voltage Range** : Output voltage range (available for some Analog output ICs). It generally depends of the temperature range and the linear temperature slope values.
- **Package** : IC package(s) Availability
- **Datasheet** : Manufacturer's datasheet link

Conclusion

Touch screen sensors are almost used in all electronic devices. These sensors developed the speed of mobile phones, laptops, printers and many other devices. My suggestion is that they may use in appliances used in home, offices in switches ,locks ,etc.

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1. Bennett, S. (1993). A History of Control Engineering 1930–1955. London: Peter Peregrinus Ltd. on behalf of the Institution of Electrical Engineers. ISBN 0-86341-280-7<The source states "controls" rather than "sensors", so its applicability is assumed. Many units are derived from the basic measurements to which it refers, such as a liquid's level measured by a differential pressure sensor.>
2. Jihong Yan (2015). Machinery Prognostics and Prognosis Oriented Maintenance Management. Wiley & Sons Singapore Pte. Ltd. p. 107.
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TOUCH SCREEN SENSORS

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Abstract:
A touch sensor is a type of equipment that captures and records physical touch or embrace on a device and/or object. It enables a device or object to detech touch, typically by a human user or operator.
Touch sensors are also called as tactile sensors touch detector or and are sensitive to touch, force or pressure. They are one of the simplest and useful sensors. The working of a touch sensor is similar to that of a simple switch. When there is contact with the surface of the touch sensor, the circuit is closed inside the sensor and there is a flow of current. When the contact is released, the circuit is opened and no current flows.

Introduction

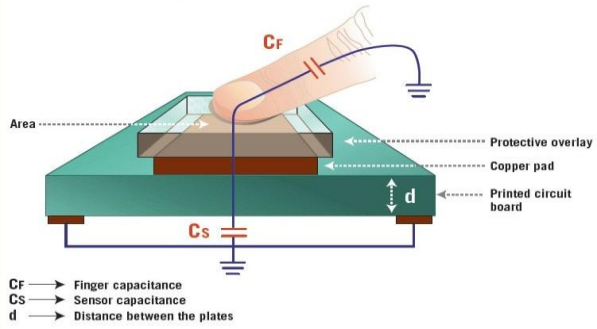
A sensor is a device, module, or subsystem whose purpose is to detect events or changes in its environment and send the information to other electronics, frequently a computer processor. A sensor is always used with other electronics, whether as simple as a light or as complex as a computer**.**

TYPES OF TOUCH SENSORS:

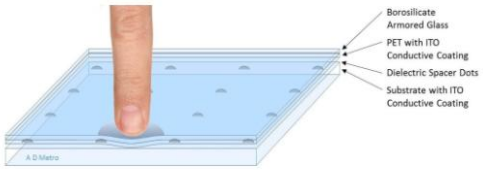
Capacitive touch sensor: Capacitive touch sensors are widely used in most portable devices like mobile phones and MP3 players. Capacitive touch sensors can be found even in home appliances, automotive and industrial applications. The reasons for this level of mass adoption are their durability, robustness, attractive product design and cost.

In capacitive touch sensors, the electrode represents one of the plates of the capacitor. The second plate is represented by two objects: one is the environment of the sensor electrode which forms parasitic capacitor C0 and the other is a conductive object like a human finger which forms touch capacitor CT. The sensor electrode is connected to a measurement circuit and the capacitance is measured periodically. The output capacitance will increase if a conductive object touches or approaches the sensor electrode. The measurement circuit will detect the change in the capacitance and converts it into a trigger signal. B

The principles of capacitive touch sensing.



b. Resistant touch sensor:A resistant touch sensor consists of two conductive layers separated by small spacer dots. The bottom layer is made up of either glass or film and the top layer is made up of film. The conductive material is coated with metallic film generally Indium Tin Oxide and is transparent in nature. A voltage is applied across the surface of the conductor. When any probe like a finger, stylus pen, pen, etc. is used to apply pressure on the top film of the sensor, it activates the sensor. When ample pressure is applied, the top film flexes inward and makes contact with the bottom film. This results in voltage drop and the point of contact creates a voltage divider network in the X – Y directions. This voltage and the changes in the voltage are detected by a controller and calculate the position of the touch where the pressure is applied based on the X – Y coordinates of the touch.



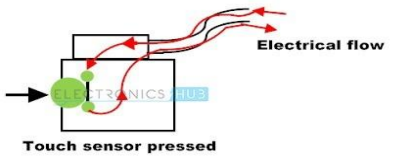
TOUCH SENSORS ACTIVITY

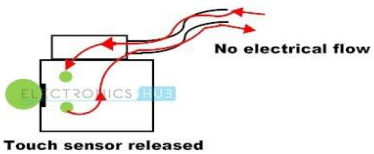
- Activity:
  - Each person pick a partner
  - Each group of two should have two pencils
  - One partner close his/her eyes and extends his/her hand to the other partner
  - Second partner pokes the first partner's hand with either one or two pencils, and have them guess whether one or two pencils were used. Try different distances apart when using two pencils at a time.
  - Attempt this at various locations on the hand, starting at the palm and ending at the back of the forearm and discuss results.
  - Switch roles. Discuss findings as a group.

Computational Neurobiology Center, University of Missouri

Touch sensor working:

Touch screens are becoming more popular because they make the user interface more exciting and intuitive for people new to modern tech gadgetry. Touchscreen technology was first developed for specialized research products in the 1970s, but now they are found in everyday devices, including Automation, Medical, Computer screens, Cell phones, Poing of Sale, GPS and ect..

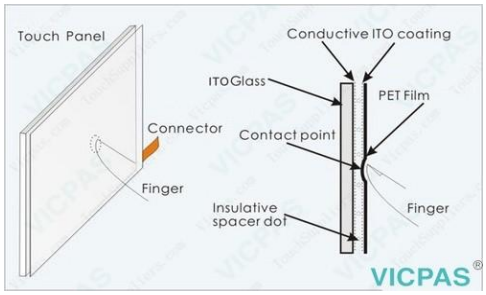




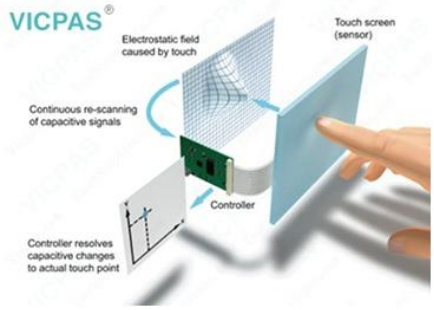
Currently, There are four basic systems used in touchscreens to recognize your touch include:

- Resistive
- Capacitive
- Infrared
- Surface Acoustic Wave

Resistive touch screen work:



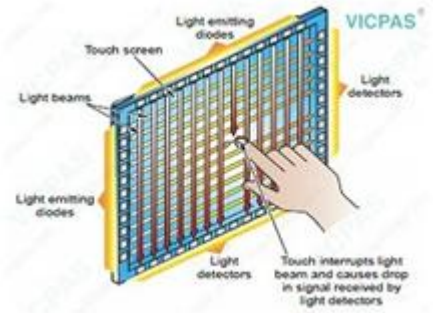
When you press your finger on a resistive screen, the top, flexible layer touches the bottom one, and the interruption in the electrical current is noted by the device, and it calculates the precise location of the point of contact. Depending on what button is located under your finger, the software registers the coordinates and performs the command. they respond to pressure, you can activate them with bare fingers, gloves, or styluses, but you can't swipe or use multi-touch gestures, because the electric current encased within can only successfully register one point of contact at a time.



Capacitive touch screen work:

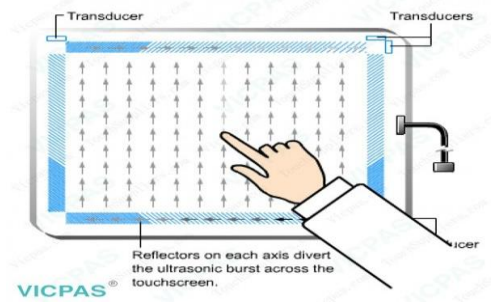
iPhones, iPads, Samsung Galaxy smart phones, and Amazon's Kindle Fire, to name a few, use the "capacitive" method. These electronic devices monitor changes in electrical currents running through the screens. The touch screens include a layer of capacitive, or electricity-storing, material. The capacitors in the screen are arranged according to a coordinate system, creating a grid. The circuitry inside the screen can then sense changes in electrical charge at each point along the grid. As a result, every individual point on the grid generates its own signal when touched, which is then relayed back to the device's processor, allowing the device to recognize multiple points of contact.

Infrared Touch screen Technology working:



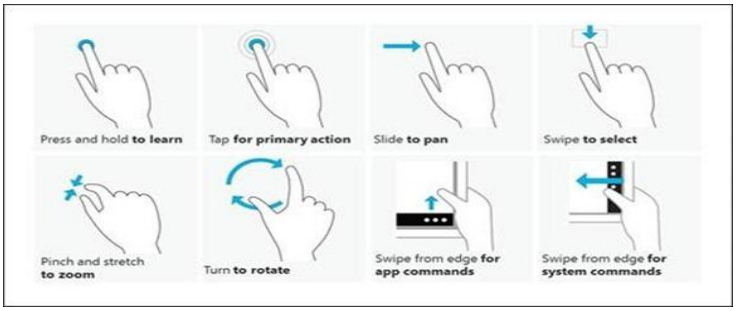
In the Infrared Touch screen Technology, an array of X- and Y- axes are fitted with pairs of IR LEDs and photo detectors. The photo detectors detect any change in the pattern of light emitted by the LEDs whenever the user touches the monitor/screen.

Surface Acoustic Wave technology working:



The Surface Acoustic Wave Touch screen technology contains two transducers (transmitting and receiving) placed along the X-axis and Y-axis of the monitor's glass plate along with some reflectors. The waves propagate across the glass and are reflected back to the sensors. When the screen is touched, the waves are absorbed and a touch is detected at that point. These reflectors reflect all electrical signals sent from one transducer to another. This technology provides excellent throughput and image clarity.

Operation of touch screen sensors:



Applications:

Touch screen sensors are used in followings:

*Informational kiosks
*Trade show displays
*Museum /tourism displays
*Point of-sale terminals
*Restaurant system
*Employee time clocks
*Industrial process controls
*World wide web access kiosks
*Home automation system
*Cession and other gaming systems
*Computer access for the physically disabled.

Conclusion:

Touch screen sensors are almost used in all electronic devices. These sensors developed the speed of mobile phones, laptops, printers and many other devices. My suggestion is that they may use in appliances used in home, offices in switches ,locks ,etc.

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AUTONOMIC COMPUTING

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Abstract
The emerging complexity in computing systems, services and applications requires the system/software architectures to be adaptive in all their attributes and functionalities. Developing a more intelligent computing system—autonomic computing system—which can run autonomously and adjust itself to the varying circumstances becomes the new major task for many system designers and system developers. The goal of this paper is to present an overview about autonomic computing including its properties, background and general architecture.

Introduction

Autonomic computing (also known as AC) refers to the self-managing characteristics of distributed computing resources, adapting to unpredictable changes while hiding intrinsic complexity to operators and users. Initiated by *IBM* in 2001, this initiative ultimately aimed to develop computer systems capable of self-management, to overcome the rapidly growing complexity of computing systems management, and to reduce the barrier that complexity poses to further growth.

Over the past few years computing equipments and systems have achieved a significant improvement since the introduction of internet. New types of entertainment areas like internet chatting, online game, online shopping make our life fruitful and colorful. Other areas benefit also from this improvement, for example, computing systems give many companies new business opportunities through web services or computing-based innovations, and simplifies researchers' work through online-sharing of technical documents. However, this improvement of computing systems brought also an unavoidable byproduct—complexity. Two reasons for the growing complexity are to be concerned—one is the growing number of internet users. Another reason is the growing demand on functionality in internet, which Paul Horn described as"another layer of complexity". Theproblemofgrowingcomplexityisbecomingserious.AsPaulHornpointed out, "the growing complexity of the I/T infrastructure threatens to undermine the very benefits information technology". Four challenges to computing systems arise from the growing complexity. First, providing a rich services to the users requires the computing systems to be scalable. Second, a computing system should have the ability to run in heterogeneous operating systems. The third challenge is the awareness of operating environment. The future operating environment is unpredictable, and the computing systems should be able to survive even under the extreme conditions. The last challenge is the reliability of system components. New services are always built on top of existed components, thus the reliability of system components becomes more important.

To solve the problem of growing complexity, "Autonomic Computing" was published by IBM researchers in the year of 2001. As the new computing vision inspired from a biological system—autonomic nervous system, autonomic computing is widely discussed. Since that time a broad set of ideas and approaches about autonomic computing have been explored through IBM Systems Journal and other projects. the extension of the presentation "Autonomic Computing" in seminar "Organic Computing" in summer semester 2006 and organized as follows. Section One introduces the definition, general view and properties of autonomic computing. Section Two presents its biological background. This is followed by a general architecture of autonomic computing. Thereafter some related projects will be listed, and finally a brief outlook of its challenges and conclusions are presented.

1 Autonomic Computing

1.1 What is Autonomic Computing

Autonomic computing was for the first time introduced by Paul Horn, IBM senior Vice Present of Research, in his one keynote presentation at the AGENDA 2001 Conference. He pointed out,

”It’s time to design and build computing systems capable of running themselves, adjusting to varying circumstances, and preparing their resources to handle efficiently the workloads we put upon them. ... Autonomic computing is thus a ”holistic” vision that will enable the whole of computing to deliver much more automation than the sum of its individually self-managed parts”

The word ”autonomic” in ”autonomic computing” comes from its inspirationautonomic nervous system. Similar to autonomic nervous system, which helps our brain concentrate on its works by dealing with low-level functions autonomously, autonomic computing is designed to ”anticipate needs and allow users to concentrate on what they want to accomplish”. The users(i.e, administrators) are ”unaware” of autonomic activities (autonomic responses) of autonomic computing. This is similar to that, the brain is unaware of some autonomic activities monitoring the hearbeat, checking blood sugar level) in autonomic nervous system. However, how the decisions of autonomic activities to be made is the basic distinction between autonomic computing and autonomic nervous system. Many of the autonomic activies in autonomic nervous system is ”involuntary”, but those in autonomic computing are based on tasks the system designers choose to ”delegate to the technology”.

1.2 Autonomic Computing — A holistic vision

The growing complexity of computing systems requires autonomic computing. With autonomic computing, computers will become self-managing, and more powerful; users and administrators will get more benefits from computers, because they can concentrate their works ”with little conscious intervention” . Due to its character: autonomic, autonomic computing require a significant integration of new technologies and many existed technologies such as distributed computing, proactive and reactive computing, ambient network, etc. Some other research areas like artificial intelligence, complex adaptive systems can also contribute to the design of autonomic computing. Autonomic computing is a global computing, which is beyond the advanced levels of automation that can be found in many products. Everest’s Mainsah pointed out, ”It is a holistic approach that envisages a far greater level of automation than can be achieved by piecemeal advances”. Therefore, A balanced automation system should be designed for autonomic computing. In other words, autonomic computing should be designed always with the awareness, that they will be deployed in a global autonomic computing system and interacted with other autonomic computing systems.

1.3 Properties of Autonomic Computing

Autonomic computing is a ”grand challenge”, it requires a wide-range of collaboration in system design area. **Eight basic properties are identified by its founder after the introduction**.

1. An autonomic computing system should have the whole knowledge of itself and its components.
2. An autonomic computing system should have the ability to configure itself in order to adjust to an ”unpredictable conditions”.
3. An autonomic computing system should always have the ability to optimize itself.
4. An autonomic computing system should have the ability to survive and recovery from some serious errors.
5. An autonomic computing system should have the ability to protect itself from the attacks from anywhere.
6. An autonomic computing system should be aware of its operating environment and act accordingly.
7. An autonomic computing system should be heterogenetical.
8. An autonomic computing system should keep the complexity of its workings hidden from users.

These basic properties illustrate how an autonomic computing may look like, and how it should work. An autonomic computing system is at first a ”self-managing” system. To make these basic properties comprehensive with a ”self-managing” system, IBM autonomic computing initiative newly defined Four fundamental properties about autonomic computing: self-configuration,selfhealing,self-optimizationand self-protection.Nowtheself-* propertieshasgrown into a wide range list. Some new features such as ”self-anticipating”, ”self adapting”, ”self-diagnosis”, ”self-recovery” are also added. But we focus ourselves here just on the four fundamental properties.

Self-configuration Autonomic computing systems should have the ability to ”adapt automatically to the dynamically changing environments” . The growing complexity brings the operating environment of computing systems unpredictable, and makes the computing systems brittle, uncertain. To address these problems, an autonomic computing system should be aware of its operating conditions, have the ability to predict trends and adapt itself to this changing environment. Two different levels of adaption are mentioned here. In system level a new system component should be able to configure itself into a existing autonomic infrastructure automatically, and the rest system components will adapt to its presence — ”much like a new cell in the body or a new person in a population” . For example, with this level of adaption a new computing node with special functions will be seamlessly added into a large computing network. In component level, each component is again a self-managing system (autonomic element), and should be able to conger itself ”on-the fly” . Some plug and play device functions, software installation may be examples of this level. Nowadays such kind of system configuration can only be performed with the assistance of administrators.

Self-healing Autonomic computing systems should have the ability to discover, diagnose and repair failed components without the disruption of system services. Systems and critical services must not be crashed, disrupted even under the extreme conditions. To achieve it, autonomic computing systems must have the ability to recovery from an unexpected situation automatically. In this process of recovery, the information of components (i.e, through log file) may be at first diagnosed, failed components will be localized using some mechanisms (i.e, ”regression tester”, a mechanism to discover and localize potential failed components), and then they will be isolated , fixed and reintroduced with the minimum of human’s intervention. Through this property autonomic computing becomes more robust and powerful.

Self-optimization Autonomic computing systems should have the ability to ”monitor and tune resources automatically”. The above properties selfconfiguration and self-healing will make autonomic computing powerful, but thinking of that, can an autonomic computing system always be powerful? The answer is obviously, ”NO”. To keep autonomic computing always powerful, an autonomic computing system need to continuely ”maximize resource utilization anciently”, like ”the brain modifies its circuitry during learning”. This process may be accomplished using some advanced feedback functions and parameter negotiations. Some existed technologies like logical

partitioning, dynamic workload management, and dynamic server clustering are the examples of this property.

self-protection Autonomic computing systems should have the ability to ”anticipate, detect, identify and protect against attacks from anywhere”. The security issue nowadays is a key issue for all systems, autonomic computing will not be an except. System components should be able to incorporate themselves to defend as a whole against large-scale attacks. In order to protect against unauthorized resource accesses and misusing resources, they should define and manage user accesses to all sharing and their own resources; Their communication channels should also be protected from eavesdropping and traffic analysis. Some existed technologies in computing security area may be integrated into this property, like ACL (access control list), Kerberos and SSL (Secure Socket Layer).

All of these four fundamental properties work together to build the essence of autonomic computing: self-management. As a result, ”the system components and devices will seem completely natural and unremarkable” and the users are unaware of the complexity of entire autonomic computing system, just like its biological inspiration—autonomic nervous system—does in our body.

2 Autonomic Nervous System and Ashby’s ultrastable System

Autonomic nervous system (ANS) executes the homeostatic regulation in our body. A homeostatic regulation controlls internal critical physiological parameters (i.e, body temperature, blood sugar level and heatbeat) within their physiological limitations. Autonomic nervous system is called autonomic, because its homeostatic regulation is self-regulating, or in other words, runs autonomously. With ANS the human brain is freed from the burden of dealing with low-level functions. The regulation of the critical physiological parameters is performed through the maintainance of a state of stable equilibrium. How this equilibrium to be maintained will be discussed in the part of Ashby’s ultrastable system.

2.1 Autonomic Nervous System

The interaction between human body and its external environment is controlled by the nervous system, which consists of ”Central Nervous System” (CNS) and and ”Peripheral Nervous System” (PNS). The central nervous system including the brain and spinal cord, is a exchange center of signals from external and internal environment in the human body. The peripheral nervous system connects all the target organs with central nervous system, acts and reacts in response to the external stimuli. The PNS can be further divided into ”Autonomic Nervous System” (ANS) and ”Sensory-Somatic Nervous System” . The Sensory-somatic nervous system controlls the muscular system and external sensory receptors
(i.e, skin), whileas the ANS regulates the critical physiological parameters in the internal environment. Two different types of neurons—”sensory neurons” and ”motor neurons”—run in ANS for the purpose of communication between internal environment and CNS . The sensory neurons carry signals from the target organs to CNS, whileas the motor neurons carry commands from CNS to target organs and take actions.

Autonomic nervous system consists of two subparts: ”sympathetic nervous system” (sympathetics) and ”parasympathetic nervous systems” (parasympathetics) Roz Carr”The Autonomic Nervous System” states that sympathetics involves ”arousal” and ”fight or flight reaction”, and parasympatheticscontrolls ”relaxation, recuperation and digestion” . Their functions are quite reciprocal. Sympathetics comes into operation under the situation of ”any stimulus over an individual’s threshold” . This kind of stimulus could be feelings, noise, light. Sympathetics’ function produces a quickening of the heartbeat, sends more blood into muscles or raises blood pressure. Unlike sympathetics, parasympathetics is activated ”after the stimulus has been responded to” and influences the human body in a opposite way. It will make the body re-balance, for example, the raised blood pressure will be lowered, the increased heartbeat will be slowed. Through the counteraction of sympathetics and parasympathetics some critical physiological parameters like blood pressure, heartbeat, body temperature are regulated autonomously. For example, a new student was invited to visit his professor. After meeting with the professor his heartbeat increased because of nervousness. He maybe didn’t notice that, but this process was the result of sympathetics. A few minutes later, after a normal conversation with the professor, his heartbeat returned to the normal level because everything ran ok. This process was the result of parasympathetics. Each critical physiological parameter is critical to the body life and has a physiological limitation. For example, if the body temperature is too high, that means, autonomic nervous system can not regulate it alone, the person must have had a illness, and requires an external means to push it back to normal level, otherwise high body temperature would cause unexpected result.

Thehomeastaticregulationofautonomicnervoussystemisahierarchicaland decentralized self-regulation, that means, from cell to neuron and from neuron to nerve system. ”Each level maintains a measure of independence while contributing to a higher level of organization”. It maintains the critical physiological parameter autonomously and contribute to adjust to the external changing environment without additional interventions. It is a good example to solve the problem of dynamic complexity in nature.

2.2 Ashby’s Ultrastable System Autonomic nervous system is a complex adaptive organ-system, which accomplishes the process of learning, measuring and adapting. To make it comprehensive, W. Ross Ashby—a cybernetics theorist—developed an ultrastable system based on his observation on organisms. This theory provides a abstract view of the solution of a complex adaptive system.

Here are some terminologies for the ultrastable system: Organism: ”a set of variables” . Every organism has an infinite properties. These properties can be abstracted as variables which have some different values and different meanings. Essential variable: ”a closely related set of physiological variables strongly linked to survivals of an organism” . If we consider autonomic nervous system as an organism, then the essential variables are something like heartheat, body temperature, blood sugar level. Each essential variable has its physiological bounderies (”viable zone” environment: ”a system whose variables affect the organism through coupling and which are in turn affected by it” behavior: The actions or reactions of an organism in response to external or internal stimuli. Since an organism is a set of variables, the behavior is also a set of variables with some kind of order. adaptive behavior: An behavior which contributes to the maintenance of the essential

variables within physiological limits. adaptive system: a system that is capable of adapting its behavior for the purpose of ”maintaining the essential variables within limits” . Ashby believes that a system is ultrastable if it remains stable after being adapted in a changing environment. This adaption is a self-regulation and maintains a state of stable equilibrium between its subsystems. the ultrastable system model is built on two subsystems: environment (Env) and an organism (Org). The organism consists of three parts: The reacting Part (R), input parameters (S), and its essential variables (the round circle). As long as an organism is alive, there exists a state of stable equilibrium between these two subsystems. If one of its subsystem (i.e, environment) has impact on another subsystem (organism), then another subsystem (organism) should maintain this state of stable equilibrium in a way that it adapts its behaviors accordingly in response to the changing environment

Manish Parashar and Salim Hariri pointed out, the environment influences an organism in two forms, ”frequent small impulses to the main variables” and ”occasional step changes to its parameters”. There are two types of variables—”normal variables” and ”essential variables”, which co-exist in an organism. In case of small changes of the environment, the normal variables will be influenced. Conversely, in case of large changes of the environment, essential variables will get influenced. After being influenced, the organism uses two feedback functions to maintain its state of stable equilibrium with environment. One is for small changes, whileas another for the large changes. The maintainance of stable equilibrium during small changes is implemented by the primary feedback through its reacting part R. The reacting part R perceives the environmental changes using its sensor channel, and takes action on its behaviors in response to these impacts using its motor channel. These channels are called in autonomic nervous system ”sensory neurons” and ”motor neurons”. Sometimes the impact on an organism is too large so that the essential variables are put outside their viable zone, then the second feedback becomes active and attempts to bring them back to their viable zone. The input parameters S will be triggered, and then they trigger the motor channel of the reacting part R, finally the motor channel changes the existing behavior sets and adapts the organism to the new changes . After this adaption a new stable equilibrium will be established and the whole system (environment and organism) is back to the stable state. It is also possible that the essential variables cannot be brought back to their viable zone, and as a result this organism will lost its identity, or die. In autonomic nervous system these essential variables are called ”critical physiological parameters” (i.e, body temperature, blood pressure and blood sugar level) and their viable zone are maintained through the counteraction of sympathetics and parasympathetics .

As mentioned above, the reaction to the changing environment requires the implementation of two feedbacks, and through them thewholeultrastablesystem remains stable again. With Ashby’s ultrastable system theory the homeostatic regulation of autonomic nervous system can be relative clearly explained. However,someapplyingproblemisstilldifficulttosolveinarealnervoussystem, for example, how long the second feedback takes, and how to define the input parameters in an organism.

3 General Architecture of Autonomic Computing

Autonomic computing is a grand challenge. The design of its architecture requires profound knowledges and technologies in diverse fields. Different architectures may be devised from different viewpoints. From the viewpoint of users autonomic computing should be service-oriented and the providing of services should be distributed. From the viewpoint of developers autonomic computing should be a collection of components, which run alone and offer services to other components. Generally, autonomic computing should be decentralized, and composed of a collection of intelligent elements. These intelligent elements should work autonomously and connect with each other in a way they share services and resources from other elements. This kind of intelligent element is called ”Autonomic Element” (AE) in the IBM architectural blueprint for autonomic computing, published in 2003. In this section a general view of autonomic element and how they form an autonomic computing will be presented.

3.1 Autonomic Element

As its name ”autonomic” implies, autonomic element is an individual system which runs autonomously and cooperates with other autonomic elements as a whole. Autonomic element consists of one or more resources

and a intelligent manager—”autonomic manager” , which manages the resources. The resources managed in autonomic element are called ”managed element” A managed element can be arranged into three categories: ”resource layer”, ”composite resource layer” and ”business solution layer” according its existing context. In resource layer a managed element is just like that in a nonautonomic environment, such as a CPU, or a printer, or a storage. In the second layer—composite resource layer—a managed element is a composition of resources for the improvement of performance and availability, such as a web server, or a database. In the third layer—business solution layer—a managed element is a system with a special business objective, for example, it may be an online shopping system or a cashier system. Each managed element have ”sensors” and ”effectors” which are used to provide internal state and adapt its behaviors in response to the environmental changes.

Autonomic nervous system regulates its critical philological parameters autonomously in our body, so does autonomic element. Autonomic element should also have the ability to maintain its managed elements. This is one task of autonomic manager. Its another task is to communicate with other autonomic elements to establish a global autonomic computing.

In order for managed elements to be maintained autonomously, the knowledge about managed elements plays a significant role. At first, knowledge is gathered about managed elements using their sensors, after that it is correlated and analyzed. Finally, managed elements are affected by the previous results using their effectors. Based on the management of knowledge, a intelligent loop ”Monitor” — ”Analyze” — ”Plan” — ”Execute” (MAPE)are used in autonomic manager to maintain the managed elements . Details about this intelligent loop are showed as the following:

– In the monitor phase, autonomic manager gathers the metrics and topological information about managed elements using some methods like filtering, collecting and reporting. – In the analyze phase, autonomic manager consults the objective of this autonomic element, correlates the monitored information and predicts situation and trends. – In the plan phase, autonomic manager plans the future action based on the analyze results and the objective of this autonomic element. – In the execution phase, autonomic manager follows the previous plan and changes the behaviors of managed elements using their effectors.

To provide services to other autonomic elements and adapt its internal state in response to the environmental changes.

ments), autonomic manager has also its own sensors and effectors and uses them to communicate with other autonomic elements.

3.2 Autonomic Computing Architecture

Autonomic element is a basic component of autonomic computing. It is intelligent because it can not only regulate internal managed elements, but also ”facilitate collaborative interaction with other autonomic managers” . The collaboration between autonomic elements represents the structure of a target IT system. In the autonomic computing environment, this structure will be peerto-peer or hierarchical. The resource sharing and parameters’ negotiation within various autonomic elements are normally policy-based. This structured collaboration with various autonomic elements forms the architecture of autonomic computing. For example, we want to build a complex IT system including many previously defined business objectives. To implement this complex system with the concept of autonomic computing, at first we must develop various autonomic element with the previously defined objectives, and then we build the structure of their collaboration based on the policies that express the goal of system. As a result, a entire self-managing system is finally established.

4 Related Applications to Autonomic Computing

Autonomic Computing brings new ideas and concepts in reducing complexity. There have been a number of research projects that use autonomic computing technologies in industry and academies. Some of them will be presented in this section.

4.1 Autonomic Computing Toolkit

Autonomic computing toolkit resents some technologies and tools which are closely referred to the properties and general architecture of autonomic computing. This toolkit includes

– Autonomic manager engine: It demonstrates the MAPE control process in the architecture of autonomic computing. – Log and Trace Analyzer: It demonstrates a partial implementation of control loops, including the part of monitoring and analyzing. – Generic log adapter: It provides a translation from log files into a common event format—Common Base Event—in order for common logs to be acceptable in a autonomic computing environment. – Resource Model Builder: this Eclipse plug-in demonstrates how to build a special resources into a autonomic computing environment using common resource model.

4.2 Dynamic Systems Initiative

Dynamic Systems Initiative (DSI) is anmicrosoft approach to reducing system complexity. As we seen in the general architecture of autonomic computing, the role of knowledge in system management is also emphasized in DSI. To benefit from the knowledge concept, DSI defines a common schema —System Definition Model— in order for other softwares to be built into its operating environment. Once this model for software is created, it can be captured in system runtime, so that system is manageable autonomously.

4.3 OceanStoreOceanStore

OceanStoreOcean Storeis a global-scale persistant data storage system from the University of California at Berkeley. It uses a introspection layer to monitor and analyze network information in order to improve performance and fault management. Each data object within OceanStore has its own GUID and is stored in distributed data location.

4.4 Other Applications Optimal Grid

OceanStoreOceanStoreprovides a solution of the problem of large-scale application by implementing runtime management and dynamic rebalancing. Policy Management for Autonomic Computing implements a autonomic policy management. The Adaptive Enterprise provides a enterprise infrastructure used to manage enterprise knowledge in real time.

5 Outlook - Challenges of Autonomic Computing

Duringtheimplementationofautonomiccomputingsomerelatedpractices show that self-managing, adaptive computing systems can be realized, and have a great perspective. However, developing those autonomic systems are ”beyond the boundaries of traditional computer sciences”and requires a global cooperation of research in diverse fields. The architecture of autonomic computing simplified this work in a large scale, but caused also some new challenges. These challenges can be divided into three categories: standardization challenges, algorithms and methods challenges and management challenges.

5.1 standardization Challenges Autonomic computing is a open computing, it needs a common, standard model in multidimension.

– Representationofautonomicelementneedsastandardization.Anautonomic element may represent a special business or scientific objective, and its services should be shared by other autonomic elements. Thus an open, standard model for autonomic element is needed to design autonomic elements.

– Knowledge management needs a standardization. In the architecture of autonomic computing knowledge is shared in the implementation of managed loop—MAPE . In the analyze phase, autonomic computing needs to understand the meaning of monitored data autonomously and selects the useful information from them. This requires (a) a common log format for the understanding of monitored data; and (b) a common event correlation to determine useful expressions. – Services sharing and parameters' negotiation between different autonomic elements need a standardization. Different autonomic elements should operate in an unpredictable environment as a whole. They need to utilize their resources efficiently and to be aware of presence of other autonomic elements and external environment. To achieve it, services should be discovered autonomously and be shared within those autonomic elements. This requires a standardization of negotiation protocol, for example, service discovery protocol and service utilization protocol. – Systemwide collaboration needs a standardization. Various autonomic elements collaborate with each other and form a great autonomic computing system. The coordination between different autonomic elements is usually policy-based. These policies should (a) exactly express the goal of the complex system; and (b) be understandable by underlying

autonomic elements. Some projects attempt to solve this problem, but a standardization of policy in autonomic computing is still required.

5.2AlgorithmsandMethodsChallenges

Autonomiccomputingneedsaglobalcooperationindiversefields.Todevelopautonomic computing, some algorithms and methods should be newly researched.

– Learning algorithm. Learning algorithm is closely tied to autonomic computing. From problem determination and autonomic remediation to systemwide optimization, learing algorithms are used everywhere, but under new conditions, namely, critical services should not be disrupted. The exploration of learning algorithms is different from the traditional one. How exact a error can be allowed, how to improve the performance of learning process, and how to coordinate different learning process, all of that remain a reseach challenge. – Process coordination methods. Autonomic computing system consists of a large scale of autonomic elements. Each of them represents a different objective (i.e, database, webserver) and expresses different optimization criteria. Within an autonomic element there run also many processes. How to coordinate such large number of processes to optimize, configure and reconfigure remains a research challenge. – Attack detection methods. With autonomic computing exchange of information is accomplished in a autonomous way. Autonomic element need not only to understand the incoming information but also to detect active attacks and protect itself against those attacks.

5.3 Management Challenges

The goal of autonomic computing is to reduce the tasks of nowadays administrators. To achieve it, there need new techniques to monitor and visualize what autonomic computing and its autonomic elements do. These techniques must be ”sufficiently expressive of preferences regarding cost vs performance, security, risk and reliability”

6. Advantages& Disadvantages

Advantages:

The most immediate Advantages of autonomic computing will be reduced deployment and maintenance cost and increased stability The challenge for a customer today is that his IT infrastructure is most likely heterogeneous, meaning it’s comprised of hardware from multiple vendors. This makes it increasingly difficult to add systems and manage them automatically Customers spend three-fourths of their application deployment time and costs on the integration equation. We need autonomic capabilities so that IT infrastructures can be self-configuring, self-healing, self-optimizing and self-protecting

Disadvantages:

The complexity construction and requires a constant internet connection because it’s impossible to reach it without an internet connection, also it doesn’t work well with low-speed connections, such as dial-up services, though that the autonomic sometimes can be slow

7. Future Application Scope

- Electricity Transmission System
- Train Route Management System
- Traffic Control System
- Multiprocessor System
- Electricity Transmission System
- Train Route Management System
- Multiprocessor System
- Traffic Control System
- Principles of Autonomic Computing
- It must ‘Know Itself’ – System Identity
- Configure and Reconfigure itself
- Look for ways to optimize its working

8. Conclusions

The increasing complexity makes computing systems brittle, uncertain and unsafe. The solution of that requires a new computing paradigm—autonomic computing—including self-managing characters. In this paper I presented an over view about autonomic computing including its properties, background, architecture and some related applications. At the end of this paper, an outlook about new challenges of autonomic computing is also presented. I think, autonomic computing is an inevitable way towards the solution of increasing complexity, and it needs to be developed in an evolutionary approach that is deferent from the traditional way.

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IOT Technologies

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Abstract
A direct interpretation of the term Internet of Things refers to the use of standard Internet protocols for the human-to-thing or thing-to-thing communication in embedded networks. The main aim of IoT is to create a virtual footprint of all the devices and people connected to it. It provides a new method of communication between all the things and the people, and also between the objects itself. IoT provides a different level of communication. This paper explains all the concepts of IoT and the mechanism in brief. The important technologies which enable IoT are RFID systems, Sensor networks and intelligence technologies. The potential applications of these technologies are reviewed and the major research issues are described.

1. Introduction

A novel paradigm named "The Internet Of Things (IoT)" has been introduced in the field of wireless communications several years ago. This term was coined by Kevin Ashton in his demo in the year 1998 from which the importance of it has been increased rigorously. Introducing IoT into embedded mobile transceivers into a wide range of devices, would add a whole new level to the world of information and communication technology. IoT plays a key role in transformation of corporations. The idea of IoT has been scrutinized in the 20th Tyrrhenian workshop on digital communications. IoT is described as a connection of various "things" or "objects" around us, like, sensors, mobile phones, Radio Frequency Identification (RFID tags) which work through a unique addressing system with which these things are able communicate with each other and complete their tasks successfully.

In order to understand IoT, first we need to understand the role of RFID systems (used to identify and communicate with other devices). IoT mainly depends on Wireless Sensor Networks (which compile the information collection, processing and transformation), intelligent technologies (in order to solve problems and initialize and control the

machine-to-machine interaction) and Nano-meter technologies (to construct small devices in order to socialize the IOT applications). There is still research being conducted in the field of IoT in order to make it more easy to use and also increase the security of the information transferred through it. The best architecture is the Unique Identifier (UID) in japan and the EPC global networks supported by Auto-Id labs are leading in the field. The main aim of these institutions is to design a system connecting every object with the help of the RFID tags and the wireless communications on a universal platform that is "Internet." In this mechanism every object is given a unique name which is called Electronic product code (EPC) and is governed by RFID system.. IBM's CEO Palmisano in the year 2009 introduced a concept called "Smart Planet" by introducing sensors into all the objects and other systems like railways, power grid etc. which communicate with each other and other devices with the help of intelligent architecture.

In the year 2009, the idea of "Sensing China" was released and a center for sensor networks was built in Wuxi, in Jiangsu province, which is an important source of science and technology patents in the country. The total principle is somewhere about 11.1 billion RMB.

Other major countries also started research in this field in order, for the development of a better infrastructure of IoT.

2. Review

IOT has been described or defined in various perspectives, thus IoT is explained in different ways. The main reason behind these many definitions is because of the two words "Internet" and "Things". Internet points towards a combination of networks and things mainly consist of generic objects.

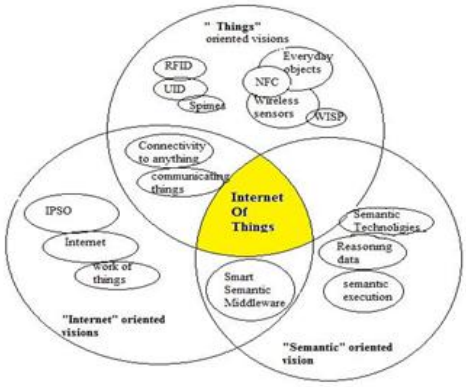

Figure 1: Convergence of deferent visions of IoT

When the two words Internet and Things are combined it leads to whole new level of advancement in the ICT world. The term IoT indirectly means a network of connected objects all around the world which have a unique EPC i.e., a unique address. The most changeling task in this scheme is the identification of the objects and storing, the exchanged information. This leads to a new concept of semantic perspective in IoT. In the figure.1 depicts the very concept of IoT, in which there is a convergence of the three spheres.

An advanced approach much better than RFID's approach was proposed by CASAGARAS consortium. This consortium mainly has two aims.

1. It promotes globalization of IoT with which we can connect the virtual and real world.
2. Supports the existing and evolving the internet and network developments.

IoT is one of the natural enabling architecture for the deployment of independent federated services and applications, characterized by a high degree of autonomous data capture, event transfer, network connectivity and interoperability. Internet focuses on developing an integrated network and things concentrates on integrating generic objects into a frame work which is easy to access. A forum formed in the year 2008, in accordance with IP for Smart Objects (IPSO) alliance, which has a protocol, which connects a large number of communication devices which runs on a battery based devices. This depicts that IP has many schemes which would make IoT a reality. The IP address and also the 6LoWPAN which would make IoT working. Implementing IoT mainly depended on the architecture, it mainly includes several layers: the field data acquisition layer to the application layer on the top. These layered architecture is implemented in such a way that they can fulfil all the requirements of various industries, enterprises, societies, institutes, governments etc. Fig. 2 presents a generic layered architecture for IoT. The layered architecture has two different divisions with an Internet layer in between so as to serve the purpose with a common media for communication. The two lower layers contribute for capturing data and the two layers at the top is responsible for data utilization.

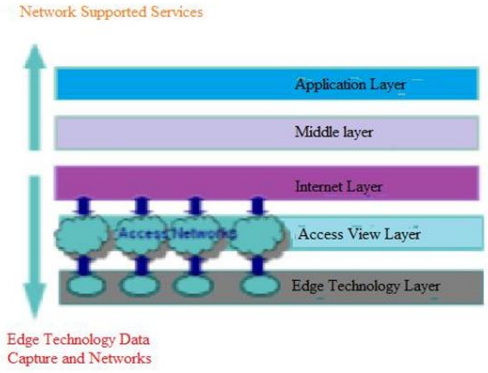

Figure 2: Layered architecture of Internet of Things

2.1 Edge layer:This hardware layer includes embedded systems, sensor networks and other different forms. These include the primary data sensors which are deployed. All of these hardware elements provide RFID tags, sensor networks and embedded edge processors.

2.2 Access gateway layer:The first step of data handling happens here. It includes message routing, publishing and subscribing and also can performs cross platform communication.

2.3 Middleware layer:This is the most critical layers in bidirectional mode. It is an interface between the hardware layer at the bottom and the application layer at the top. It is responsible for critical functions such as device management and information management and also includes data filtering, data aggregation, semantic analysis, access control, information discovery such as EPC (Electronic Product Code) information service and ONS (Object Naming Service).

2.4 Application layer:This layer is at the top of the stack and is responsible for delivery of various applications to different users in IoT. The applications can be from different industry verticals such as: manufacturing, logistics, retail, environment, public safety, healthcare, food and drug etc. With the increasing maturity of RFID technology, numerous applications are evolving which will be under the umbrella of IoT.

2.5 Applications

IoT enables the objects in our everyday working or living environment to communicate and elaborate the information collected from the surroundings which will make a lot of applications possible. The applications of IoT technologies, which are either directly applicable or closer to our current living habitats, grouped into 3 domains.

3. **Supply Chain Management:**Real-time information processing technology based on RFID and NFC is being used in IoT. We can overlook accurately and manage real-time information, work-in-progress, and in-transit stages with reliable due dates can be obtained. This would result in an increase in the forecast that would be more accurate. Automatic replenishment of out-of-stock goods and reduction of inventory would be possible. Applying these technologies would require only a few days and can basically work with zero safety stock. Transportation Cars, buses and taxis as well as roads intersections will become more instrumented with sensors, actuators, and processing power. Important information could be collected to realize traffic control and guidance, help in the management of the depots, and provide tourists with appropriate transportation information. One of the important applications of IoT is the Traffic Information Grid (TIG) which is implemented on Shanghai Grid.

3.1 Healthcare:The IoT technologies such as RFID, WSN, etc., could provide many benefits in the healthcare domain. For example, a person's health status could be inferred from the RFID tags on clothes or from discovering a wearable medical device. The applications in hospital could be categorized into: tracking of hospital staff and patients, identification and authentication of people, automatic data collection and sensing, and remote healthcare.

3.2 Disaster Alert and Recovery: Recently, due to the natural disasters and accidental disasters which are taking place frequently. Technologies like RFID and WSN plays a crucial role in alerting the disaster before it happens, and recovery after it ends. The timely access to relevant information on hazardous environmental conditions would give the residents in the nearby area some time to prepare themselves procedures, alleviating the damage and reducing the number of casualties derived from the event. WSN enables the acquisition, processing and transmission of environmental data from the location where disasters originate to potentially threatened cities. Then this information could be used for authorities to rapidly assess critical situations and to organize resources. As to accident disaster recovery, for example, after a coalmine accident occurs, instant tracking and positioning of trapped workers using RFID technologies could provide timely rescue and lessen casualties and economic loss to the largest extent. Knowing trapped workers' geographic distribution and comparatively accurate position, the rescue action would be more targeting thus is time-efficient. Apart from the above applications, many others could be described as futuristic since they rely on some (communications, sensing, material and industrial processes) technologies that are still to come or

whose implementation is still too complex. The most appealing futuristic applications included robot taxi, city information model and enhanced game room.

4. **Open Issues:**

Standardization: Although considerable efforts have been made to standardize the IoT paradigm by scientific communities, European Standards Organizations (ETSI, CEN, CENELEC, etc.), Standardization Institutions (ISO, ITU) and global Interest Groups and Alliances (IETF, EPC global, etc.), they are not integrated in a comprehensive framework. Efforts towards standardization have focused on several principal areas: RFID frequency, protocols of communication between readers and tags, and data formats placed on tags and labels. EPC global, European Commission and ISO are major standardization bodies dealing with RFID systems. EPC global mainly aims at supporting the global adoption of a EPC for each tag and related industry driven standards. European Commission has made coordinated efforts aiming at defining RFID technologies and supporting the transition from localized RFID applications to the IoT. Differently from these, ISO deals with how to modulate, utilize frequencies and prevent collision technically.

The European Telecommunications Standards Institute (ETSI) has launched the Machine-to-Machine (M2M) Technical Committee to conduct standardization activities relevant to M2M systems and define cost-effective solutions for M2M communications. Due to lack of standardization of this leading paradigm towards IoT, standard Internet, Cellular and Web technologies have been used for the solution of standards. Therefore, the ETSI M2M committee aims to develop and maintain an end-to-end architecture for M2M (with end-to-end IP philosophy behind it), and strengthen the standardization efforts on M2M. Within the Internet Engineering Task Force (IETF), there are two working groups 6LoWPAN and ROLL dealing with integrating sensor nodes into IPv6 networks. 6LoWPAN is to define a set of protocols to make the IPv6 protocol compatible with low capacity devices. Core protocols have been already specified. While ROLL recently produced the RPL (pronounced "ripple") draft for routing over low power and loss networks including 6LoWPAN. Lots of contributions are needed to reach a full solution.

5. **Security and Privacy:**

Authentication and data integrity is the main concern of security. Due to lack of proper infrastructures and servers to exchange messages among nodes, authentication is particularly difficult in IoT scenarios. Furthermore, things have scarcer resources comparing to PCs, PDAs, cell phones, etc., to carry out complex computing. Some solutions about authentication have been proposed, but they all have serious problems and can't help solve the man-in-the-middle attack problem. Data integrity solutions require that an adversary cannot modify data in the transaction without the system detecting the change. In traditional information area, the problem of data integrity has been widely studied. When RFID systems and sensor networks are integrated in the Internet here would be a new problem. Sensor nodes or RFID tags are spread in a wide area and spend most of the time unattended. Data can be modified by adversaries while it is stored in the node or when it traverses the network. To protect data against the first type of attack, memory is protected in most tag technologies and solutions have been proposed for wireless sensor networks as well.

To protect data against the second type of attack, messages may be protected according to the Keyed-Hash Message Authentication Code (HMAC) scheme. Some cryptographic methodologies are proposed to support security. Such solutions cannot be completely applied to the IoT, given that they will include IoT components such like RFID tags and sensor nodes that are limited in energy, communications, and computation capabilities. It follows that new solutions are required to be able to balance between security level and resource scarcity. The right to privacy can be considered as a personal right or possession. In IoT people's privacy problem mainly relates to data collection (which of their personal data is being collected, who is collecting such data, and when this is happening), the use of collected data (only for authorized services by authorized service providers) and recently begun data (the collected data should be stored only until it is strictly needed). In RFID systems, there are two problems concerning data collection. In fact, on the one hand usually RFID tags are passive and reply to readers queries regardless of the desire of their proprietary. Thereby, individuals' data could be collected without them even knowing about it.

On the other hand an attacker can eavesdrop the reply from a tag to another authorized reader. As been mentioned above, authentication of authorized readers cannot solve the first type of problems. A new system based on preferences set by the user has been proposed in to negotiate privacy on the individual's behalf. The privacy decisions taken by the above system can be enforced by creating collisions in the wireless channel with the replies transmitted by the RFID tags, which should not be read. Using encryption to protect communication from eavesdropping still allow malicious readers to detect the presence of RFID tags by scanning. The proposed solution for the above problem, there is a new family of solutions where the signal transmitted by the reader has the form of a pseudo-noise. Such noisy signal is modulated by the RFID tags and therefore, its transmission cannot be detected by malicious readers. To fix the problem of un-authorized use of personal data collected, solutions have been proposed that usually rely on a system called privacy broker. The proxy interacts with the user on the one side and with the services on the other, which guarantees the provider obtains only the strictly needed information about the user. The user can set the preferences of the proxy. However, such solutions are based on privacy proxies suffer from scalability problems. And the policy adopted by privacy brokers could not be influenced by individuals. As an important issue recognized recently, digital forgetting is still studied at the beginning phase. In fact, as the cost of storage decreases, the amount of recordable data increases dramatically. Accordingly, once information is generated, it will most probably be retained indefinitely. Accordingly there is the need to create solutions that periodically delete information of no use for the purpose it was generated. The full deployment of IoT should support such forgetting functionalities, requiring further research effort.

6. **Governance:** The questions of "thin" legitimacy and lack of sufficient transparency and accountability arise in the IoT environment just as in present Internet. Since IoT is not only a mere extension of today's Internet, but rather a networking of independent but interoperable systems, the Internet Governance concepts are no longer suitable to identically be applied. Learning from the regulation of the Internet, the concept of "multi-stakeholder in governance" should be perceived as the new way forward in favor of the inclusion of the whole society. Such a development challenges the traditional understanding of legitimacy and makes it necessary to tackle the general question of who could be a legitimate stakeholder. Consequently, architectural principles are to be developed and compiled in an international legal framework.

Conclusion

In this paper, we survey the state-of-art on the IoT which includes the manifold definitions, enabling technologies and other applications and open research issues with efforts. However, this paper provides a comprehensive review of the relevant technologies. It is believed that in the near future the achievement of the vision of "from anytime, anyplace connectivity for anyone, we will now have connectivity for anything" should depend on cross-discipline and cooperative efforts in related fields.

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CRITICAL ISSUES IN HYPERSPACE TECHNOLOGIES

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Abstract
The World Wide Web (WWW) [LCG92] is a distributed hypermedia system for information discovery, retrieval, and collaboration. The hypertext paradigm has proven its usefulness for browsing large, distributed document structures. The ease of use provided by this paradigm is one of the reasons for the great popularity which the World Wide Web has gained through the last months. However, as the amount of information available through the World Wide Web grows, it becomes more and more important to provide additional tools and techniques for finding servers or documents which contain relevant information on a given topic. Bibliographic and literature text searching is a difficult task, the provision of a free text search mechanism can greatly facilitate this task. By supplying a pre-computed index of keywords, a fully indexed server eliminates the need for automatic indexers (such as web robots or spiders) to walk the entire server tree, which is an unnecessary waste of resources. Some World Wide Web servers already implement keyword searches via an interface to WAISINDEX. However, this approach lacks many important features that free text search engines provide, and does not support remapping of physical directory structures to virtual paths. In this document, we will present the ICE indexing server extension which has recently been developed at the Fraunhofer Institute for Computer Graphics. This freely available software package provides a set of routines which allow for sophisticated free text searches on a World Wide Web archive.

1. Introduction

Hyperspace is a faster-than-light (FTL) method of travelling used in science fiction. It is typically described as an alternative "sub-region" of space co-existing with our own universe which may be entered using an energy field or other device. As seen in most fiction hyperspace is most succinctly described as a "somewhere else" within which the laws of general and special relativity decidedly do *not* apply – especially with respect to the speed of light being the cosmic speed limit. Entering and exiting said "elsewhere" thus directly enables travel near or faster than the speed of light – almost universally with the aid of extremely advanced technology. "Through hyper-space, that unimaginable region that was neither space nor time, matter nor energy, something nor nothing, one could traverse the length of the Galaxy in the interval between two neighbouring instants of time.

1.1. Normal Space: In normal 3-D space, the "shortest path" between two events A and B is by travelling in a straight line. Because of relativity, there is no such thing as universal time: so let the time be measured with respect to a clock whose motion matches the space-time path. Call this space-time path "P". Then the shortest path in space is simply the path in space traced by the space-time path P.

Spaceships travelling at speeds faster than light is a staple of science fiction writers, who call the concept by many names, including hyperspace, hyper drive, warp speed and subspace. One famous example is "Star Trek," where the star ship Enterprise jumps from star system to star system to visit other planets.

1.2. Other dimensions: Physics suggests that shortcuts through space do exist, Shostak said. The curved nature of space was first proposed by Einstein, and quickly led to the idea of a wormhole: a portion of space that curves in on itself, connecting two otherwise distant parts of space. A spacecraft could theoretically skip ahead to a distant region of space if it enters such a wormhole between the two locations. As in our familiar universe, objects in a wormhole would have to travel slower than the speed of light, which, in a vacuum is 186,282 miles per second (299,792 kilometres per second). But, a spaceship could appear to have exceeded this limit by travelling through a wormhole and reaching a star system thousand of lights years away in a matter of hours, for example. However, our access to these inter-space freeways would be limited by the size

of the portal. Finding or creating a wormhole that's going to the right place and scooting through it before it closes up and smashes your spaceship to pieces are two unsolved problems that the laws of physics don't clearly bar or allow.

Technically, it would be possible to warp space to create wormhole if one could place a very dense piece of mass in front of their ship, Shasta said. Perhaps similar to the "hyperspace engine" seen in the "Star Wars" movies, the object would distort the shape of space around it, essentially bringing the chosen destination closer to the ship. But the object would need to have the density of the centre of a black hole in order to work.

1.3. Teleportation : A related science fiction idea is teleportation — the possibility of instantly conveying a person or ship into another part of the universe. The phenomenon is seen in "Star Trek," where the so-called transporter deconstructs one's body and reconstructs it at another, distant location. There is some scientific basis for this idea — scientists have shown that subatomic particles can be moved from one point to another faster than the speed of light, said physicist Ian Durham at Saint Anselm College in a 2010 interview. But the ability to break apart and reassemble an entire human appears impossible, Durham said. Because of the randomized aspects behind the arrangement of subatomic particles, perfectly reversing them becomes increasingly difficult as they accumulate in greater numbers.

1.4. Scientifically looking at hyperspace: While hyperspace is not a current form of space travel, there is ongoing research to determine how viable it is — and what the experience would be like. In 2013, a group of physics students corrected the view of what happens when spaceships fly at the speed of light. The familiar special effect of streaks of light (seen in "Star Trek," "Star Wars" and other series) would not actually be the case. Instead, the view would appear more like a centralized bright glow. The fast travel would cause light to shift into longer wavelengths due to the Doppler effect, which also explains phenomena such as why the sound of a car horn changes before it passes an observer and afterward. In space, humans would not be able to see starlight because its wavelengths would be stretched into the X-ray spectrum. Also, the glow of the universe — which glows in microwaves — would become visible because its light would be stretched into the visible spectrum.

For the past few years, news reports have been circulating about a real-life engine called the EmDrive. The concept was first designed by British researcher Roger Shawyer more than a decade ago, but hit wide public attention in 2015 after there were rumors saying that NASA was creating a warp drive. (NASA quickly said the effort "has not shown any tangible results" and emphasized it is not a warp drive.)

1.5. Warp drives in science fiction

These are few of the many examples of warp drives used in science fiction, with an emphasis on television series and movies.

- An early mention of warp drive (many sources say it was the first mention) was in the 1931 novel "Islands of Space," by John W. Campbell. The plot in part concerned testing of faster-than-light ship.
- "**Doctor Who":** In this long-running British series, a machine called the TARDIS (which stands for Time and Relative Dimension in Space) can transport the occupants through space or time, plopping them down in exact locations in the universe. The lore of the TARDIS is as sprawling as the "Doctor Who" series itself, which began in 1963 and continues to this day. Famously, a TARDIS looks bigger on the inside than it does on the outside. Some versions of a TARDIS look like an old British police box.
- "**Dune":** In this series of novels by Frank Herbert, the Holtzman Drive takes colonists to far-flung locations. This drive takes ships around the universe by warping space.
- "**Star Trek":** This is the most famous example of warp drives, which were first brought up in the 1967 episode "Metamorphosis." Essentially, the device works through matter-antimatter reactions and can easily propel interstellar ships between star systems. The newest spinoff, "Star Trek: Discovery" (which premiered in 2017) uses another propulsion system called the "spore drive," which can travel almost instantaneously between different locations.

- **"Star Wars":** This universe has certain ships that use a hyper drive. The use of "hypermatter particles" allows a ship to go at the speed of light and then move in between stars in an alternate dimension called hyperspace. The hyper drive (and the famous view of star streaks seen by the people operating it) was first seen in the 1977 movie "A New Hope" and has been a staple of the series ever since.
- "The Hitchhiker's Guide To The Galaxy": The Infinite Probability drive worked on sort of a quantum model, where it would transport people to one of the least improbable locations you'd expect. Originally a 1978 BBC radio comedy, the story rapidly expanded into books, television and a movie.
- "**Farscape":** The universe of "Farscape," a Syfy network series that ran from 1999 to 2003, includes living ships called Leviathans. Some Leviathans have a starburst ability that lets them travel faster than light in case of emergency.
- "**Battlestar Galactica":** This ship, from a 1978 TV series of the same name and its reboot from 2004 to 2009, had a faster-than-light (or FTL) drive that it used to try to stay one step ahead of the menacing Cylons, mechanical beings who rose up to take revenge on their human creators. The cool thing about FTL drives was that it was hard to track a ship's location between "jumps," making it easier for the ship to evade the Cylons.

2. Five Faster-Than-Light Travel Methods

Science tells us that it is impossible for an object to travel at light speed, let alone *faster* than that. But so many of our favourite science-fiction movies, games, and TV shows rely on faster-than-light travel to craft their interplanetary adventures. Let's take a look at five means of FTL found in sci-fi that don't break the rules of relativity and examine how plausible they are based on the science behind them.

1. Hyper drive: Popularized by *Star Wars* and used extensively in fiction, a hyperdrive enables a spaceship to travel at FTL speeds by entering another dimension known as "hyperspace." The spaceship isn't actually traveling faster than the speed of light, but rather is making use of hyperspace as a shortcut, and the hyperdrive is the mechanism that shunts the spaceship into and out of this parallel dimension. Specific coordinates within hyperspace have corresponding coordinates in normal space, but the distance between those two points will be shorter in hyperspace, allowing for a faster journey. Before making a "hyperspace jump," calculations must be made to find the matching coordinates between hyperspace and normal space in order to know when and where to exit hyperspace at the desired normal space destination.

2. Jump Drive: Seen in such works as *Battlestar Galactica*, a jump drive allows for instantaneous teleportation between two points. Similar to a hyperdrive, coordinates must be calculated to ensure a safe jump; the longer the desired travel distance, the more complex the calculation. In theory, there is no limit to how far a jump can take a ship, but an incorrect calculation may result in a catastrophic collision with a planet or space debris. The *Dune* universe's FTL, based on the fictional "Holtzman effect," can also be considered a jump drive.

3. Wormholes: A wormhole, as seen in the *Star gate* franchise, allows for near-instantaneous travel across vast distances. Wormholes may be naturally-occurring or man-made, but are almost always temporary and serve as tunnels through space-time. Imagine our universe as a piece of paper, and an ant walking on that piece of paper as a spaceship. If the ant wants to walk from one end of that piece of paper to the other, the fastest way to do so would be to travel in a straight line. But paper, like space, bends. If you bend the paper into a U shape, the ant's journey goes largely undisturbed - it still has to traverse the same distance along that line. However, in 3D space, the two ends of the paper are very close to each other now. Cut off a piece of a drinking straw and let the ant use it as a bridge or tunnel between the two ends of the paper, and the journey is suddenly much shorter.

4. Slipstream: The concept of slipstream can be found in such works as *Star Trek*, *Doctor Who*, and the *Halo* video game franchise, but there is no widely-agreed upon definition of what slipstream is or how it works beyond it being a means of FTL. We'll consider the slipstream seen in Gene Roddenberry's *Andromeda*, where it is "not the best way to travel faster than light, it's just the only way," as per the show's protagonist. Slipstream is a form of interdimensional highway in which ships ride a series of slipstream "strings" - the unseen connections between all objects in the universe. These strings are in constant flux and form a tangled

mess of intersections and divergent paths. Any time a pilot reaches a fork in the road, he has to guess which is the correct path to take to continue along toward his desired destination.

5. Warp Drive: Popularized by *Star Trek*, a warp drive distorts space around a ship while leaving the ship itself inside a "bubble" of normal space. The space in front of the ship is contracted, while the space behind it is expanded, and the ship "rides" the distortion wave at FTL speeds. Technically, it is not the ship that is moving, but rather space itself, which is how we avoid breaking any laws of physics. Imagine a surfer slowly paddling back to shore. When a wave comes, it will lower the water level in front of him and raise the water level behind him, and he can ride the downward slope all the way to shore. Relative to the wave, the surfer isn't moving - he's staying between the crest and the trough, and it is instead the wave that is moving. Surfing doesn't *quite* work like that, but it's a simplification that we can all visualize. In a similar manner to how a wave will distort water to propel a surfer, a warp drive will distort space to propel a ship.

3. Basic FTL Methods

There are three starting types of FTL travel; an empire starts with one of the three basic types and may never access the others (though non-Hyperspace empires can research Hyperlane Mapping to understand the FTL routes and strategies available to Hyperspace adversaries). The starting types, from the simplest to the most complex: warp, hyperspace and wormhole.

Eventually empires may gain the Jump Drive, an advanced form of FTL that operates like a mix between all drive systems at once, but getting and using it presents its own challenge.

1. Warp: Ships equipped with a warp drive are capable of traveling faster than light by creating a subspace "bubble" around the ship, simultaneously contracting space in front of the ship and expanding space behind it; this is referred to as an Alcubierre Drive . Warp drives have a modest cost and energy drain based upon their level, and allow movement freely (albeit slowly) across empty space. When a ship "jumps" to another system, its drive is put under considerable strain and has to cool down for a bit before performing another "jump" or even move, which along with the fact that warp travel is the slowest of the three FTL types greatly hinders the strategic mobility of a Warp empire, particularly when rapid movement over long distances is required, which is often the case when attacking an enemy empire or defending an extensive empire. In short, warp drives are recommended for empires that favour freedom of movement and independence from pre-established movement paths and can accept slow movement, long cool downs, and limited overall range. Research can increase range, increase speed, and reduce cool down time by up to 100%, 40%, and 40% respectively. For a full breakdown of mineral and power requirements, plus multipliers/etc., see the table below;

Wrap Drive	Cost	Power Uage	Warmup	Coll Down Multiplier	Speed	Range
Marks 1	5	5	.1	Jump Distance .55 days	3.51y/day	501y
Marks 2	7.5	7.5	.1	Jump Distance .44 days	3.51y/day	701y
Marks 3	10	10	.1	Jump Distance .33 days	3.51y/day	901y

Ships on cooldown after using warp drive are unable to move in the System, start combat or initiate a new FTL travel. They are able to defend themselves if in combat while on cooldown. The cooldown scales with the distance, so making a jump to a nearby system can be beneficial. The cooldown time also scales with the distance from friendly territory.

2. Hyperspace: Hidden network predates all other known construction in the galaxy. Its so-called "hyperlanes" connect the stars and they are only visible for those who know where (and how) to look. Those that don't can still research Hyperlane Mapping in order to grasp the layout of the network, and thus be able to predict the paths a hyperdrive-using empire must take and their likely strategies.

Ships with a hyperdrive can use these hyperlanes for quick and efficient travel between systems. Hyperdrive ships have among the shortest charge-up times. Hyperspace travel can greatly speed exploration and both

military and civilian travel, but a major vulnerability is the limited number of hyperlanes and therefore limited routes to a ship's final destination. Travel between nearby stars may require a circuitous route through multiple star systems, and an informed enemy might fortify a number of systems to create strategic choke-points that block an opponent. A hostile empire may even fully prevent fleets from reaching large parts of the galaxy.

Hyper Drive	Cost	Power Uage	Warmup	Coll Down Multiplier	Speed	Range
Marks 1	5	5	15	No cool down	101y/day	Depends on hyper lane length
Mark 2	7.5	7.5	11.25	No cool down	10ly/day	Depends on hyper lane length
Mark 3	10	10	7.5	No cool down	10ly/day	Depends on hyper lane length

In short, hyperdrives are recommended for empires that favor relatively quick travel and a rapid naval response with minimal cool downs, but at the cost of working with a limited and fixed set of movement routes.

(i) Strategy

- Hyper drives are the fastest early-game means of travel, which can give an edge in sending ships out to scout for habitable planets and establish contact with other empires. Since all hyper lanes are visible to a hyper lane empire from the start, planning where to explore and grow early on is important.
- Keeping the entire empire safely linked up with secured routes through the hyper lane network is a strategic priority, as an enemy aware of the Hyper lane network may seek to cut these links and block transit through choke points by fortifying the arrival points through which the hyperspace fleet must pass.
- The bigger the galaxy, the worse travelling by hyperspace can get, especially if the empire is wrapping around or intermixed with other empires.
- Difficulty or inability to cross the voids between the arms of spiral galaxies due to having few or no hyper lanes can be a serious strategic problem. Wormhole stations and high-end warp drives can potentially cross the void, but a lack of hyper lanes can't be changed.
- Despite their movement restrictions, fleets with hyper drive are notoriously tricky to intercept or trap. Hyperspace fleets can use their speed and quick warm-up time to evade an otherwise superior warp or wormhole fleet. Against equal level Warp or Wormhole drives they can easily outrun the enemy.

a. Wormhole: Empires with access to wormhole technology can create sophisticated wormhole stations at the outer edges of a star system. In contrast to warp bubbles and hyperlanes, wormholes create a temporary but direct connection between two systems. Ships that use wormhole stations experience instant travel between star systems and, as a very small bonus, the wormhole modulator drive does not require energy or add to the cost of the ship. The only costs are in building and (cheap) maintaining the wormhole stations. There is also the benefit that entire fleets can use it to transit all at once, but the bigger the fleet, the longer it takes to fully generate a usable wormhole portal. The two important factors are jump cost and preparation speed: The "cost" or "Wormhole-size" for a single jump is 200 + the Fleet size. Another 30% penalty is added to that total, if the connection does not end in own or allied territory. This applies even if the target system has the station generating the wormhole. This cost is worked off starting with about 15-16 units/day (the exact figure is unknown and even the displayed time might not be 100% accurate).

There are a few important constraints for wormhole empires;

1. One end of the connection must terminate in the same system as the station. This limits the mobility of fleets when operating on the offensive, unless construction ships are brought along to build stations in occupied territory.

2. A single station can only generate a single connection at a time. In order to adequately keep up with high volumes of traffic (such as multiple separate fleets incoming or outgoing for attacks, patrols, or retrofits), building multiple wormhole stations is a must. Loss of wormhole stations can force a fleet to return with emergency FTL.

3. For very small or very large fleets, the system is somewhat inefficient. It will always take *at least* 15 days to generate a wormhole at the basic level, or *at least* 10 days to generate a wormhole with stations fully upgraded. However, it can take well over a month to generate a wormhole large enough for a single massive fleet awaiting transit.

While wormhole range is long, it is not unlimited. Physics research topics allow an increase in both the range of wormholes and speed of wormhole generation.

(ii) Strategy

- Wormhole stations are cheap, extremely low-maintenance, quick to build, and most important of all they can be built in enemy territory, which is essential for maintaining flexible fleet mobility when on the offensive and when occupying enemy territory for extended periods.
- Building wormhole stations in all colonized systems of an empire provides a quick way for a fleet to defend those planets, as it can travel into any system within a large radius with a single jump. It also helps to prevent disruption of ship traffic if a few stations are lost.
- When fighting against a wormhole empire, one of the most effective and dangerous strategies is to use fast-moving raider fleets to take out as many of their wormhole stations as possible. Wormhole travel bypasses intervening borders and territory, so careful positioning of stations can freely 'slingshot' or 'long jump' fleets over intervening empires.
- Given the time it takes to generate wormholes for massive fleets, it may be more time-efficient to use several smaller fleets along with a surplus of wormhole stations.
- Empires with Wormhole Drive T3 have a significantly increased chance to get Jump drives, over other Empires (in earlier versions basic jump drive was even restricted to them and the Psionic Techpath).

b. Jump Drive

Described as an experimental "extremely fast ship technology", this has the potential risk to create a crisis by "boring a hole into another dimension" populated by an empire of energy beings called the Unbidden.

Jump Drive technology operates somewhat like a mix of all FTL systems at once;

1. It allows free movement from system to system, unbound by hyper lanes or the need to establish wormhole stations - like the Warp Drive.
2. Its warm-up and cool down times are relatively short - like Hyper lanes.
3. Finally, it has long range and transit is essentially instantaneous regardless of distance - like Wormholes.

There are three ways to access Jump Drive technology;

1. Research up to Zero Point Power. All basic FTL types may access it, but Wormhole users who have the highest level of wormhole generation (Wormhole Containment Fields) have a higher chance of the technology appearing.
2. Defeating the Dimensional Horror in the Leviathans DLC.
3. Salvage it from a defeated fleet from an enemy that possesses the technology; like the Unbidden.

Jump Drive	Cost	Power Uage	Warmup	Coll Down Multiplier	Speed	Range
Jump Drive	15	12.5	15	5	Instant	100
Psi Jump Drive	15	15	15	5	Instant	150

Note: Fleets with Jump Drives and Psi Jump Drives can be merged together. In this case the fleet will use the range of the Psi Jump Drive.

General Strategy: There is one exception to the 'jump within gravity well' rule, and that is the Emergency FTL used when retreating from battle. There are several drawbacks:

1. It can only be engaged when in combat with an enemy fleet and after a few days cooldown. Snare fields can drastically increase that time.
2. The fleets will be missing in action for some time, depending on the distance from their empire's borders, until they reappear at a port.
3. Ships in the fleet may be damaged or lost due to the emergency FTL. They will be damaged, with 25% of their maximum hull points being taken from their current hull points.
4. All ships no matter how undamaged have a chance to be lost. But it seems that the chance is very slim

At a glance

FTL Means	Cost	Power Usage	Warmup	Cooldown	Speed	Range
Warp Engines	Low	Average	Short	Varies	Slow	Short
	5/7.5/10 per drive	5/7.5/10	Scales with Distance	Scales with Distance	3.5 ly/day	50/70/90
Wormhole Station	Moderate	None (EC Maintenance)	Moderate-Long	None	Instant	Moderate-Long
	75 per station	0.25 maintenance	Scales with Fleet Size			65/97.5/130
Hyperlane Engines	Low	Average	Moderate	None	Fast	Restricted
	5/7.5/10 per drive	5/7.5/10	15/11.25/7.5 days		10 ly/day	Lane Based
Jump Drive	High	Average	Moderate	Short	Instant	Moderate
	30 per drive	10	15 days	5 days		100
Psi Jump Drive	High	Average	Moderate	Short	Instant	Long
	15 per drive	10	15 days	5 days		150

Conclusion

The Committee on Technologies for the Mining Industries has reviewed information concerning the U.S. mining industry. To Identified critical research and development needs related to the exploration, mining, and processing of coal, industrial minerals, and metals, and examined the federal contribution to research and development in the mining process. The committee has attended presentations and received information from representatives of government programs, industry, and academia. The committee also reviewed government documents, pertinent NRC reports, other technical reports, and published literature

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Internet of Things for Smart Cities

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Abstract
The Internet of Things (IoT) is a recent communication paradigm that envisions a near future, in which the objects of everyday life will be equipped with microcontrollers, transceivers for digital communication, and suitable protocol stacks that will make them able to communicate with one another and with the users, becoming an integral part of the Internet. The IoT concept, hence, aims at making the Internet even more immersive and pervasive. Furthermore, by enabling easy access and interaction with a wide variety of devices such as, for instance, home appliances, surveillance cameras, monitoring sensors, actuators, displays, vehicles, and so on, the IoT

INTRODUCTION

The Internet of Things (IoT) is a recent communication paradigm that envisions a near future, in which the objects of everyday life will be equipped with microcontrollers, transceivers for digital communication, and suitable protocol stacks that will make them able to communicate with one another and with the users, becoming an integral part of the Internet. The IoT concept, hence, aims at making the Internet even more immersive and pervasive. Furthermore, by enabling easy access and interaction with a wide variety of devices such as, for instance, home appliances, surveillance cameras, monitoring sensors, actuators, displays, vehicles, and so on, the IoT will foster the development of a number of applications that make use of the potentially enormous amount and variety of data generated by such objects to provide new services to citizens, companies, and public administrations. This paradigm indeed finds application in many different domains, such as home automation, industrial automation, medical aids, mobile healthcare, elderly assistance, intelligent energy management and smart grids, automotive, traffic management, and many others.

However, such a heterogeneous field of application makes the identification of solutions capable of satisfying the requirements of all possible application scenarios a formidable challenge. This difficulty has led to the proliferation of different and, sometimes, in compatible proposals for the practical realization of IoT systems. Therefore, from a system perspective, the realization of an IoT network, together with the required backend network services and devices, still lacks an established best practice because of its novelty and complexity. In addition to the technical difficulties, the adoption of the IoT paradigm is also hindered by the lack of a clear and widely accepted business model that can attract investments to promote the deployment of these technologies . In this complex scenario, the application of the IoT paradigmto an urban context is of particular interest, as it responds to the strong push of many national governments to adopt ICT solutionsin the management of public affairs, thus realizing theso-called Smart Cityconcept. Although there is not yet aformal and widely accepted definition of “Smart City,” the final aim is to make a better use of the public resources, increasing the quality of the services offered to the citizens, while reducing theoperational costs of the public administrations. This objective can be pursued by the deployment of an urban IoT, i.e., acommunication infrastructure that provides unified, simple, and economical access to a plethora of public services, thus unleashing potential synergies and increasing transparency to the citizens.An urban IoT, indeed, may bring a number of benefits in them an agreement and optimization of traditional public services,such as transport and parking, lighting, surveillance and maintenance of public areas, preservation of cultural heritage, garbage collection, celebrity of hospitals, and school.1 Furthermore, the availability of different types of data, collected by a pervasive urban IoT, may also be exploited to increase the transparency and promote the actions of the local government toward the citizens, enhance the awareness of people about the status of their city,stimulate the active participation of the citizens in the management of public administration, and also stimulate the creation of new services upon those provided by the IoT .

INTERNET OF THINGS FOR SMART CITIES:

SERVICES SPECIFICATION FOR THE PADOVA SMART CITY PROJECT

Service	Network type(s)	Traffic rate	Tolerable delay	Energy source	Feasibility
Structural health	802.15.4; WiFi and Ethernet	1 pkt every 10 min per device	30 min for data; 10 s for alarms	Mostly battery powered	1: easy to realize, but seismograph may be difficult to integrate
Waste management	WiFi; 3G and 4G	1 pkt every hour per device	30 min for data	Battery powered or energy harvesters	2: possible to realize, but requires smart garbage containers
Air quality monitoring	802.15.4; Bluetooth and WiFi	1 pkt every 30 min per device	5 min for data	Photovoltaic panels for each device	1: easy to realize, but greenhouse gas sensors may not be cost effective
Noise monitoring	802.15.4 and Ethernet	1 pkt every 10 min per device	5 min for data; 10 s for alarms	Battery powered or energy harvesters	2: the sound pattern detection scheme may be difficult to implement on constrained devices
Traffic congestion	802.15.4; Bluetooth and WiFi; Ethernet	1 pkt every 10 min per device	5 min for data	Battery powered or energy harvesters	3: requires the realization of both air quality and noise monitoring
City energy consumption	PLC and Ethernet	1 pkt every 10 min per device	5 min for data; tighter requirements for control	Mains powered	2: simple to realize, but requires authorization from energy operators
Smart parking	802.15.4 and Ethernet	On demand	1 min	Energy harvester	1: Smart parking systems are already available on the market and their integration should be simple
Smart lighting	802.15.4; WiFi and Ethernet	On demand	1 min	Mains powered	2: does not present major difficulties, but requires intervention on existing infrastructures
Automation and salubrity of public buildings	802.15.4; WiFi and Ethernet	1 pkt every 10 min for remote monitoring; 1 pck every 30" for in-loco control	5 min for remote monitoring, few seconds for in-loco control	Mains powered and battery powered	2: does not present major difficulties, but requires intervention on existing infrastructures

Therefore,the application of the IoT paradigm to the Smart City is particularly attractive tolocal and regional administrations that may become the early adopters of such technologies,thus acting as catalyzers for the adoption of the IoT paradigm on a widerscale.The objective of this paper is to discuss a general reference framework for the design of an urban IoT. We describe thespecific characteristics of an urban IoT, and the services that maydrive the adoption of urban IoT by local governments. We then overview the web-based approach for the design of IoT services,and the related protocols and technologies, discussing theirsuitability for the Smart City environment. Finally, we substantiatethe discussion by reporting our experience in the "PadovaSmart City" project, which is a proof-of-concept deployment ofan IoT island in the city of Padova (Italy) and interconnected withthe data network of the city municipality. In this regard, wedescribe the technical solutions adopted for the realization of theIoT island and report some of the measurements that have beencollected by the system in its first operational days.

The rest of the paper is organized as follows. Section IIoverviews the services that are commonly associated to theSmart City vision and that can be enabled by the deploymentof an urban IoT. Section III provides a general overview of thesystem architecture for an urban IoT. More in detail, this sectiondescribes the web service approach for the realization of IoTservices, with the related data formats and communicationprotocols, and the link layer technologies. Finally, Section IVpresents the "Padova Smart City" project, which exemplifies apossible implementation of an urban IoT and provides examplesof the type of data that can be collected with such a structure.

SMART CITY CONCEPT AND SERVICES

According to Pike Research on Smart Cities,2 the Smart Citymarket is estimated at hundreds of billion dollars by 2020,withan annual spending reaching nearly 16 billions. This market springs from the synergic interconnection of key industry and service sectors, such as Smart Governance, Smart Mobility, Smart Utilities, Smart Buildings, and Smart Environment. Thesesectors have also been considered in the European Smart Cities projet define a ranking criterion that can be used to assess the level of "smartness" of European cities. Nonetheless, the Smart City market has not really taken off yet, for a number of political, technical, andfinancial barriers.Under the political dimension, the primary obstacle is theattribution of decision-making power to the different stakeholders.A possible way to remove this roadblock is to institutionalizethe entire decision and execution process, concentratingthe strategic planning and management of the smart city aspectsinto a single, dedicated department in the city.On the technical side, the most relevant issue consists in thenoninteroperability of theheterogeneous technologies currentlyused in city and urban developments. In this respect, the IoTvision can become the building block to realize a unified urbanscaleICT platform, thus unleashing the potential of the SmartCity vision.

Finally, concerning the financial dimension, a clear businessmodel is still lacking, although some initiative to fill this gap hasbeen recently undertaken. The situation is worsened by theadverse global economic situation,

which has determined ageneral shrinking of investments on public services. This situationprevents the potentially huge Smart City market frombecoming reality. A possible way out of this impasse is to firstdevelop those services that conjugate social utility with veryclear return on investment, such as smart parking and smartbuildings, and will hence act as catalyzers for the other addedvalueservices.

In the rest of this section, we overview some of the servicesthat might be enabled by an urban IoT paradigm and that are ofpotential interest in the Smart City context because they canrealize the win–win situation of increasing the quality and enhancing the services offered to the citizens while bringing aneconomical advantage forthecity administration in terms ofreduction of the operational costs . To better appreciate thelevel of maturity of the enabling technologies for these services,we report in Table I a synoptic view of the services in terms ofsuggested type(s) of network to be deployed, expected trafficgenerated by the service, maximum tolerable delay, devicepowering, and an estimate of the feasibility of each servicewith currently available technologies. From the table, it clearlyemerges that, in general, the practical realization of mostof such services is not hindered by technical issues, but ratherby the lack of a widely accepted communication and servicearchitecture that can abstract from the specific features of thesingle technologies and provide harmonized access to theservices.

Structural Health of Buildings: Proper maintenance of thehistorical buildings of a city requires the continuous monitoringof the actual conditions of each building and identification ofthe areas that are most subject to the impact of external agents.The urban IoT may provide a distributed database of buildingstructural integrity measurements, collected by suitable sensorslocated in the buildings, such as vibration and deformation sensors to monitor the building stress, atmospheric agent sensors in the surrounding areas to monitor pollution levels, and temperature and humidity sensors to have a complete characterization of the environmental conditions. This database should reduce the need for expensive periodic structural testing by human operators and will allow targeted and proactive maintenance and restoration actions. Finally, it will be possible to combine vibration and seismic readings in order to better study and understand the impact of light earthquakes on city buildings.This database can be made publicly accessible in order to make the citizens aware of the care taken in preserving the city historical heritage. The practical realization of this service, however, requires the installation of sensors in the buildingsand surrounding areas and their interconnection to a controlsystem, which may require an initial investment in order to create the needed infrastructure.

Waste Management: Waste management is a primary issue inmany modern cities, due to both the cost of the service and theproblem of the storage of garbage in landfills. A deeper penetrationof ICT solutions in this domain, however, may result insignificant savings and economical and ecological advantages.For instance, the use ofintelligent waste containers, which detectthe level of load and allow for an optimization of the collectortrucks route, can reduce the cost of waste collection and improvethe quality of recycling .3 To realize such a smart wastemanagement service, the IoT shall connect the end devices, i.e.,ntelligent waste containers, to a control center where an optimizationsoftware processes the data and determines the optimalmanagement of the collector truck fleet.

Air Quality: The European Union officially adopted a 20-20-20 Renewable Energy Directive setting climate change reductiongoals for the next decade.4 The targets call for a 20% reduction ingreenhouse gas emissions by 2020 compared with 1990 levels, a 20% cut inenergy consumption through improved energyefficiency by 2020, and a 20% increase in theuse of renewableenergy by 2020. To such an extent, an urban IoT can providemeans to monitor the quality of the air in crowded areas, parks, orfitness trails In addition, communication facilities can beprovided to let health applications running on joggers'devices beconnected to the infrastructure. In such a way, people can alwaysfind the healthiest path for outdoor activities and can be continuouslyconnected to their preferred personal training application.The realization of such a service requires that air quality andpollution sensors be deployed across the city and that the sensordata be made publicly available to citizens.

Noise Monitoring: Noise can be seen as a form of acousticpollution as much as carbon oxide (CO) is for air. In that sense,the city authorities have already issued specific laws to reduce theamount of noise in the city centre at specific hours. An urban IoTcan offer a noise monitoring service to measure the amount ofnoise produced at any given hour in the places that adopt theservice. Besides building a space-time map of the noisepollution in the area, such a service can also be used to enforcepublic security, by means of sound detection algorithms that canrecognize, for instance, the noise of glass crashes or brawls. Thisservice can hence improve both the quiet of the nights in the cityand the confidence ofpublicestablishment owners, although theinstallation of sound detectors or environmental microphones isquite controversial, because of the obvious privacy concerns forthis type of monitoring.

Traffic Congestion: On the same line of air quality and noisemonitoring, a possible Smart City service that can be enabled byurban IoT consists in monitoring the traffic congestion in the city.Even though camera-based traffic monitoring systems are alreadyavailable anddeployed in many cities, low-power widespreadcommunication can provide a densersource of information.Traffic monitoring may be realized by using the sensingcapabilitiesand GPS installed onmodern vehicles, and also adoptinga combination of air quality and acoustic sensors along agiven road. This information is ofgreat importance for cityauthorities and citizens: for the former to discipline traffic andto sendofficers where needed and for the latter to plan in advancethe route to reach the office orto better schedule a shopping trip tothe city centre.

City Energy Consumption: Together with the air quality monitoring service, an urban IoT may provide a service to monitor the energy consumption of the whole city, thus enabling authorities and citizens to get a clear and detailed view of the amount of energy required by the different services (public lighting, transportation, traffic lights, control cameras, heating/ cooling of public buildings, and so on).

In turn, this will make it possible to identify the main energy consumption sources and to set priorities in order to optimize their behavior. This goes in the direction indicated by the European directive for energy efficiency improvement in the next years. In order to obtain such a service, power draw monitoring devices must be integrated with the power grid in the city. In addition, it will also be possible to enhance these service with active functionalities to control local power production structures (e.g., photovoltaic panels). Smart Parking: The smart parking service is based on road sensors and intelligent displays that direct motorists along the best path for parking in the city. The benefits deriving from this service are manifold: faster time to locate a parking slot means fewer CO emission from the car, lesser traffic congestion, and happier citizens. The smart parking service can be directly integrated in the urban IoT infrastructure, because many companies in Europe are providing market products for this application. Furthermore, by using short-range communication technologies, such as Radio Frequency Identifiers (RFID) or Near Field Communication (NFC), it is possible to realize an electronic verification system of parking permits in slots reserved for residents or disabled, thus offering a better service to citizens that can legitimately use those slots and an efficient tool to
quickly spot violations.

Smart Lighting: In order to support the 20-20-20 directive, theoptimization of the street lighting efficiency is an importantfeature. In particular, this service can optimize the street lampintensity according to the time of the day, the weather condition,and the presence of people. In order to properly work, such aservice needs to include thestreet lights into the Smart Cityinfrastructure. It is also possible to exploit the increased numberof connected spots to provide WiFi connection to citizens. Inaddition, a fault detection systemwill be easily realized on top ofthe street light controllers. Automation and Salubrity ofPublic.

Buildings: Another important application of IoT technologies is the monitoringofthe energy consumption and the salubrity of the environment in public buildings (schools, administration offices, and museums) by means of different types of sensors and actuators that control lights, temperature, and humidity. By controlling these parameters, indeed, it is possible to enhance the level of comfort of the persons that live in these environments, which may also have a
positive return in terms of productivity, while reducing the costsfor heating/cooling.

URBAN IOT ARCHITECTURE: From the analysis of the services described in Section II, itclearly emerges that most SmartCity services are based on acentralized architecture, where a dense and heterogeneous set ofperipheral devices deployed over the urban area generate differenttypes of data that are then delivered through suitable communicationtechnologies to a control center, where data storage and processing are performed.A primary characteristic of an urban IoT infrastructure,hence,is its capability of integrating different technologies with the existingcommunication infrastructures in order to support aprogressive evolution of the IoT, with the interconnection ofother devices and the realization of novel functionalities andservices. Another fundamental aspect is the necessity to make(part of) the data collected by the urban IoT easily accessibleby authorities and citizens, to increase the responsiveness ofauthorities to city problems, and to promote the awareness and the participation of citizens in public matters [9]. In the rest of this section, we describe the different componentsof an urban IoT system, as sketched in Fig. 1. We start describingthe web service approach for the design of IoT services, whichrequires the deployment of suitable protocol layers in the differentelements of the network, as shown in the protocol stacks depicted in Fig. 1, besides the key elements of the architecture. Then, we briefly overview the link layer technologies that can be used to interconnect the different parts of the IoT. Finally, we describe the heterogeneous set of devices that concur to the realization of an urban IoT.

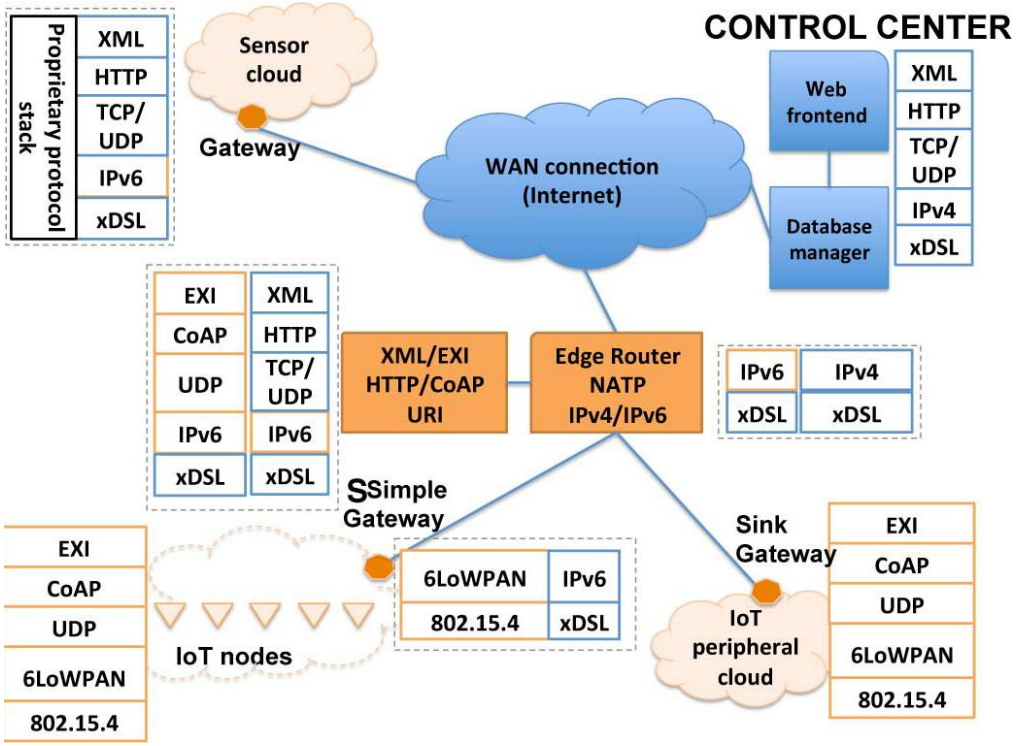

Fig. 1. Conceptual representation of an urban IoT network based on the web service approach.

A. Web Service Approach for IOT Service Architecture

Although in the IoT domain many different standards are still struggling to be the reference one and the most adopted, in this section we focus specifically on IETF standards because they are open and royalty-free, are based on Internet best practices, and can count on a wide community. The IETF standards for IoT embrace a web service architecture for IoT services, which has been widely documented in the literature as a very promising and flexible approach. In fact, web services permit to realize a flexible and interoperable system that can be extended to IoT nodes, through the adoption of the web based paradigm known as Representational State Transfer(ReST) IoT services designed in accordance with theReSTparadigm exhibit very strong similarity with traditional web services, thus greatly facilitating the adoption and use of IoTby both end users and service developers, which will be able toeasily reuse much of the knowledge gained from traditional web technologies

in the development of services for networks containingsmart objects. The web service approach is also promotedby international standardization bodies such as IETF,ETSI,andW3C, among others, as well as European research projects on theIoT such as SENSEI,5 IoT-A,6 and SmartSantander.1Fig. 2 shows a reference protocol architecture for the urban IoTsystem that entails both an unconstrained and a constrainedprotocol stack. Thefirst consists of the protocols that arecurrently the de-facto standards for Internetcommunications,and are commonly used by regular Internet hosts, such as XML,HTTP, and IPv4. These protocols are mirrored in the constrained protocol stack by their low-complexity counterparts, i.e., theEfficient XML Interchange (EXI), the Constrained ApplicationProtocol (CoAP), and 6LoWPAN, which are suitable even forvery constrained devices. The transcoding operations betweenthe protocols in the left and right stacks in Fig. 2 can be performedin a standard and low complexity manner, thus guaranteeing easyaccess and interoperability of the IoT nodes with the Internet.It may be worth remarking that systems that do not adopt theEXI/CoAP/6LoWPAN protocol stack can still be seamlesslyincluded in the urban IoT system, provided that they are capable of interfacing with all the layers of the left-hand side of theprotocol architecture in Fig. 2.In the protocol architecture shown in Fig. 2, we can distinguishthree distinct functional layers, namely (i) Data, (ii) Application/Transport, and (iii) Network, that may require dedicated entitiesto operate the transcoding between constrained and unconstrainedformats andprotocols. In the rest of this section, wespecify in greater detail the requirements at each of the threefunctional layers in order to guarantee interoperability among thedifferent parts of the system.

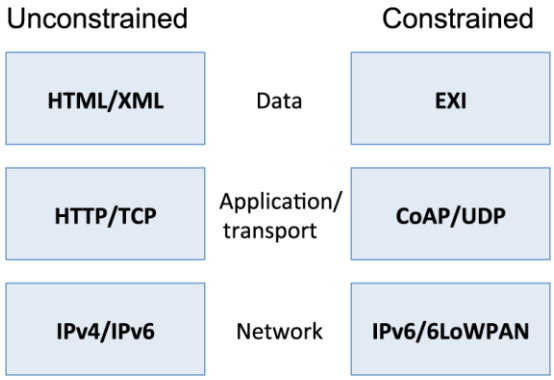

Fig. 2. Protocol stacks for unconstrained (left) and constrained (right) IoT nodes.

1) Data Format: As mentioned, the urban IoT paradigm setsspecific requirements in terms of data accessibility. In architecturesbased on web services, data exchange is typically accompanied by a description of the transferred content by means of semantic representation languages, of which the eXtensible Markup Language (XML) is probably the most common. Nevertheless, the size of XML messages is often too large for the limited capacity of typical devices for the IoT. Furthermore, the text nature of XML representationmakes the parsing of messages by CPU-limited devices morecomplex compared to the binary formats. For these reasons, theworking group of the World Wide Web Consortium (W3C)7 hasproposed the EXI format, which makes it possible even forvery constrained devices to natively support and generatemessages using an open data format compatible with XML. EXI defines two types of encoding, namely schema-less andschema-informed. While theschema-less encoding is generateddirectly from the XML data and can be decoded by any EXI entity without any prior knowledge about the data, the schemainformed encoding assumes that the two EXI processors share an XML Schema before actual encoding and decoding can take place. This shared schema makes it possible to assign numeric identifiers to the XML tags in the schema and build the EXI grammars upon such coding. As discussed in, a general purpose schema-informed EXI processor can be easily integrated even in very constrained devices, enabling them to interpret EXI formats and, hence, making it possible to build multipurpose IoT nodes even out of very constrained devices. Using the schemainformed approach, however, requires additional care in the development of higher layer application, since developers need to define an XML Schema for the messages involved in theapplication and use EXI processors that support this operatingmode. Further details about EXI and schema-informed processingcan be found in ntegration of

multiple XML/EXI data sources into an IoTsystem can be obtained by using the databases typically createdand maintained by high-level applications. In fact, IoT applicationsgenerally build a database of the nodes controlled by the application and, often, of the data generated by such nodes. The database makes it possible to integrate the data received by any IoT device to provide the specific service the application is built for. A generic framework for building IoT web applications according to the guidelines described in this section has been proposed in, where the authors also suggest exploiting the Asynchronous JavaScript and XML (AJAX) capabilities of modern web browsers that allow for a direct communication between the browser and the final IoT node, demonstrating the full internetworking of the protocol stack and the open data nature of the proposed approach.

2) Application and Transport Layers: Most of the traffic thatcrosses the Internet nowadays is carried at the application layer by HTTP over TCP. However, the verbosity and complexity ofnative HTTP make it unsuitable for a straight deployment onconstrained IoT devices. For such an environment, in fact, thehuman-readable format of HTTP, which has been one of thereasons of its success in traditional networks, turns out to be alimiting factor due to the large amount of heavily correlated (and,hence, redundant) data. Moreover, HTTPtypically relies uponthe TCP transport protocol that, however, does not scale well on constrained devices, yielding poor performance for small dataflows in lossy environments. The CoAP protocol overcomes these difficulties by proposing a binary format transported over UDP, handling only the retransmissions strictly required to provide a reliable service. Moreover, CoAP can easily interoperate with HTTP because: (i) it supports the ReST methods of HTTP (GET, PUT, POST, and DELETE), (ii) there is a one-to-one correspondence betweenthe response codes of the two protocols, and (iii) the CoAP

options can support a wide range of HTTP usage scenarios. Even though regular Internet hosts can natively support CoAP to directly talk to IoT devices, the most general and easily interoperable solution requires the deployment of an HTTP-CoAP intermediary, also known as cross proxy that can straightforwardly translate requests/responses between the two protocols, thus enabling transparent interoperation with native HTTP devices and applications.

3) Network Layer: IPv4 is the leading addressing technology

supported by Internet hosts. However, IANA, the international organization that assigns IP addresses at a global level, hasrecently announced the exhaustion of IPv4 address blocks. IoTnetworks, in turn, are expected to include billions of nodes, each ofwhich shall be (in principle) uniquely addressable. A solution tothis problem is offered by the IPv6 standard [24], which providesa 128-bit address field, thus making it possible to assign a unique IPv6 address to any possible node in the IoT network.

While, on the one hand, the huge address space of IPv6 makesit possible to solve the addressing issues in IoT; on the otherhand, it introduces overheads that are not compatible with thescarce capabilities of constrained nodes. This problem can beovercome by adopting 6LoWPAN, which is anestablished compression format for IPv6 and UDP headers overlow-power constrained networks. A border router, which is adevice directly attached to the 6LoWPANnetwork, transparentlyperforms the conversionbetween IPv6 and 6LoWPAN, translatingany IPv6 packet intended for a node in the 6LoWPANnetwork into a packet with 6LoWPAN header compressionformat, and operating the inverse translation in the oppositedirection.

While the deployment of a 6LoWPAN border router enablestransparent interaction between IoT nodes and any IPv6 host inthe Internet, the interaction with IPv4-only hosts remains anissue. More specifically, the problem consists in finding a way toaddress a specific IPv6 host using an IPv4 address and othermeta-data available in the packet. In the following, we presentdifferent approaches to achieve this goal. v4/v6 Port Address Translation (v4/v6 PAT). This methodmaps arbitrary pairs of IPv4 addresses and TCP/UDP ports intoIPv6 addresses and TCP/UDP ports. It resembles the classical Network Address and Port Translation (NAPT) service currently supported in many LANs to provide Internet access to a numberof hosts in a private network by sharing a common public IPv4address, which isused to address the packets over the public Internet. When a packet is returned to the IPv4 common address,the edge router that supports the NATP service will intercept the

packet and replace the common IPv4 destination address with the(private) address of the intended receiver, which is determined bylooking up in the NATP table the address of the host associated tothe specific destination port carried by the packet. The same technique can be used to map multiple IPv6 addresses into asingle IPv4 public address, which allows the forwarding of thedatagrams in the IPv4 network and its correct management atIPv4-only hosts. The application of this technique requires lowcomplexity and, indeed, port mapping is an established techniquefor v4/v6 transition. On the other hand, this approach raisesa scalability problem, since the number of IPv6 hosts that can bemultiplexed into a singleIPv4 address is limited by the number ofrequires that the connection be initiated by the IPv6 nodes inorder to create the correct entries in the NATP look-up table.Connections starting from the IPv4 cloud can also be realized,but this requires a more complex architecture, with the local DNSplaced within the IPv6 network and statically associated to public IPv4 address in the NATP translation table v4/v6 Domain Name Conversion. This method, originally proposed in [23], is similar to the technique used to provide virtual hosting service in HTTP 1.1, which makes it possible tosupport multiple websites on the same web server, sharing thesame IPv4 address, by exploiting the information contained inthe HTTP Host header to identify the specific web site requestedby the user. Similarly, it is possible to programthe DNS servers insuch a way that, upon a DNS request for the domain name of anIoT web service, the DNS returns the IPv4 address of an HTTPCoAPcross proxy to be contacted to access the IoT node. Once addressed by an HTTP request, the proxy requires the resolutionof the domain namecontained in the HTTP Host header to theIPv6 DNS server, which replies with the IPv6 address thatidentifies the final IoT node involved in the request. The proxy can then forward the HTTP message to the intended IoT viaCoAP.URI mapping. The Universal Resource Identifier (URI) mappingtechnique is also described. This technique involvesa particular type of HTTP-CoAP cross proxy, the reverse crossproxy. Thisproxy behaves as being the final web server to theHTTP/IPv4 client and as the originalclient to the CoAP/IPv6web server. Since this machine needs to be placed in a part of thenetwork where IPv6 connectivity is present to allowdirect accessto the final IoT nodes, IPv4/IPv6 conversion is internallyresolved by the applied URI mapping function. B. Link Layer TechnologiesAn urban IoT system, due to its inherently large deploymentarea, requires a set of link layer technologies that can easily covera wide geographical area and, at the same time, support a possiblylarge amount of traffic resulting from the aggregation of anextremely high number of smaller data flows. For these reasons,link layer technologies enabling the realization of an urban IoTsystem are classified into unconstrained and constrained technologies.The first group includes all the traditional LAN,MAN,and WAN communication technologies, such as Ethernet, WiFi,fiber optic, broadband Power Line Communication (PLC), andcellular technologies such asUMTS and LTE. They are generally

characterized by high reliability, low latency, and high transferrates (order of Mbit/s or higher), and due to their inherentcomplexity and energy consumption are generally not suitablefor peripheral IoT nodes.

The constrained physical and link layer technologies are,instead, generally characterizedbylow energy consumption andrelatively low transfer rates, typically smaller than 1 Mbit/s. Themore prominent solutions in this category are IEEE 802.15.4

Bluetooth and Bluetooth Low Energy,8 IEEE 802.11Low Power, PLC [29], NFC and RFID [These links usuallyexhibit long latencies, mainly due to two factors: 1) the intrinsicallylow transmission rate at the physical layer and 2) the powersavingpolicies implemented by the nodes to save energy, whichusually involve duty cycling withshort active periods.

C. Devices

We finally describe the devices that are essential to realize anurban IoT, classified based on the position they occupy in thecommunication flow.

1) Backend Servers: At the root of the system, we find thebackend servers, located in the control center, where data arecollected, stored, and processed to produce added-value services.In principle, backend servers are not mandatory for an IoT systemto properly operate, though they become a fundamentalcomponent of an urban IoT where they can facilitate the access tothe smart city services and open data through the legacy

networkinfrastructure. Backend systems commonly considered forinterfacing with the IoTdata feeders include the following.

Database management systems: These systems are incharge of storing the large amount of information produced byIoT peripheral nodes, such assensors. Depending on the particularusage scenario, the load on these systems can be quite large,so that proper dimensioning of the backend system is required.

Web sites: The widespread acquaintance of people with webinterfaces makes them the first option to enable interoperationbetween the IoT system and the "data consumers," e.g., publicauthorities, service operators, utility providers, and commoncitizens.

Enterprise resource planning systems (ERP): ERP componentssupport a variety of business functions and are precioustools to manage the flow of information across a complexorganization, such as a city administration. Interfacing ERPcomponents withdatabase management systems that collect thedata generated by the IoT allows for a simpler management ofthe potentially massive amount of data gathered by the IoT,making it possible to separate the information flows based ontheir nature and relevance and easing the creation of newservices.

2) Gateways: Moving toward the "edge" of the IoT, we findthe gateways, whose role is to interconnect the end devicesto the main communication infrastructure of the system. With
reference to the conceptual protocol architecture depicted inFig. 2, the gateway ishencerequired to provide protocoltranslation and functional mapping between the unconstrainedprotocols and their constrained counterparts, that is to say XMLEXI,HTTP-CoAP, IPv4/v6-6LoWPAN.Note that while all these translations may be required in orderto enable interoperability with IoT peripheral devices and control stations, it is not necessary toconcentrate all of them in a singlegateway. Rather, it is possible, and sometimes convenient, todistribute the translation tasks over different devices in thenetwork. For example, a single HTTP-CoAP proxy can bedeployed to support multiple 6LoWPAN border routers.Gateway devices shall also provide the interconnection betweenunconstrained link layer technologies, mainly used in thecore of the IoT network, and constrained technologies that,instead, provide connectivity among the IoT peripheral nodes.

3) IoT Peripheral Nodes: Finally, at the periphery of the IoTsystem, we find the devices in charge of producing the datato be delivered to the control center, which are usually calledIoT peripheral nodes or, more simply, IoT nodes. Generallyspeaking, the cost of these devices is very low, starting from10 USD or even less, depending on the kind and number ofsensors/actuators mounted on the board. IoT nodes may beclassified based on a wide number of characteristics, such as powering mode, networking role (relay or leaf), sensor/actuatorequipment, and supported link layer technologies. The mostconstrained IoT nodes are likely the Radio Frequency tags(RFtags) that, despite their very limited capabilities, can stillplay an important role in IoT systems, mainly because of theextremely low cost and the passive nature of their communication hardware, which does not require any internal energysource. The typical application of RFtags is object identification by proximity reading, which can be used for logistics, maintenance, monitoring, and other services.Mobile devices, such as smart phones, tablet PCs, or laptops, may also be an important part of an urban IoT, providing otherways to interact with it. For instance, the NFC transceiver integrated in last-generation smart phones may be used to identify tagged objects, while the geolocation service provided by most common operating systems for mobile devices can enrich the context information associated to that object. Furthermore,mobile devices can provide access to the IoT in different ways,e.g., 1) through an IP connection provided by the cellular datalinkservice or 2) setting up a direct connection with some objectsby using short-range wireless technologies, such as BluetoothLow Energy, low-power WiFi, or IEEE 802.15.4. Furthermore, itis possible to develop specific applications for mobile devices that can ease the interaction with the IoT objects, and with the system as a whole.

CONCLUSION

In this paper, we analyzed the solutions currently available for the implementation of urban IoTs. The discussed technologies are close to being standardized, and industry players are alreadyactive in the production of devices that take advantage of the setechnologies to enable the applications of interest, such as

those described in Section II. In fact, while the range of design options for IoT systems is rather wide, the set of open and standardized protocols is significantly smaller. The enabling technologies, furthermore, have reached a level of maturity that allows for the practical realization of IoT solutions and services, starting from field trials that will hopefully help clear the uncertainty that still prevents a massive adoption of the IoT paradigm. A concrete proof-of-concept implementation, deployed in collaboration
with the city of Padova, Italy, has also been described as relevant example of application of the IoT paradigm to smart cities.

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THE INTERNET OF THINGS (IOT) - NEXT LEVEL OF INNOVATION

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Abstract
The Internet of things (IoT) is the network of physical devices, vehicles, home appliances and other items embedded with electronics, software, sensors, actuators, and network connectivity which enables these objects to connect and exchange data. Each thing is uniquely identifiable through its embedded computing system but is able to inter-operate within the existing Internet infrastructure. Experts estimate that the IoT will consist of about 30 billion objects by 2020. It is also estimated that the global market value of IoT will reach $7.1 trillion by 2020. This paper analyse the evaluation of IoT, top 10 IoT applications in the world, world IoT market size and also Indian IoT Market Size.

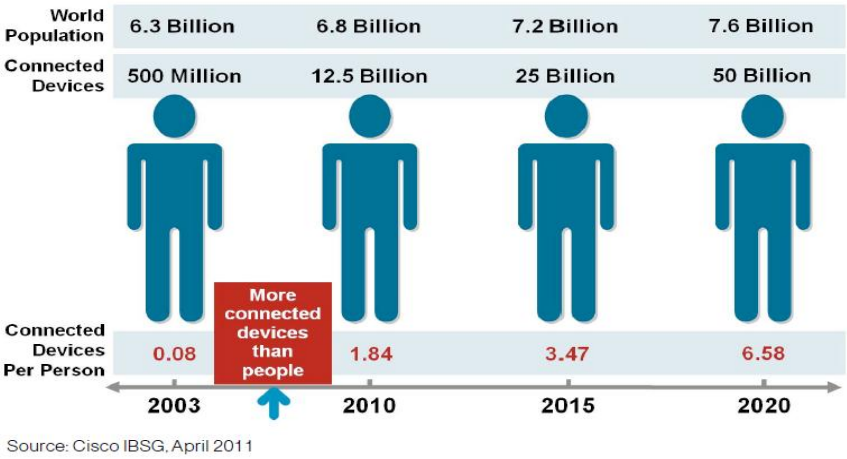
1. Introduction

The Internet of Things (IoT), sometimes referred to as the Internet of Objects, will change everything—including ourselves. This may seem like a bold statement, but consider the impact the Internet already has had on education, communication, business, science, government, and humanity. Clearly, the Internet is one of the most important and powerful creations in all of human history. Now consider that IoT represents the next evolution of the Internet, taking a huge leap in its ability to gather, analyze, and distribute data that we can turn into information, knowledge, and, ultimately, wisdom. In this context, IoT becomes immensely important. Already, IoT projects are under way that promise to close the gap between poor and rich, improve distribution of the world's resources to those who need them most, and help us understand our planet so we can be more proactive and less reactive. Even so, several barriers exist that threaten to slow IoT development, including the transition to IP, having a common set of standards, and developing energy sources for millions—even billions—of minute sensors. However, as businesses, governments, standards bodies, and academia work together to solve these challenges, IoT will continue to progress. The goal of this paper, therefore, is to educate you in plain and simple terms so you can be well versed in IoT and understand its potential to change everything we know to be true today.

IoT Today As with many new concepts, IoT's roots can be traced back to the Massachusetts Institute of Technology (MIT), from work at the Auto-ID Center. Founded in 1999, this group was working in the field of networked radio frequency identification (RFID) and emerging sensing technologies. The labs consisted of seven research universities located across four continents. These institutions were chosen by the Auto-ID Center to design the architecture for IoT. Before we talk about the current state of IoT, it is important to agree on a definition. According to the Cisco Internet Business Solutions Group (IBSG), IoT is simply the point in time when more "things or objects" were connected to the Internet than people. In 2003, there were approximately 6.3 billion people living on the planet and 500 million devices connected to the Internet. By dividing the number of connected devices by the world population, we find that there was less than one (0.08) device for every person. Based on Cisco IBSG's definition, IoT didn't yet exist in 2003 because the number of connected things was relatively small given that ubiquitous devices such as smartphones were just being introduced. For example, Steve Jobs, Apple's CEO, didn't unveil the iPhone until January 9, 2007 at the Macworld conference.

Explosive growth of smartphones and tablet PCs brought the number of devices connected to the Internet to 12.5 billion in 2010, while the world's human population increased to 6.8 billion, making the number of connected devices per person more than 1 (1.84 to be exact) for the first time in history. Refining these numbers further, Cisco IBSG estimates IoT was "born" sometime between 2008 and 2009 (see Figure 1).

Today, IoT is well under way, as initiatives such as Cisco's Planetary Skin, smart grid, and intelligent vehicles continue to progress.

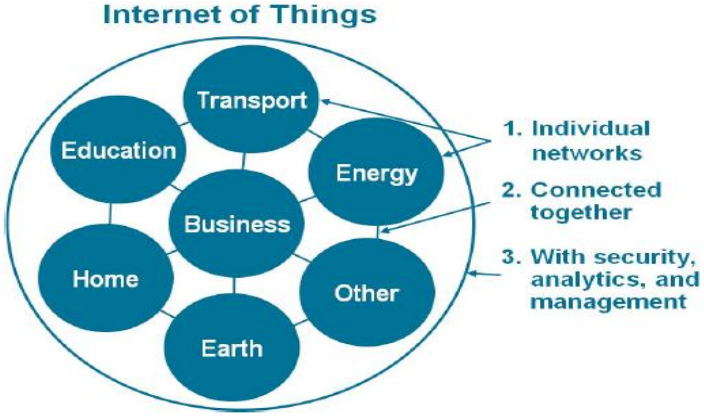


Source: Cisco IBSG, April 2011

Looking to the future, Cisco IBSG predicts there will be 25 billion devices connected to the Internet by 2015 and 50 billion by 2020. It is important to note that these estimates do not take into account rapid advances in Internet or device technology; the numbers presented are based on what is known to be true today. Additionally, the number of connected devices per person may seem low. This is because the calculation is based on the entire world population, much of which is not yet connected to the Internet. By reducing the population sample to people actually connected to the Internet, the number of connected devices per person rises dramatically. For example, we know that approximately 2 billion people use the Internet today. Using this figure, the number of connected devices per person jumps to 6.25 in 2010, instead of 1.84. Of course, we know nothing remains static, especially when it comes to the Internet. Initiatives and advances, such as Cisco's Planetary Skin, HP's central nervous system for the earth (CeNSE), and smart dust, have the potential to add millions—even billions—of sensors to the Internet. As cows, water pipes, people, and even shoes, trees, and animals become connected to IoT, the world has the potential to become a better place.

IoT as a Network of Networks Currently, IoT is made up of a loose collection of disparate, purpose-built networks. Today's cars, for example, have multiple networks to control engine function, safety features, communications systems, and so on. Commercial and residential buildings also have various control systems for heating, venting, and air conditioning (HVAC); telephone service; security; and lighting. As IoT evolves, these networks, and many others, will be connected with added security, analytics, and management capabilities (see Figure 2). This will allow IoT to become even more powerful in what it can help people achieve.

Figure 2. IoT Can Be Viewed as a Network of Networks



Source: Cisco IBSG, April 2011

Interestingly, this situation mirrors what the technology industry experienced in the early days of networking. In the late 1980s and early 1990s, Cisco, for example, established itself by bringing disparate networks together with multi-protocol routing, eventually leading to IP as the common networking standard. With IoT, history is repeating itself, albeit on a much grander scale.

Why Is IoT Important? Before we can begin to see the importance of IoT, it is first necessary to understand the differences between the Internet and the World Wide Web (or web)—terms that are often used interchangeably. The Internet is the physical layer or network made up of switches, routers, and other equipment. Its primary function is to transport information from one point to another quickly, reliably, and securely. The web, on the other hand, is an application layer that operates on top of the Internet. Its primary role is to provide an interface that makes the information flowing across the Internet usable.

2. Evolution of the Web Versus the Internet

The web has gone through several distinct evolutionary stages:

1. **Stage 1.** First was the research phase, when the web was called the Advanced Research Projects Agency Network (ARPANET). During this time, the web was primarily used by academia for research purposes.
2. **Stage 2.** The second phase of the web can be coined "brochureware." Characterized by the domain name "gold rush," this stage focused on the need for almost every company to share information on the Internet so that people could learn about products and services.
3. **Stage 3.** The third evolution moved the web from static data to transactional information, where products and services could be bought and sold, and services could be delivered. During this phase, companies like eBay and Amazon.com exploded on the scene. This phase also will be infamously remembered as the "dot-com" boom and bust.
4. **Stage 4.** The fourth stage, where we are now, is the "social" or "experience" web, where companies like Facebook, Twitter, and Groupon have become immensely popular and profitable (a notable distinction from the third stage of the web) by allowing people to communicate, connect, and share information (text, photos, and video) about themselves with friends, family, and colleagues.

3. IoT: First Evolution of the Internet

By comparison, the Internet has been on a steady path of development and improvement, but arguably hasn't changed much. It essentially does the same thing that it was designed to do during the ARPANET era. For example, in the early days, there were several communication protocols, including AppleTalk, Token Ring, and IP.

Today, the Internet is largely standardized on IP. In this context, IoT becomes immensely important because it is the first real evolution of the Internet—a leap that will lead to revolutionary applications that have the potential to dramatically improve the way people live, learn, work, and entertain themselves. Already, IoT has made the Internet sensory (temperature, pressure, vibration, light, moisture, stress), allowing us to become more proactive and less reactive.

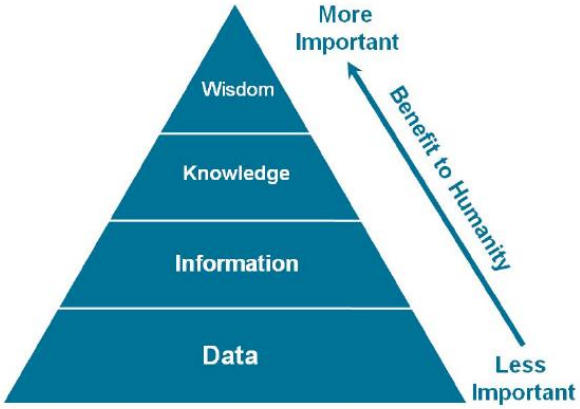
In addition, the Internet is expanding into places that until now have been unreachable. Patients are ingesting Internet devices into their own bodies to help doctors diagnose and determine the causes of certain diseases. 10 Extremely small sensors can be placed on plants, animals, and geologic features, and connected to the Internet. 11 At the other end of the spectrum, the Internet is going into space through Cisco's Internet Routing in Space (IRIS) program.

4. We Evolve Because We Communicate

Humans evolve because they communicate. Once fire was discovered and shared, for example, it didn't need to be rediscovered, only communicated. A more modern-day example is the discovery of the helix structure of DNA, molecules that carry genetic information from one generation to another. After the article was published in a scientific paper by James Watson and Francis Crick in April 1953, the disciplines of medicine and genetics were able to build on this information to take giant leaps forward.

This principle of sharing information and building on discoveries can best be understood by examining how humans process data (see Figure 3). From bottom to top, the pyramid layers include data, information, knowledge, and wisdom. Data is the raw material that is processed into information. Individual data by itself is not very useful, but volumes of it can identify trends and patterns. This and other sources of information come together to form knowledge. In the simplest sense, knowledge is information of which someone is aware. Wisdom is then born from knowledge plus experience. While knowledge changes over time, wisdom is timeless, and it all begins with the acquisition of data.

Figure 3. Humans Turn Data into Wisdom

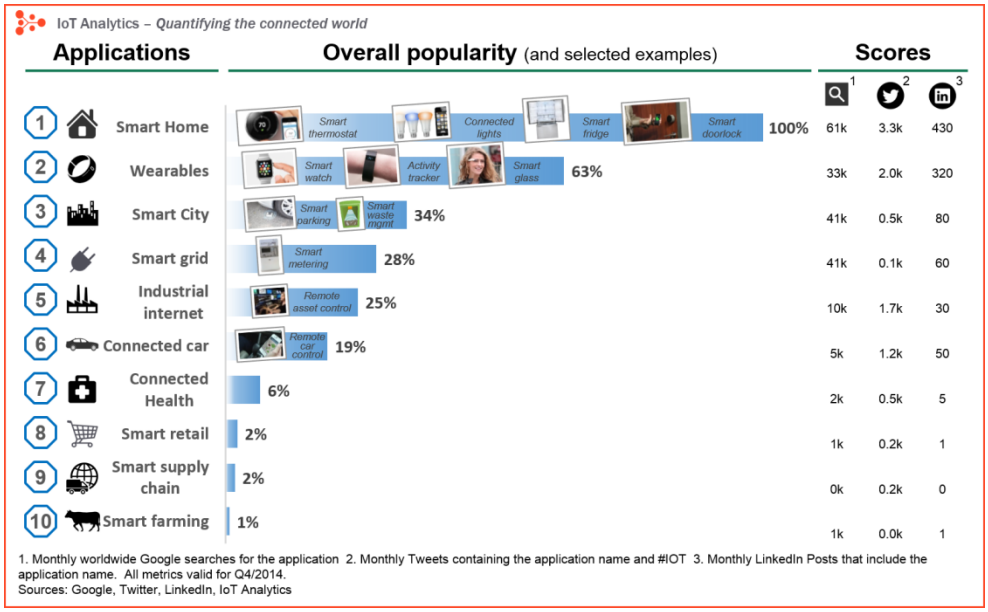


Source: Cisco IBSG, April 2011

It is also important to note there is a direct correlation between the input (data) and output (wisdom). The more data that is created, the more knowledge and wisdom people can obtain. IoT dramatically increases the amount of data available for us to process. This, coupled with the Internet's ability to communicate this data, will enable people to advance even further.

5. The Internet of Things applications ranking

The highest score received a rating of 100%, the other Internet of Things applications were ranked with a percentage that represents the relation to the highest score (relative ranking).



- **Smart home:** Smart Home clearly stands out, ranking as highest Internet of Things application on all measured channels. More than 60,000 people currently search for the term "Smart Home" each month. This is not a surprise. The IoT Analytics company database for Smart Home includes 256 companies and startups.

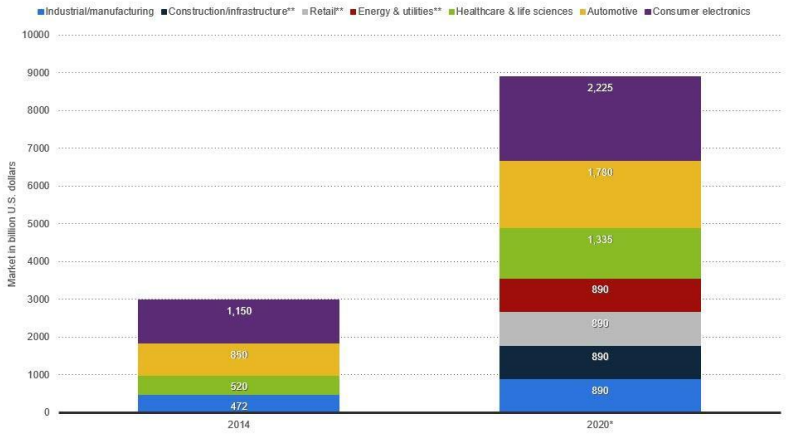
More companies are active in smart home than any other application in the field of IoT. The total amount of funding for Smart Home startups currently exceeds $2.5bn. This list includes prominent startup names such as Nest or AlertMe as well as a number of multinational corporations like Philips, Haier, or Belkin.

- **Wearables:** Wearables remains a hot topic too. As consumers await the release of Apple's new smart watch in April 2015, there are plenty of other wearable innovations to be excited about: like the Sony Smart B Trainer, the Myo gesture control, or LookSee bracelet. Of all the IoT startups, wearables maker Jawbone is probably the one with the biggest funding to date.
- **Smart City:** Smart city spans a wide variety of use cases, from traffic management to water distribution, to waste management, urban security and environmental monitoring. Its popularity is fueled by the fact that many Smart City solutions promise to alleviate real pains of people living in cities these days. IoT solutions in the area of Smart City solve traffic congestion problems, reduce noise and pollution and help make cities safer.
- **Smart grids:** Smart grids is a special one. A future smart grid promises to use information about the behaviors of electricity suppliers and consumers in an automated fashion to improve the efficiency, reliability, and economics of electricity. 41,000 monthly Google searches highlights the concept's popularity. However, the lack of tweets (Just 100 per month) shows that people don't have much to say about it.
- **Industrial internet:** The industrial internet is also one of the special Internet of Things applications. While many market researches such as Gartner or Cisco see the industrial internet as the IoT concept with the highest overall potential, its popularity currently doesn't reach the masses like smart home or wearables do. The industrial internet however has a lot going for it. The industrial internet gets the biggest push of people on Twitter (~1,700 tweets per month) compared to other non-consumer-oriented IoT concepts.
- **Connected car:** The connected car is coming up slowly. Owing to the fact that the development cycles in the automotive industry typically take 2-4 years, we haven't seen much buzz around the connected car yet. But it seems we are getting there. Most large auto makers as well as some brave startups are working on connected car solutions. And if the BMWs and Fords of this world don't present the next generation internet connected car soon, other well-known giants will: Google, Microsoft, and Apple have all announced connected car platforms.
- **Connected Health (Digital health/Telehealth/Telemedicine):** Connected health remains the sleeping giant of the Internet of Things applications. The concept of a connected health care system and smart medical devices bears enormous potential, not just for companies also for the well-being of people in general. Yet, Connected Health has not reached the masses yet. Prominent use cases and large-scale startup successes are still to be seen.
- **Smart retail**: Proximity-based advertising as a subset of smart retail is starting to take off. But the popularity ranking shows that it is still a niche segment. One LinkedIn post per month is nothing compared to 430 for smart home.
- **Smart supply chain:** Supply chains have been getting smarter for some years already. Solutions for tracking goods while they are on the road, or getting suppliers to exchange inventory information have been on the market for years. So while it is perfectly logic that the topic will get a new push with the Internet of Things, it seems that so far its popularity remains limited.
- **Smart farming:** Smart farming is an often overlooked business-case for the internet of Things because it does not really fit into the well-known categories such as health, mobility, or industrial. However, due to the remoteness of farming operations and the large number of livestock that could be monitored the Internet of Things could revolutionize the way farmers work. But this idea has not yet reached large-scale attention. Nevertheless, one of the Internet of Things applications that should not be underestimated. Smart farming will become the important application field in the predominantly agricultural-product exporting countries.

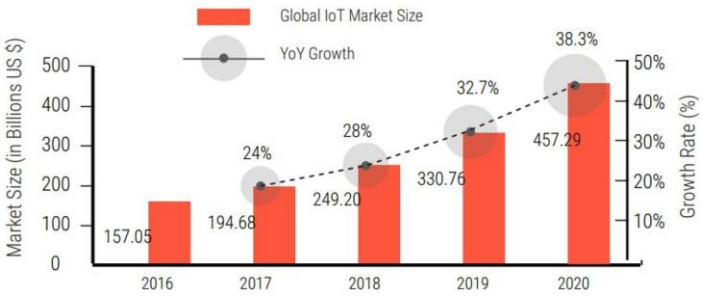
6. World IOT Market:

The global Internet of Things (IoT) market is projected to grow from $2.99T in 2014 to $8.9T in 2020, attaining a 19.92% Compound Annual Growth Rate (CAGR). Industrial manufacturing is predicted to increase from $472B in 2014 to $890B in global IoT spending. Healthcare and life sciences are projected to increase from $520B in 2014 to $1.335T in 2020, attaining a 17% CAGR.

Size of the Internet of Things market worldwide in 2014 and 2020, by industry (in billion U.S. dollars)

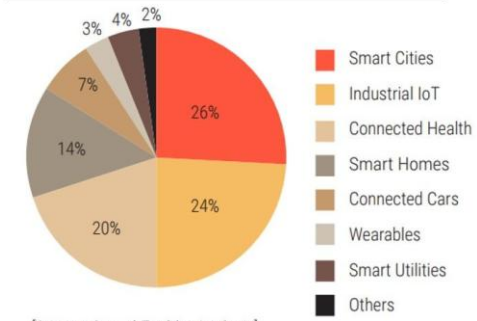


The global IoT market will grow from $157B in 2016 to $457B by 2020, attaining a Compound Annual Growth Rate (CAGR) of 28.5%. According to GrowthEnabler & MarketsandMarkets analysis, the global IoT market share will be dominated by three sub-sectors; Smart Cities (26%), Industrial IoT (24%) and Connected Health (20%). Followed by Smart Homes (14%), Connected Cars (7%), Smart Utilities (4%) and Wearables (3%).



[Sources: GrowthEnabler Analysis/MarketsandMarkets]

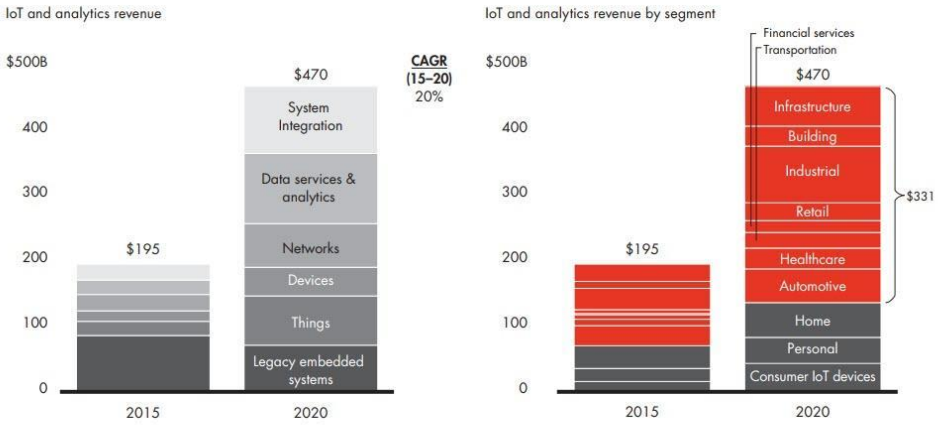
Global IoT Market Share by Sub-Sector



[Source: GrowthEnabler Analysis]

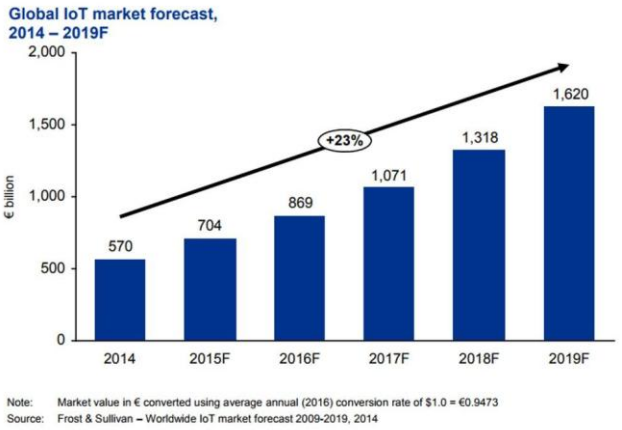
Bain predicts B2B IoT segments will generate more than $300B annually by 2020, including about $85B in the industrial sector. Advisory firm Bain predicts the most competitive areas of IoT will be in the enterprise and industrial segments. Bain predicts consumer applications will generate $150B by 2020, with B2B applications being worth more than $300B. Globally, enthusiasm for the Internet of Things has fueled more than $80B in merger and acquisition (M&A) investments by major vendors and more than $30B in venture capital, according to Bain's estimates.

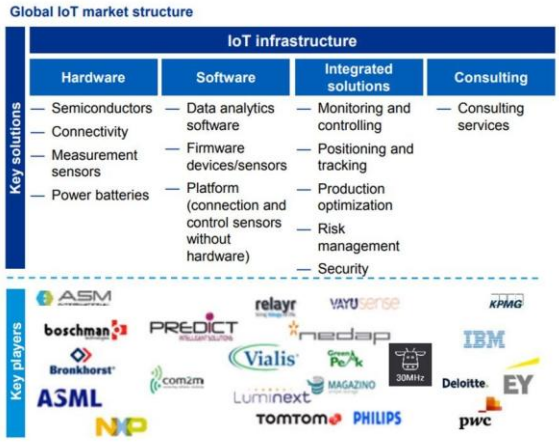
Figure 1: B2B segments will generate more than $300 billion annually by 2020, including about $85 billion in the industrial sector



Notes: Things and legacy hardware include semiconductors for sensing, communication, processing, memory and modules (boards for housing silicon); consumer IoT devices includes hobbyist drones, smart garments, smartwatches, sports watches, wearable cameras, wristbands, head-mounted displays, other fitness monitors; data services includes the value of subsidized consumer IoT devices
Sources: Gartner; IDC; Harbor; Cisco; Ericsson; Machina Research; Ovum; industry interviews; Bain & Company

The global IoT market is growing at a 23% CAGR of 23% between 2014-2019, enabling smart solutions in major industries including agriculture, automotive and infrastructure. — Key challenges to growth are the security and scalability of all-new connected devices and the adherence to open standards to facilitate large-scale monitoring of different systems.





7. IOT in India: India's $150 billion information technology (IT) industry is in a state of turmoil, but there is one bright spot: the Internet of Things (IoT). Employees at the country's billion-dollar behemoths are quickly re-skilling themselves to work with the new-age technology needed to add sensors to machines so that they can be monitored and controlled over the internet. As a result, India's technology firms are doing IoT-related business worth $1.52 billion, accounting for 44% of the $3.5 billion global IoT technology services outsourcing market in 2017, according to a report by Bengaluru-based research, consulting, and advisory firm Zinnov, released on Aug. 07. The largest share—43%—of India's IoT-services activity is dedicated to product engineering. India-based legacy companies like Tata Consultancy Services (TCS), HCL, Wipro, Infosys, and Tech Mahindra are listed among the "established" and "expansive" market leaders in the IoT space. And other local companies, like L&T Technologies, TATA Elxsi, Persistent Systems, L&T Infotech, and Happiest Minds, have moved significantly over the past year in rankings among Indian providers.

All of these players are set to gain as the global IoT technology products and services spend is expected to climb up significantly from around $140 billion in 2017 to $322 billion by 2022. But while IoT technology is expected to create 25,000 jobs by 2021, far more jobs—94,000 of them—will be eliminated at the same time, Zinnov estimated last year, compounding the problem of layoffs related to automation. That means that

going forward, Indian companies will not only need to diversify in the kind of technology services they offer, but also look beyond the IT industry for work.

8. Conclusion:

The vast network of devices connected to the Internet, including smart phones and tablets and almost anything with a sensor on it – cars, machines in production plants, jet engines, oil drills, wearable devices, and more. These "things" collect and exchange data. IoT – and the machine-to-machine (M2M) technology behind it – are bringing a kind of "super visibility" to nearly every industry. With over 20 billion internet-connected devices expected to run by 2020, the deluge of data streams from these devices would warrant the use of edge computing, sophisticated analytics and AI. Innovative interplay of such technologies to produce desirable use cases is egging on the growth of Internet of Things (IoT) today.

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ENERGY METER

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Abstract:
The world we live in has limited energy resources and thus there exists a need to save as much as energy as possible. We have a traditional energy meter which is used to measure the amount of electric energy consumed in any residence. But this traditional energy meter has quite a few shortcomings such as construction liabilities, narrow bandwidth, low rate, poor real time, not two-way communication quickly etc. To overcome these problems, we use Energy Meter based on the Internet of Things. Countries such as the United States of America and a few European countries have adopted Automated Meter Reading (AMR) systems. The methodology we propose uses hardware Raspberry Pi which is used to take data from the device and calculate the bill which is sent to the customer.

1. Introduction

Internet of things (IOT) is a network comprising of electronic devices and sensors connected to exchange information over the internet. In our experiment, the current is extracted from the electronic devices and sent to the ADC, where the converted values are sent to the Raspberry Pi where the power value is calculated and then sent to the database across internet. Before the invention of the smart meter traditional meters were used.

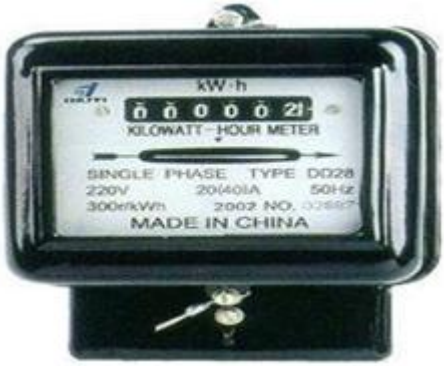

Figure 1. Traditional Energy Meter

But they had problems such as more prone to errors and not being able to detect tampering. IOT is comparatively cost effective than SMS which makes monitoring energy meters at lower cost possible. Month end consumption reports are generated which is monitored via web portal. Registered customers can also make their payment online. The customer initially has to go to the website and register, this is where the customer details gets recorded in the database, with an auto generated registration number which becomes the primary key. He later need only to log into his account and check for payment details. The payment notification can be send either to his email or as an SMS to the customer. Through such a system the users can be aware of their electricity consumption and give a helping hand towards Energy meter.

2. System Design

This section deals with overall working and system design of this project. Our main aim is to send the power consumed by the customer directly to the utility without manual reading at the end of the month. The power consumed and its corresponding bill is then mailed to the customer. To simulate home wiring and meter w have used a simple circuit. Information is transmitted by modulating a continuous transmission signal by amplifying signal's strength or varying its frequency to add or take away data. The current flow through this circuit is measured using a current sensor which is analog and converted into digital using an ADC. The current

value is obtained and the power is calculated using Raspberry Pi. This value is then sent to the database and stored and the total bill is calculated and email is generated for the respective user. So if a user wants to avail this service he/she should register and the pi is set up for the user and thereafter the working is as mentioned above. The user is also provided with a service of online payment of his bills and given deadlines. Failure of payment will be notified to the admin and he is authorized to take further actions.

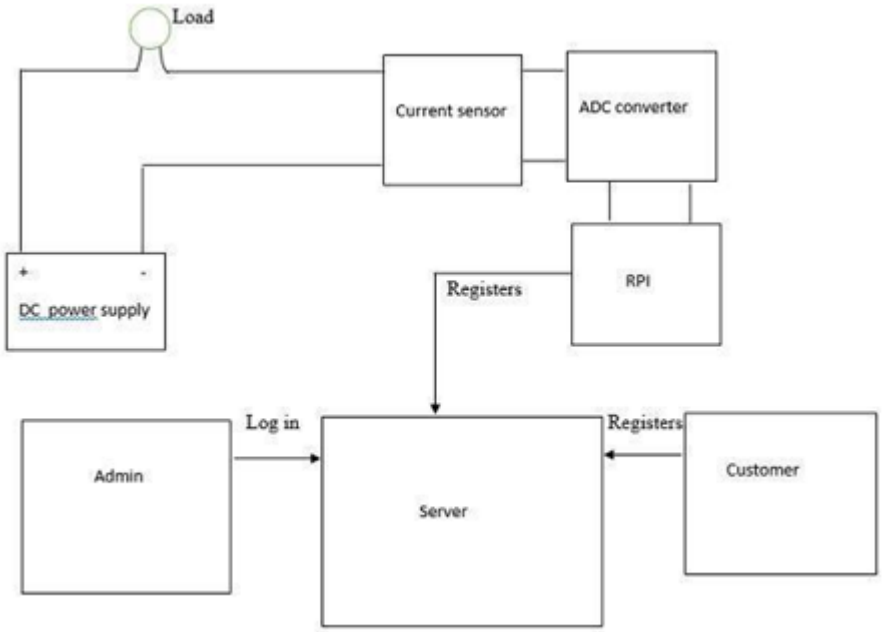

Figure 2. Circuit diagram

3. Hardware

3.1. Raspberry Pi: The Raspberry Pi is a credit-card-sized computer that plugs into your TV and a keyboard. It is a capable little computer which can be used in electronics projects, and for many of the things your desktop PC does, like spreadsheets, word. processing, browsing the internet, and playing games.

3.2. Analog-to -digital Converter: An analog-to-digital converter, or ADC as it is more commonly called, is a device that converts analog signals into digital signals. Analog information is transmitted by modulating a continuous transmission signal by amplifying a signal's strength or varying its frequency to add or take away data.

3.3. Current Sensor: A current sensor is a device that detects electric current (AC or DC) in a wire, and generates a signal proportional to it. The generated signal could be analog voltage or current or even digital output. It can be then utilized to display the measured current in an ammeter or can be stored for further analysis in a data acquisition system or can be utilized for control purpose .

3.4. Resistor: A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. In electronic circuits, resistors are used to reduce current flow, adjust signal levels, to divide voltages, bias active elements, and terminate transmission lines, among other uses.

3.5. Adapter: An adapter or adaptor is a device that converts attributes of one electrical device or system to those of an otherwise incompatible device or system. Some modify power or signal attributes, while others merely adapt the physical form of one electrical connector to another

4. Software

4.1. Angry ip Scanner: Angry ip scanner is a very fast ip address and port scanner. It runs on Linux, Windows, and Mac OS X, possibly supporting other platforms as well. It can scan IP addresses in any range as well as any their ports. The gathered information may include the following:

1. Whether the host is up (alive, responding) or down (dead, not responding).
2. Average roundtrip time (of IP packets to the destination address and back)
3. Host and domain name (by using a DNS reverse lookup) versions of particular services running on the host open.
4. Filtered TCP and UDP ports.

4.2. VNC Viewer

Also known as virtual network computing. VNC is a graphical desktop sharing system that uses the Remote Frame Buffer protocol (RFB) to remotely control another computer. It transmits the keyboard and mouse events from one computer to another, relaying the graphical screen
updates back in the other direction, over a network. VNC is platform independent – there are clients and servers for many GUI-based operating systems and for Java. Multiple clients may connect to a VNC server at the same time. The VNC client (or viewer) is the program that represents the screen data originating from the server, receives updates from it, and presumably controls it by informing the server of collected local input. The VNC protocol (RFB protocol) is very simple, based on one graphic primitive from server to client ("Put a rectangle of pixel data at the specified X,Y position") and event messages from client to server.

5. Experimental Results

The project obtained results can be divided into three parts namely:

1. Hardware Setup
2. Readings from the hardware
3. Web dashboard for user interaction

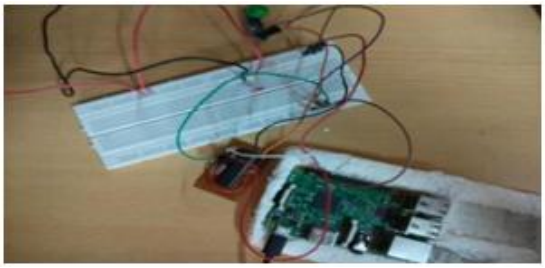

Figure 3. Hardware setup

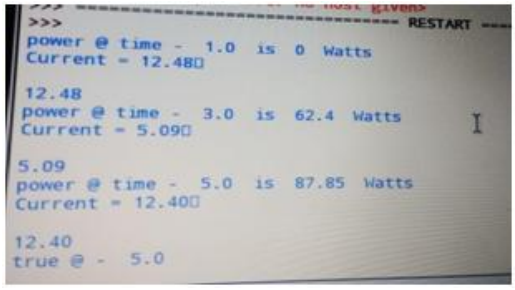

Figure 4. Readings from current sensor

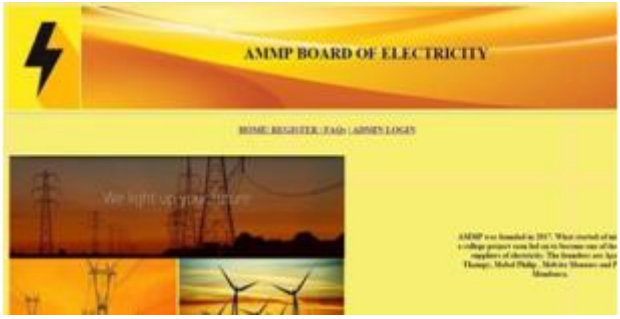

Figure 5. Web page for customers

6. Conclusions

The main aim of this project is to reduce the man power involved in power management. It also avoids data loss. However, the initial setup will cost more than the existing mechanism. It provides better power management for the utility office as the values are directly sent from the meter and stored in their database. This data can be used in future to analyze the usage of power and take necessary measures to optimize power consumption. In addition to this, this mechanism can also provide self-analysis of power consumption of a user so can he/she can reduce the usage.

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INTERNET OF THINGS

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ABSTRACT

Going on for more than a decade and reaches back to Mark Research study on the Internet of Things and Smart Things has been Weiser's original dream of ubiquitous computing. Bruce Sterling recently popularized the idea of Smart Objects and the IoT. Smart Things is another paradigm shift in IT world. Smart Things are the things that are having embedding smartness or intelligence, identification, automation, monitoring and controlling calibre. Smart Things are assisting human life a lot, nowadays without their applications life is becoming cumbersome. This paper exhibits systematically on Internet, Things, and then explores on Internet of Things and finally Smart Things from researchers', and corporate's perspective. Moreover, this article focuses on the state of Smart Things and its applications.

This in turn would help the new researchers, who want to do research in this IoT domain Abstract—Research study on the Internet of Things and Smart Things has been going on for more than a decade and reaches back to Mark Weiser's original dream of ubiquitous computing. Bruce Sterling recently popularized the idea of Smart Objects and the IoT. Smart Things is another paradigm shift in IT world. Smart Things are the things that are having embedding smartness or intelligence, identification, automation, monitoring and controlling calibre. Smart Things are assisting human life a lot, nowadays without their applications life is becoming cumbersome. This paper exhibits systematically on Internet, Things, and then explores on Internet of Things and finally Smart Things from researchers', and corporate's perspective. Moreover, this article focuses on the state of Smart Things and its applications. This in turn would help the new researchers, who want to do research in this IoT domain.

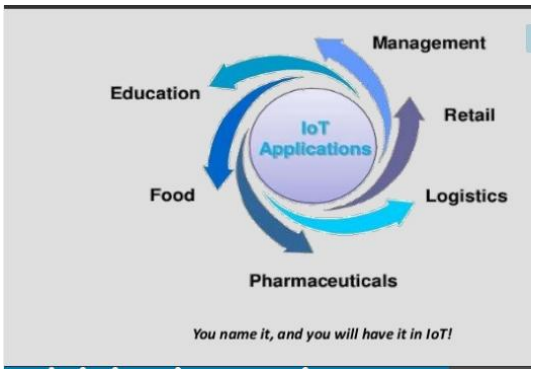
INTRODUCTION

Internet of Things is defined as "An open and comprehensive network of intelligent objects that have the capacity to auto–organize, share information, data and resources, reacting and acting in face situations and changes in the environment". Internet of Things is one of the last advances in Information and Communication Technologies, providing global connectivity and management of sensors, devices, users and information [4]. Imagining the Internet of Things (IoT) being used to track objects like a can of cola or a box of cereal from sites of production to sites of consumption is perhaps not too difficult to imagine. However, there is a movement under way to add almost every imaginable physical object into the Internet of Things. In New Zealand, for example, all cows might had IP addresses embedded in RFID chips .

Furthermore, objects are increasingly able to not just be characterized by a unique identifier, but also to transmit location, automate the things, monitor and context-sensitive datum. The Internet of Things refers to the coding and networking of everyday objects and the things to render them individually machine readable and traceable on the Internet [6]-[11]. Much existing content in the Internet of Things has been created through coded RFID tags and IP addresses linked into an Electronic Product Code network [12]. Currently,

there are 9 billion interconnected devices and it is expected to reach 24 billion devices by 2020. US National Intelligence Counsel foresees that "by 2025 Internet nodes may reside in everyday things-food packages, furniture, paper documents and more" [3]. Internet of Things (IoT) describes a world where just about anything can be connected and communicates in an intelligent fashion that ever before.

APPLICATION:



1. SMART HOME: With IoT creating the buzz, 'Smart Home' is the most searched IoT associated feature on Google. But, what is a Smart Home?

Wouldn't you love if you could switch on air conditioning before reaching home or switch off lights even after you have left home? Or unlock the doors to friends for temporary access even when you are not at home. Don't be surprised with IoT taking shape companies are building products to make your life simpler and convenient.

Smart Home has become the revolutionary ladder of success in the residential spaces and it is predicted Smart homes will become as common as smartphones.

The cost of owning a house is the biggest expense in a homeowner's life. Smart Home products are promised to save time, energy and money. With Smart home companies like Nest, Ecobee, Ring and August, to name a few, will become household brands and are planning to deliver a never seen before experience.

Smart home and concept

2. WEARABLES: Wearables have experienced a explosive demand in markets all over the world. Companies like Google, Samsung have invested heavily in building such devices. But, how do they work?

Wearable devices are installed with sensors and softwares which collect data and information about the users. This data is later pre-processed to extract essential insights about user.

These devices broadly cover fitness, health and entertainment requirements. The pre-requisite from internet of things technology for wearable applications is to be highly energy efficient or ultra-low power and small sized.

Here are some top examples of wearable IoT devices that fulfill these requirements.

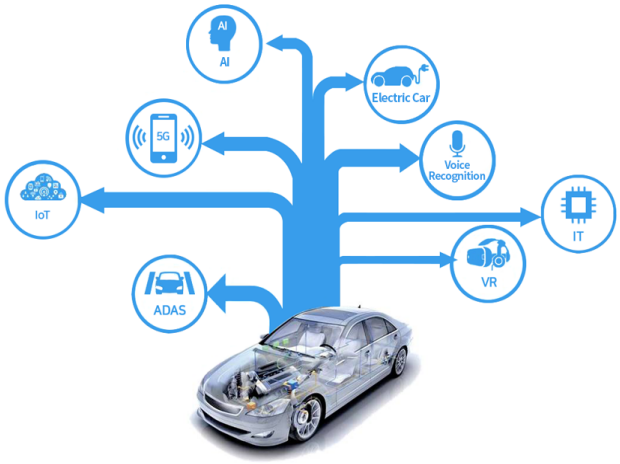
Wearables and concept

3. CONNECTED CARS

The automotive digital technology has focused on optimizing vehicles internal functions. But now, this attention is growing towards enhancing the in-car experience.

A connected car is a vehicle which is able to optimize it's own operation, maintenance as well as comfort of passengers using onboard sensors and internet connectivity.

Most large auto makers as well as some brave startups are working on connected car solutions. Major brands like Tesla, BMW, Apple, Google are working on bringing the next revolution in automobiles.

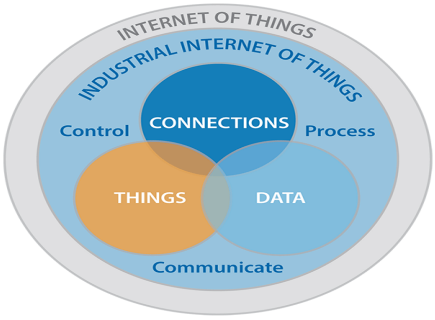


Connected cars and concept

4. INDUSTRIAL INTERNET

Industrial Internet is the new buzz in the industrial sector, also termed as Industrial Internet of Things (IIoT). It is empowering industrial engineering with sensors, software and big data analytics to create brilliant machines. According to Jeff Immelt, CEO, GE Electric, IIoT is a "beautiful, desirable and investable" asset. The driving philosophy behind IIoT is that, smart machines are more accurate and consistent than humans in communicating through data. And, this data can help companies pick inefficiencies and problems sooner.

IIoT holds great potential for quality control and sustainability. Applications for tracking goods, real time information exchange about inventory among suppliers and retailers and automated delivery will increase the supply chain efficiency. According to GE the improvement industry productivity will generate $10 trillion to $15 trillion in GDP worldwide over next 15 years.



Industrial Internet and concept

5. SMART CITIES

Smart city is another powerful application of IoT generating curiosity among world's population. Smart surveillance, automated transportation, smarter energy management systems, water distribution, urban security and environmental monitoring all are examples of internet of things applications for smart cities.

IoT will solve major problems faced by the people living in cities like pollution, traffic congestion and shortage of energy supplies etc. Products like cellular communication enabled Smart Belly trash will send alerts to municipal services when a bin needs to be emptied.

By installing sensors and using web applications, citizens can find free available parking slots across the city. Also, the sensors can detect meter tampering issues, general malfunctions and any installation issues in the electricity system.

Smart cities and Concept

6. AGRICULTURE

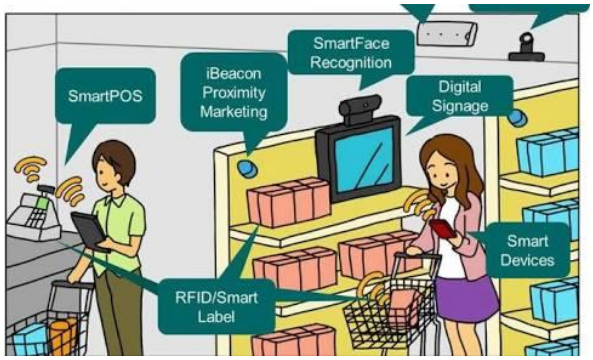
With the continous increase in world's population, demand for food supply is extremely raised. Governments are helping farmers to use advanced techniques and research to increase food production. Smart farming is one of the fastest growing field in IoT.

Farmers are using meaningful insights from the data to yield better return on investment. Sensing for soil moisture and nutrients, controlling water usage for plant growth and determining custom fertilizer are some simple uses of IoT

Agriculture and Concept

7.SMART RETAIL

The potential of IoT in the retail sector is enormous. IoT provides an opportunity to retailers to connect with the customers to enhance the in-store experience. Smartphones will be the way for retailers to remain connected with their consumers even out of store. Interacting through Smartphones and using Beacon technology can help retailers serve their consumers better. They can also track consumers path through a store and improve store layout and place premium products in high traffic areas.



Smart Retail and Concept

8.ENERGY ENGAGEMENT

Power grids of the future will not only be smart enough but also highly reliable. Smart grid concept is becoming very popular all over world.

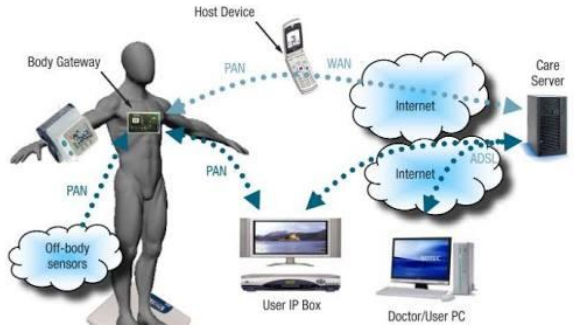
The basic idea behind the smart grids is to collect data in an automated fashion and analyze the behavior or electricity consumers and suppliers for improving efficiency as well as economics of electricity use. Smart Grids will also be able to detect sources of power outages more quickly and at individual household levels like near by solar panel, making possible distributed energy system.

Energy Engagement and Concept

9. HEALTHCARE: Connected healthcare yet remains the sleeping giant of the Internet of Things applications. The concept of connected healthcare system and smart medical devices bears enormous potential not just for companies, but also for the well-being of people in general.

Research shows IoT in healthcare will be massive in coming years. IoT in healthcare is aimed at empowering people to live healthier life by wearing connected devices.

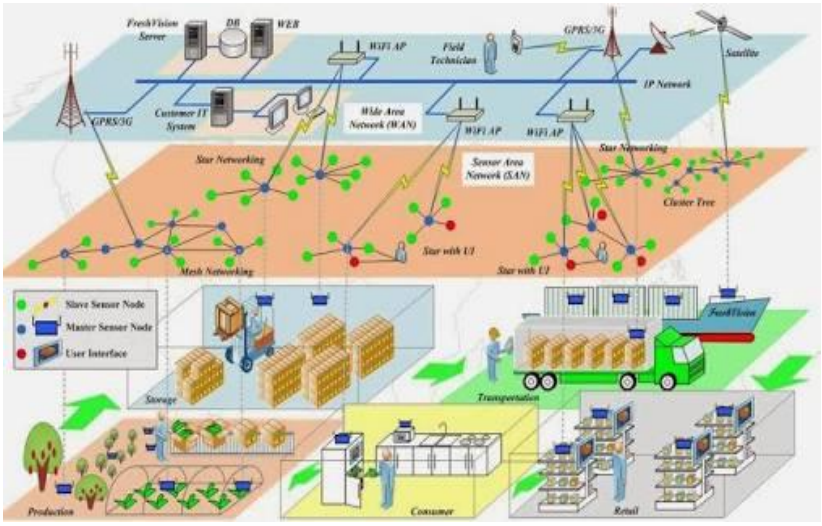
The collected data will help in personalized analysis of an individual's health and provide tailor made strategies to combat illness. The video below explains how IoT can revolutionize treatment and medical help.



Healthcare and Concept

10. POULTRY AND FARMING

Livestock monitoring is about animal husbandry and cost saving. Using IoT applications to gather data about the health and well being of the cattle, ranchers knowing early about the sick animal can pull out and help prevent large number of sick cattle.



Poultry and Farming and Concept

CONCLUSION:

In the long term, a new communication model will probably emerge following the post-IP and future Internet/network developments. The next generation of IoT services will then naturally be deployed, being user-centric but mostly object-centric where network scalability needs will increase. It is expected that more than a billion objects will be connected and orchestrated by IoT applications, focusing on adding increasing task automation and monitoring the real-world environment to improve human life. We conclude this book by saying that after the identification of the main IoT-enabling technologies, issues and challenges, the next step is the design of the network architecture and framework to efficiently support the future IoT applications. This will shape the future networking concepts and functionalities of the future Internet. Only the future will show how successful IoT services will be! Meanwhile, society is not very welcoming of certain IoT services, especially those proposing to use RFID technology for automatic tasks without a clear view of how to protect the person's privacy, protect them from being tracked, and management any other privacy-related information. These issues need to be tackled before such services become used in every-day situations. Other IoT services are very close to the market, however, such as touch-a-tag applications and sensor-based monitoring services or home networking.

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Mobile E-Care Health Service System Using IOT for Indian Scenario

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Abstract – The premise of this research idea is to develop smart health centers in India. The proposal basically exploits the idea of Internet of things and aims to use the existing technology and background. The work has been motivated by the fact that India is lacking in terms of number of health centers corresponding to the population of country and in villages especially. More prominently if a health center is available, Doctors generally either are not willing to serve the rural areas or they are not available 24x7 leading to rural population turning to cities even for casual ailments. This adds to long queues in hospitals and lot of annoyance to patients. In order to avoid above mentioned limitations, the proposed model aims to address the patient without even physically visiting the health center and also prescription can be generated in the absence of Doctor. It is expected that such a smart system would not only facilitate sick but also will add prosperity indirectly to villages. The proposed framework would definitely bring a significant change in the health care sector of India.

1. INTRODUCTION

Internet of Things (IoT) is gaining widespread popularity among research community because of its potential to digitize real world physical objects around us. IoT has emerged due to present wireless telecommunication services and ubiquitous presence of Internet. Wireless sensor networks, RFID tags, actuators and various handheld intelligent devices such as mobile phones, PDAs, Tabs etc. are leading to the emergence of IoT. IoT seems appealing and its emergence is being accepted by research and industries, due to its impact on our day to day life both in production and consumption processes. It has opened up wide spectrum of innovative scenarios to improve quality of human life. Sensor networks have already proved their excellence in making human life easy in routine tasks such as controlling water tanks, to save electricity at public places like museums, libraries as well as critical tasks such as habitat monitoring, controlling/ assisting industrial processes etc. Intelligent devices such as mobile phones have been transformed from embedded keypad based traditional phones to lightweight touch screen based devices. Applications of sensors in our day to day life are numerous which indicates their importance, however they are constrained due to limited battery life which limits their use. Radio Frequency Identification Tags (RFID) technology provided substitute to sensors as these tags can be used to identify , track and locateany object using unique Electronic product code (EPC) which is encoded in these tags.

RFID tag comprises of a small chip, an antenna and a cover for encapsulating chip and antenna. Antenna receives signal from RFID reader device and transmits the tag ID to it. These tags can be either active or passive based on power source. Active tags are associated with a battery life and thus depend on it for their lifetime, just like sensors. However, passive tags acquire energy from reader device either through magnetic induction or electromagnetic wave capture techniques . Signal received by RFID antenna, produces a current in it through induction, which is further utilized by the antenna to revert back the tag ID to the reader. This technique can help transmit tag Id to a radio range of few kilometers. Thus RFID tags eliminate battery limitation of sensors, further being small in size they can be embedded in any real life object for its monitoring. Thus RFID tags are helping great deal to convert every real life physical object into digital entity. Such RFID sensing objects will form their RFID sensor networks with reader devices as sinks of data generated. Emergence of these RFID sensor networks, in our day to day life will fill the gap in omnipresence of Internet and will help IoT spread its roots in our society. *'Anytime, anywhere, anymedia'* computing has turned into reality with every object embedded with either RFID tag or sensors, these when combined with already existing wireless communication technologies make everything digitized and on Internet. This gives avenue for

large range of innovative applications such as smart homes, E-healthcare, traffic monitoring and route management, resource management at retail stores, automated checkouts at shopping centers, condition based maintaince of vehicles are some possibilities. Applications of IoT has been divided into four categories i.e.:Transportation and logistics domain

- Healthcare domain
- Smart environment (home, office, plant) domain
- Personal and social domain

The current proposal focuses on developing smart healthcare centers and it outlines a framework for mobile based portable health care services for ruler population in India. Next section provides an overview of relevant literature in this field. Section 3 provides proposed framework and section 4 finally concludes with requirements to develop the proposed smart healthcare center and its future scope.

2.RELATED WORK

This section explores work already done in the field of IoT. Atzori et al. presented a survey on Internet of Things highlighting the most appealing point of IoT which is the integration of several technologies and communication solutions. Their work emphasized that any contribution towards advancement of IoT must be a result of synergetic activities in various fields such as telecommunications, informatics, electronics and social science.

Coetzee and Eksteen have elaborated IoT domain and emphasized that various application domains such as Green IT, energy efficiency and logistics have already started gaining benefits from it. Because of large potential of this domain, IoT has grabbed higher priority on the research agenda of academia, industry and governments such as IBM's Smarter Planet, Microsoft's Eye-on-Earth platform and HP's Earth initiative, just to list a few. European commission and Chinese Government is also making efforts in this direction. However, advancements in IoT is also raising trust and security issues simultaneously. Standardized protocols and governance strategies are required for IoT to work at global level. Survey on IoT presented by Mckinsey Global Insitute highlighted that most IoT data being captured today is not used currently. Presently the captured data is used only for anomaly detection and control, however it may be used for optimization and prediction which is of more importance. Further, they pointed that there is large scope for IoT in developing economies such as India. The critical investigation of available literature clearly reflects that IoT is the demand and strong requirement of developing countries and there is a huge gap prevailing between theory and practice. The proposal submitted aims to fulfill this gap in one of the domains i.e. health care.Next section presents a proposal for Mobile E-care Health Services using IoT for Indian Scenario.

3.PORPOSED MOBILE E-CARE MODEL

From literature review it is clear that IoT has large possibilities for innovative applications to help improve human life. Among four main categories of IoT applications listed above, healthcare domain is the one, most beneficial for common people, especially in India. In India large population still lives in villages and is deprived of good healthcare facilities. However, in villages also, the Internet facility is being made available (Owing the credit to Scheme Digital India) and rural population is already making use of mobile phones to its maximum extent. This factor motivates the present proposal that using basic internet or telecommunication services, RFID tags and existing dispensaries in villages, we can facilitate promising basic healthcare services to everyone. This proposal can also contribute towards Government of India Digital India initiative.

Presently, all most all villages in India have at least one health center to provide basic healthcare services, however there is scarcity of doctors in those dispensaries, due to which people have to visit nearest urban cities to avail medical facilities. Because of limited number of government hospitals in urban cities and still limited doctors in those hospitals, creates bottleneck in providing satisfactory medical facilities to all citizens. Long queues at all hospitals in India, clearly indicates demand for a better alternative.

Using IoT and its enabling technologies, existing government health centers can provide services for common diseases, such as common flu, cold, cough, typhoid, malaria etc. This meagerly requires establishing one computer system with internet connectivity to healthcare server established at nearest urban government

hospital or the server may be established in cloud. Villagers will be required to visit local health center once where with the help of a medical assistant they will undergo registration on healthcare server. On registration, present status of vital organs will be recorded along with any medical history and a unique RFID tag will be issued to the person, containing registration identity of that person. While RFID tag being very small can be embedded within a wrist band, the RFID reader will remain available online at the health center itself.

Now whenever a person is sick, instead of visiting the health center physically, the patient will only be required to press a button in RFID band which in turn transmits the identity information to RFID reader at health center. On this call, RFID reader identifies the patient with its registration number and will access patients health card from healthcare server. The health card along with present symptoms of the patient will be submitted to an expert medical system such as Mycin (a new software may also be developed), which will be installed at healthcare server. This expert system is capable of generating a prescription to the patients, even in the absence of a doctor based on present symptoms and past medical history of the patient. Based on generated prescription, medical assistant may provide medicines to the patient (in the absence of Doctor too). This Expert system and health care database may be kept on cloud, so as to make it accessible everywhere in the country.

Thus, the patient can move anywhere in India and can avail medical facilities using that RFID tag, which will help any doctor to become familiar with patient's history and medicines already prescribed and taken. Further, common problem of villagers will get timely identified and resolved avoiding long queues which in turn would save lot of time, money and energy. provides high level view of proposed Mobile E-Care Health Services System.

4.CONCLUSION

The proposed model can be easily implemented using existing RFID technology and an expert health care system such as Mycin. A new intelligent e-health system can also be designed considering the Indian health issues and environments. The proposal would act as an aid to sick and would also contribute towards Digital India.

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FACE RECOGNIZATION TO CONTROL SMART DOOR LOCK SYSTEM

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Abstract
Face recognition is a commonly used biometric strategy in various field because of its accuracy and security. However, any feasible system will have its drawbacks. Some of the drawbacks of the face recognition system include, pose change, aging, light variation and many more. By focusing on these, illumination effect is taken into account and an advanced face recognition technique is developed. The technique that is used here is Principle Component Analysis (PCA) and Fast Fourier Transform (FFT-2). This solution is applied to a smart door lock system which allows the authorized people to access the door of the house by using face recognition technique.

1. Introduction

Biometric strategies are very important in recognizing humans because it has the capacity to uniquely identify a person based on his body parts. It can be face, fingerprint, iris, retina, voice etc. Among these techniques, face recognition method is commonly used for identification of the human because, it has the ability to recognize a person without his participation in the recognition technique. This has a prominent role to play in security purposes. Face recognition is used to criminal identification and many more because of its feasible characteristic. Studying the essence of high dimension training data in a low dimension form has become very common in the recent years. The study of reducing the dimension of the training data is known to Dimensionality Reduction.

One of the important concepts in Dimensionality reduction is the subspace method. There are 2 types of subspace methods. The first one is a Linear Subspace method. The other one is a Nonlinear Subspace method. The method that is used in the proposed system is based on Linear subspace method.

This image is reduced to one dimensional subspace and the orthogonal diagonal element is obtained. This transformation is shown in the Figure 2.

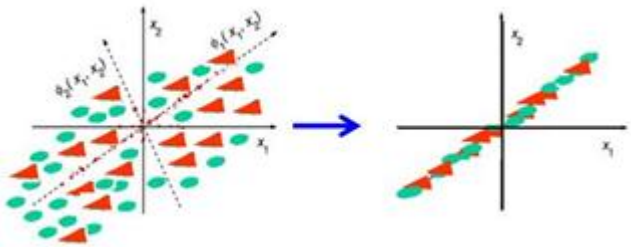

Figure 1. PCA basis (2D)

Figure 2. PCA reduced to 1D subspace

There are several disadvantages of face recognition. Some of them include pose changes, blur or foggy image, illumination or light variation and face changes. Several methods and approaches were proposed to overcome these problems. In the proposed system, focus is put on the illumination effect of face recognition. Therefore, PCA algorithm is combined with FFT2. PCA algorithm is commonly used for face recognition. And FFT2 or 2-D fast Fourier transform is employed to process the 2-D data like images. The normalization of the image for illumination is shown in the Figure 3.

The proposed solution is applied to a home environment for controlling the door lock. When there are many people living in house, it is required that all the people should have the key to open or close the door. Or, they should wait for the person who has key to access the door. Other than the charges which cost for keeping the duplicated keys, there are also security concerns if the key is lost. There are chances of stealing

the key as well which is another security issue for a house or any building. In the recent years, several door lock systems were developed to overcome these issues. With the advancement in internet technology and the traditional door system, a new technique can be presented. Such a variation in the prototype is based on the fact that using the emerging technologies with the old systems will yield a smart and secure system.

The proposed system is a door lock system which makes use of face recognition rather than the mechanical key to access the door.

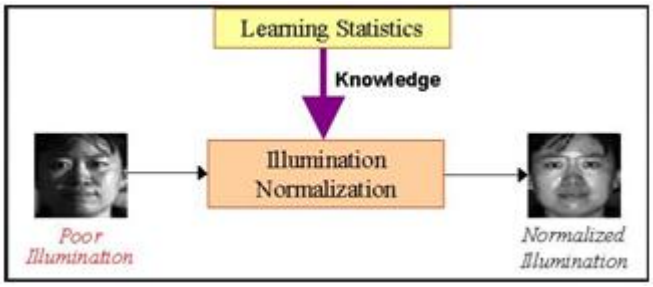

Figure 3. Image Normalization using FFT2

2. Related Work

Paul Viola, Michael J. Jones, net all says recognition of face is a method for face detection in an image. There are several methods for face detection and one of the commonly used method is viola jones. Once the detection of the face is done, the author explains the process for face recognition. This is accomplished using the Principal Component Analysis (PCA) algorithm. In PCA, the recognition is based on the Euclidean Distance and hence the face can be recognized.

PCA is one of the common and basic method employed for face recognition. Even after commonly using this technique, there are several drawbacks associated speaks about the disadvantages associated with the traditional PCA. PCA extracts the feature of the face in an input image and converts it into a one dimensional matrix of vectors. Once the feature extraction process is done, then K-L transformation is applied to this one dimensional vector which yields in the image vector that is enormous and computationally complex. This will be a problem to compute the covariance matrix.

Other door lock system was presented by Ushie et al. GSM enabled phone is used to control the door lock system for enhancing the security of the house. This setup requires 2 mobile devices with GSM enabled in it. This operation can be done through a distant area in which the phone with GSM acts as a transmitter. The receiver part for the system is setup using another mobile device. This phone is connected to the door through tone multi frequency (DTMF), a controller. As an addition, SMS along with GSM/GPRS was used to access the door where the locking and unlocking mechanism for the door is done based on the SMS from a particular user. When the device receives a particular message, the control passes to the door lock system and the locking and unlocking mechanism takes place. Using this concept, a PIC system was proposed which provide security with the password. This system makes use of GSM for alerting on the intervention.

Wi-Fi is another technique through which the door lock can be accessed. When the controller is operated by the Wi-Fi by the user who has smart phone results in a secure system. The user will have a mobile phone in which the application for managing the door lock will be installed. The door locks can also be accessed by the user through the application with the automated key. people lose their keys easily than the phones. Therefore, the security concern for the door locks of the house can be improved. The authors also speak of encrypting the automated keys using various encryption algorithm for providing additional security. The standard AES encryption algorithm is the one used by the author to encrypt the automated key or the password.

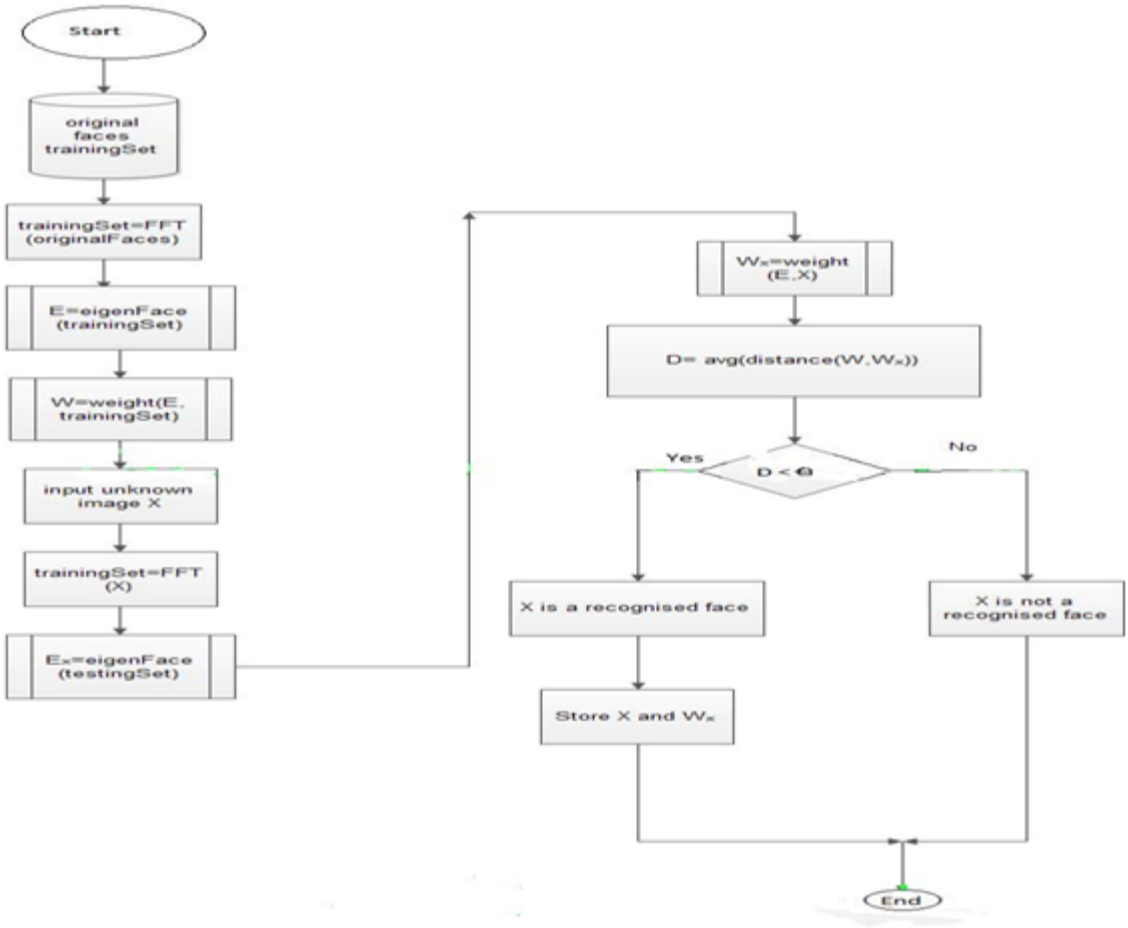

Figure 4. Flowchart showing the implementation of PCA with FFT-2

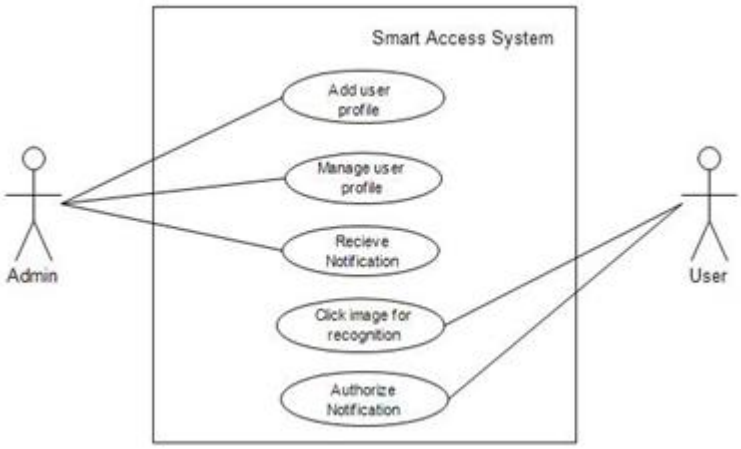

Figure 5. Use Case Diagram

3. Methodology

In the proposed system, the drawbacks of Face recognition system were identified and focus was provided in overcoming illumination effect. When there is change in the light condition, the face recognition system fails to identify the user even though the user is a valid one. Therefore, the proposed system normalises the images before recognition so that the validation takes place accurately without failure. Also, the propose system compares the traditional PCA with the advanced PCA to verify the changes.

This solution is applied to a real time problem of providing security to the house. The door lock will be attached to the controller which controls the access to the door if the face is recognized. Initially, the database will be containing the details and images of privileged users that are being updated by the owner of the house. When any of the members of the house wants to lock/unlock the door, he/she needs to use the front camera of their smartphone which captures an image. The captured image is then compared with the images stored in the database. If the face is recognized and matched, then the access to that person is granted.

The implementation of the smart door lock system is as follows:

3.1. Implementation of the Algorithm for Face Recognition

The technique for face recognition has the following steps. Initially the feature extraction of the face takes place using PCA. It is one of the common linear subspace methods which converts the 2 dimensional input data into 1 dimension, thus employing dimensionality reduction. Therefore, the second step of face recognition after extracting the features will be the feature reduction.

The final step of face recognition is the validation or classification. This method is implemented using Euclidean distance. This method classifies the attributes of the face within the images which is stored in the database with the Test image. The advances PCA overcomes the problem of illumination by implementing FFT2 along with PCA. FFT2 is a normalizing technique which is usually implemented to process signals and data such as images.

The flowchart showing the implementation of the algorithm is shown in the Figure 4.

3.2. User Interface

The android application is installed in the user's phone which acts as an interface between the user and the door. The android application allows the admin to add and manage the user profiles and receive notification about the user whenever he/ she enters or leaves the house along with the time. The application allows the user to capture the image and authorize notifications. This function of the android application is depicted in the Fig

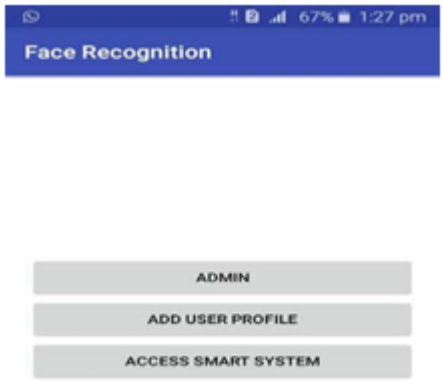

Figure 6. User Interface of the Android Application

3.3. Communication of the Client and the Server

The image clicked by the user from the smart phone is sent to the server. Since the door can be remotely controlled by the user, the image has to be stored in the server. Once the recognition is done, the control is passed to the smart access system which is controlled by the microcontroller. The controller used in the proposed system is the Aurdino microcontroller. When the microcontroller receives the command from the local system, locking/ unlocking mechanism takes place. Figure 7 shows the Aurdino Microcontroller board to which the door lock will be attached. For the purpose of simulation, a LED light is attached to Aurdino board instead of the door lock.

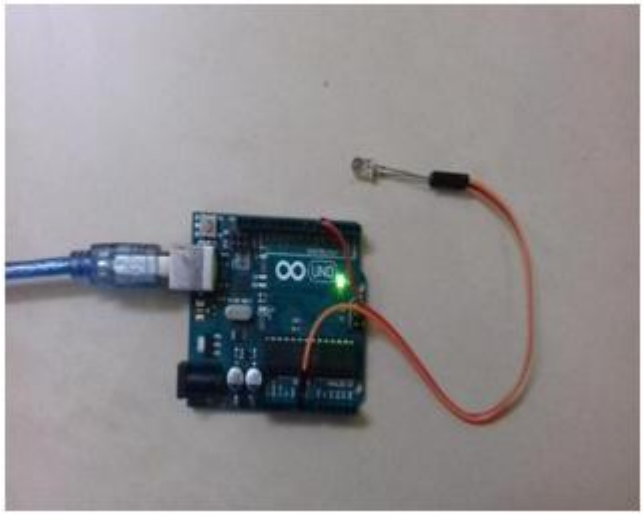

Figure 7. Aurdino-Uno Microcontroller with LED

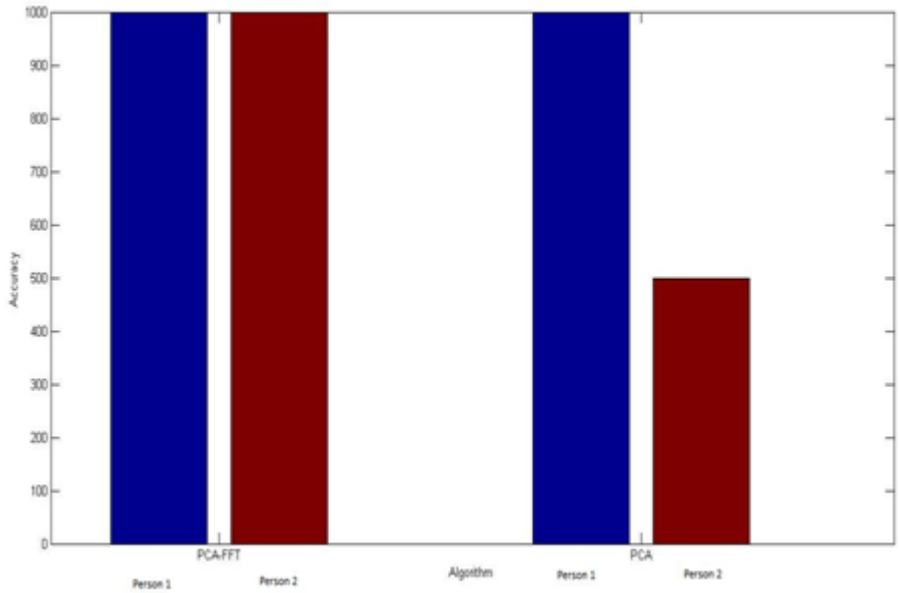

Figure 8. Graph- Accuracy vs. Algorithm

4. Evaluation

The smart access system with enhanced face recognition is compared with the traditional PCA. The system is tested with 2 users and changed light condition. Among the 2 users, the illumination enhanced PCA was able to recognize the users without any issue thus proving to be accurate. However, the traditional PCA failed to recognize the users. Based on this evaluation, a graph was plotted for Accuracy vs. Algorithm and it is shown in the Figure 8.

5. Conclusions

There are several drawbacks in a face recognition system such as pose change, aging, light variation and many more. By considering the drawback of the illumination effect, an advanced PCA is proposed by combining the PCA algorithm with FFT2. The advanced algorithm recognizes the human under different light condition with a greater accuracy when compared to the traditional PCA.

Since security is a main concern in our daily life, the proposed algorithm is applied to a smart access system. This provides security because of using human face for recognition. The solution is cost effective since the camera of smart phone is used to capture the human face instead of a separate web camera. The system can be generalised to offices, buildings, cars etc.

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GARBAGE COLLECTOR ROBOT

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Abstract:
The world today faces major garbage crisis- the product of rapid economic growth, overcrowding, poor urbanplanning, corrosive corruption and political dysfunction. The present tried and tested methods of garbage collection have so far been proven ineffective. And the world today is looking at smarter ways of overcoming the garbage collection problem. This paper presents the Garbage Collector robot for foot path using Arduino microcontroller. The robot is built on a metallic base of size 50x40 cm which is powered by battery of 12V, 7.5Ah. The robot movement is controlled by programming the Arduino. The robot is designed to collect Garbage at foot path, public places (parks, schools and colleges), mostly cemented paths and beach. The robot cannot be used on muddy surfaces. The robot is built in such a way that, when it is started it will move on the path defined in the program. When it encounters the obstacle, depending on the conditions applied in the program the bot proceeds with further motion and then robot picks up the garbage.

1. Introduction

Garbage is the major problem not only in cities but also in rural areas of India. It is a major source of pollution. Indian cities alone generate more than 100 million tons of solid waste a year. In 2000, India's Supreme Court directed all Indian cities to implement a comprehensive waste-management programme that would include household collection of segregated waste, recycling and composting. These directions have simply been ignored. No major city runs a comprehensive programme of the kind envisioned by the Supreme Court. It is not wrong to say that India is on verge of garbage crisis even though 9000crore rupees are allotted for the Swachh Bharath Abhiyan.

There are already different type of garbage collection robots like Robo-dumpster which mainly aims at collecting garbage from full cans and dispose it designated area and Dust cart which is designed to navigate through urban areas avoiding static and dynamic obstacle and waste door to door. These robots which are in use have various disadvantages like high implementation cost, not user friendly and aims at only collecting filled dustbins but not on collecting mechanism, etc.

Also, Municipal solid waste workers (MSWWs) or refuse collectors, universally expose too many work related health hazards and safety risks, notably allergic and other diseases of the respiratory system. Health impacts could also entail musculoskeletal, gastro intestinal and infectious diseases as well as injuries caused by work-related accidents.

Hence to overcome this major problem of waste collection Autonomous Garbage Collection robot is developed. It aims at providing automatic control to collect the garbage. It differentiates between static and dynamic obstacle and move accordingly as it programmed. It basically consists of sensors at different levels to detect the dynamic obstacle. It also disposes the garbage to a pre-specified place. If the trash bin is filled, it will be detected and the garbage will be disposed.

2. Methodology: The design of garbage collector robot uses engineering method. In sequence, the method is identification of the needs required. Then these needs are analysed to get specific components. These components are later integrated to get the desired output. The basic methodology is as shown in figure 3.1.

The operation of the robot can be classified into three main categories. They are motion control of the robot, garbage collection and disposal of garbage.

2.1. Locomotion of the Robot: The robot can travel in the predetermined path by using a combination of motors, drivers, and sensors connected to the Arduino. This system consists of four geared motors of 30rpm each, motor drivers and three ultrasonic sensors. The ultrasonic sensors act as input to the Arduino. The

motors are connected to the output of the Arduino through the drivers. The ultrasonic sensors detect the obstacles and the motors are made to rotate based on the pre-programmed instructionsin the Arduino.

2.2. Garbage Collection:The robot Garbage collection system consists of a set of rotating blades mounted on a shaft connected to the motors. The mechanism will not operate for entirety of the vehicle operation and will rotate only for predetermined set of conditions. The rotating blades may be made of galvanised iron or stainless steel to suit outdoor applications as well as durability. The main aim of the mechanism is to collect garbage which is of similar dimensions to that of juice cartons, plastic bottles, crushed papers, and all light items whose height is between 5 to 20cms. Mechanism is mounted on the front side of the base with an appropriate ground clearance. Two motors are mounted on the two sides of the shaft and is connected to Arduino to perform rotating mechanism. The collection mechanism is built is such a way as to suit public places like gardens, bus stands, footpaths. When the sensor detects static obstacle, the mechanism rotates and the garbage is pushed into a bin which is placed right behind the mechanism. The robot keeps collecting the garbage until it reaches certain height in the bin. Once the bin is filled the collected garbage is disposed to a selected place.

2.3. Disposal of Garbage:This action is done using tilting mechanism. The speed of the motor attached to shaft is kept at nominal value to get proper rotating action to move the garbage right into the bin. This is just a prototype and hence the mechanism used can pick only above-mentioned garbage. The mechanism can be changed according to the place where it is being used.

3. Block Diagram:

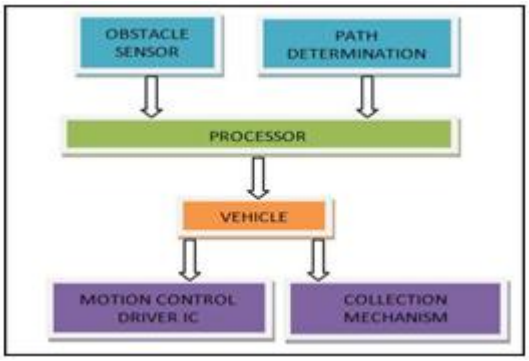

Figure 3.1. Block diagram of a proposed project

4. Circuitry:Some of the system requirements of the project are listed below:

Motor driver circuit is used for the motion of the robot.

Power supply as to get sufficient power for the motor.

- The robot requires a motion controlling unit i.e. Arduino Uno kit with adapter.
- Automatic motion of robot is obtained by using sensors in the navigation system.
- Metallic structure of the robot.

Other auxiliary circuits are added as per the requirements.

Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started.

5. Design of the Robot: A rectangle metal sheet of size 50 X 40 cm is taken as base of the robot. Four wheels are attached with geared motors to the base. The motors are of 30rpm each to move the bot to accurately detect the garbage. The mechanism of the bot has four which of are placed at an angle of 90 degrees from each other. The blades are fixed to a shaft. The blades rotate along with the shaft to collect the garbage. A curved metal sheet is placed below the blades so that the garbage is properly directed to the collecting box

placed on the base. The collecting box has a tilting mechanism so that the garbage collected can be disposed to a specified place. There is another level on the base.

Figure 5.1. Skeleton of the bot from top view

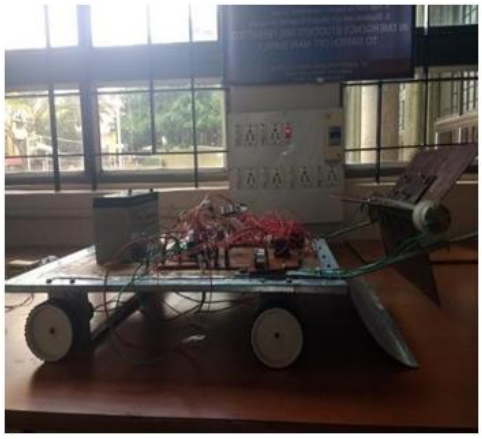

Figure 5.2. Skeleton of the bot from side view

6. Flow Chart:

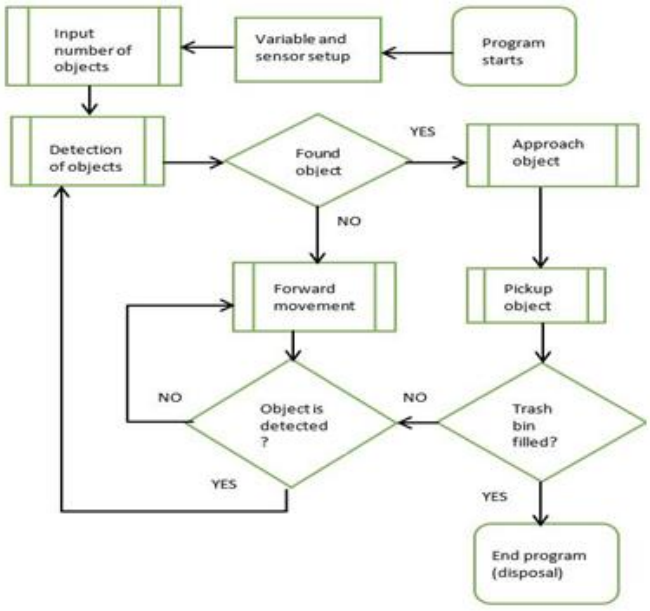

Figure 6.1. Flow chart of a proposed project

7.Results:The objective of the project was achieved to some extent. The garbage collected efficiently and effectively. The robot moves in a constant speed. The garbage gets detected when it is at 20cm from the trash. The project is still in progress to achieve the optimised results with few more modifications.

8. Conclusions:The Garbage and recycling pickup work is physically demanding and it exposes workers to many occupational hazards. This project is designed to fulfil the task of collecting garbage from certain places and then dispose it at a single place from where the garbage will then be taken for disposal or process of recycling. To build an automatic trash robot using Arduino microcontroller which detects and collects the paper and plastic items automatically and process it. So, this reduces the requirement of manual clearance of plastic waste.

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EFFICIENT VEHICLE LOCATION HELP LINE SYSTEM USING NFC

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Abstract – Now-a-days increasing density of vehicles on road is becoming the problem for the traffic control. Ultimately arising obstacle in the managing and tracking of the vehicle. Because of the problem state, it is necessary for every organizations and individuals to track the vehicle. People will monitor and track their vehicles for the safety concerns with the help of our project. Public transport and private buses tracked to citizens with traffic and transportation details like location, crowd, etc. The proposed system will be used for the positioning of the bus from remote location. Once the NFC tag is scanned and identified, it generates the code corresponding to the location it reached and updates to the end user, when he uses to view the last location of the bus. As before GPS systems are used which locates the bus only in the metropolitan cities and once it deviates from the location, the information will be lost. Here, in this project a NFC reader is fixed in every bus stop and once the bus crosses the stopping the microcontroller updates the location to the IOT and once we access the page it shows the last location and the time it has crossed the location, so that we can update the time the bus will reach us.

1.INTRODUCTION

Now-a-days, due to growing world & importance of the time in day to day life there is need of effortless transport. So we are providing an IOT application which will provide the information of vehicle location tracing and monitoring . It also includes the feature of density measure for the user convenience and nearest bus available on the route and will make the user up to date as bus moves.

As we know the lots of work is done previously on this system to provide the user what they need & is to solve the various challenges. So to reduce the extra efforts to track the object and also to improve the previous demerits.

2.ERATULITRE REVIEW

GPS is more popular technology which is used in many applications. This existing system gives information about vehicle position and route travelled by vehicle and this information can be monitor from any remote place or location. This system depends on GPS and GSM technology. This system lags in some features like its track vehicle only on PC not on mobile. And also there is no application depending on mobile device to track and get a real time and current view of target or vehicle.

Tracking systems are rarely available in the market and available systems are not good and effective systems are costly. The above stated system is much economical than other system. This suggested system helps to getting information and location of college bus by using mobile or smart phone. But we got some lagging points in this system, there is only provision for tracking & this tracking is based only on SMS. There is no real time view of location for bus and also there is no any application based on mobile for tracking.

The above mentioned paper includes the integrated use of the smart cards with GPS system. In today's world smart cards became mostly used things which contains the user's data and GPS used in many areas like tracking and monitoring or surveillance which is used in this system for finding the actual distance travelled by that passenger. The given system does not provide the facility like ticketing and also it has shortcoming like passengers can't buy tickets, who don't have smart card.

The system does not gives the dynamically changing the bus routes .

The above stated existing system is based on the ticketing & identifications in the public transports for bus passengers. There are many passengers having more confusion about fares and which leads to corruption. System will provide automatically fare collection of passengers according to travelled distance. This system uses RFID & GPS for transactions and it make traveling is very precise. This system has some shortcomings as like system provide only automated ticketing facilities not provision for tracking the bus. And also there is no

provision for crowd (density) measurement. This system has not any kind of user application for passengers to track the bus and view the schedule of buses.

3.PROPOSED SYSTEM

A. Introduction

Now-a-days, due to growing world & importance of the time in day to day life there is need of effortless transport. So we are also providing a webpage application which will provide the all system information of vehicle tracking and monitoring. It also provides the feature of nearest bus available on the route and will make the user up to date as bus moves.

The location of the bus can be observed continuously using NFC system. The NFC card transmits signals to a NFC reader. These readers statically receive signals. These signals are then transferred to IOT web access that indicates the location and time of the vehicle.

The NFC Card provides authentication, identification, application processing along with data storage. Every bus will carry the NFC card. The Card holds information of the bus such as name, bus number, owners' information. By integrating both IOT technology and NFC cards we are going to design a whole bus tracking system.

Whenever the passengers standing in the bus stop he/she can be accessed to the web to view the last station of the bus and the time it crossed. If NFC card is shown to the reader, the microcontroller attached with the reader transmits the location and the time it crossed using a GPRS modem. According to Source and destination the time it will reach us can be estimated.

B. Architecture

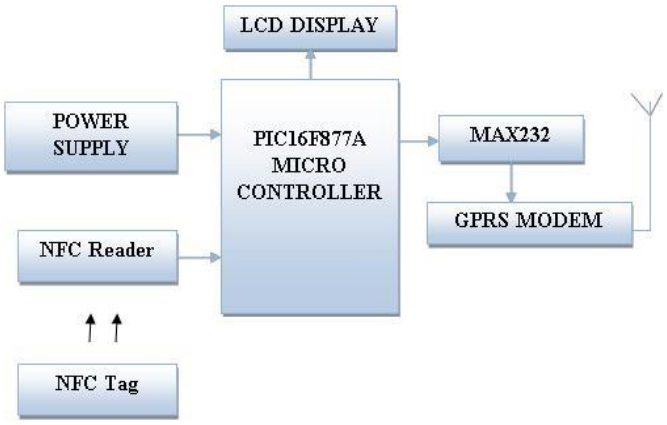

Figure 1: Architecture of bus tracking system

Architecture of IOT supported bus tracking & Updating system includes

1. Architecture of Tracking System
2. Architecture of IOT access

The architecture has a NFC module of transmitter and receiver, PIC16F877A micro-controller, GPRS modem interlinked by a pair of MAX232 IC's.

For the purpose of tracking NFC kit enabled by the USART's receiver pin is used and for IOT access the GPRS connected with MAX232 to the transmitter pin of USART is used.

Figure1 shows the architecture of Bus tracking system:

The fig.1 shows the tracking system architecture, which defines the intercommunication among these components. The basic level components include server, databases, and communication networks along with satellite.

User application is http based application which will include the GPRS tracker. The general information feed is given by the user application which will send to the server for further operation. The general feed may include the current location, destination location, timing, etc.

In fig.1 the Server includes the database containing the vector table of location name and it's coordinates along with the number of buses available at that location at a specific time. This database on the server automatically updates using GSM.

The current location coordinates are directly taken by the application and search for the nearest bus. If the nearest bus is crowded then it again performs the search operation to locate the next available bus with its time and current location.

C. Internet of Things – An overview.

The new rule for the future is going to be, "Anything that can be connected, will be connected."

This is the concept of basically connecting any devices with an ON and OFF switch to the internet (and/or to each other). This includes everything from cell phones, coffee makers, washing machines, headphones, lamps, wearable devices and almost anything else you can think of.

This applies to components of machines, for example a jet engine of an airplane or the drill of an oil rig.

The commands used for the interpretation with IOT device are;

AT+CMGF

AT+CIPSTATUS – To get the status of the program.

AT+CSIT – To view the network provider.

AT+CIFSR – To get our IP address (if needed).

AT+CIPSTART – To ping the IP address.

AT+CIPSEND – TO transfer the information.

D. Near Field Communications:

NFC tags are passive data stores which can be read, and under some circumstances written to, by an NFC device. They typically contain data between 96 to 8192 bytes and are read-only in normal use, but may be re-writable. They are based on existing radio-frequency identification (RFID) standards including ISO/IEC 14443 and FeliCa.

NFC works totally in three modes:

NFC card emulation- enables NFC-enabled devices such as smartphones to act like smart cards, allowing users to perform transactions.

NFC reader/writer- enables NFC-enabled devices to read information stored on inexpensive NFC tags embedded in labels or smart posters.

NFC peer-to-peer- enables NFC-enabled devices to communicate with each other to exchange information in an adhoc fashion.

E. PIC Configurations

In this project, PIC16F877A is used. This is used because it has all the peripherals like Timer, ADC, PSP, USART, SPI, I2C, EEPROM, CCP, etc.

It is a 40 pin RISC machine of Haward architecture with following specifications:

Operating voltage : 5 V
Operating frequency : 4 MHz
ROM : 8 kb
RAM : 368 bytes

RISC has 35 instructions and the peripherals here to be enabled are USART and PSP.

Mnemonic, Operands		Description
ADDWF	f, d	Add W and f
ANDWF	f, d	AND W with f
CLRF	f	Clear f
CLRW	-	Clear W
COMF	f, d	Complement f
DECF	f, d	Decrement f
DECFSZ	f, d	Decrement f, Skip if 0
INCF	f, d	Increment f
INCFSZ	f, d	Increment f, Skip if 0
IORWF	f, d	Inclusive OR W with f
MOVF	f, d	Move f
MOVWF	f	Move W to f
NOP	-	No Operation
RLF	f, d	Rotate left f through carry
RRF	f, d	Rotate right f through carry
SUBWF	f, d	Subtract W from f
SWAPF	f, d	Swap nibbles in f
XORWF	f, d	Exclusive OR W with f
BIT-ORIENTED FILE REGISTER OPERATIONS		
BCF	f, b	Bit Clear f
BSF	f, b	Bit Set f
BTFSC	f, b	Bit Test f, Skip if Clear
BTFSS	f, b	Bit Test f, Skip if Set
LITERAL AND CONTROL OPERATIONS		
ADDLW	k	Add literal and W
ANDLW	k	AND literal with W
CALL	k	Call subroutine
CLRWDT	-	Clear Watchdog Timer
GOTO	k	Go to address
IORLW	k	Inclusive OR literal with W
MOVLW	k	Move literal to W
RETFIE	-	Return from interrupt
RETLW	k	Return with literal in W
RETURN	-	Return from subroutine
SLEEP	-	Go into standby mode
SUBLW	k	Subtract W from literal
XORLW	k	Exclusive OR literal with W

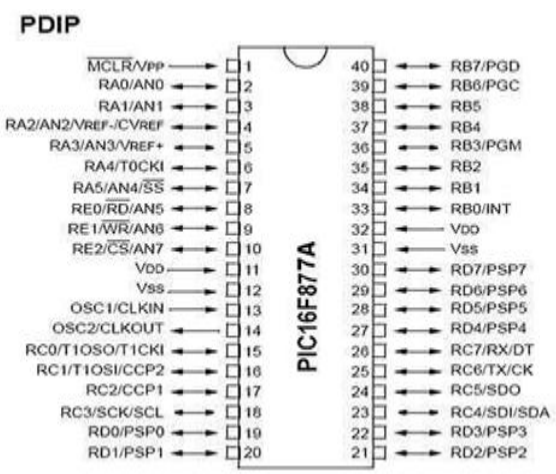

Figure 1: Pin configuration of PIC16F877A

USART: Here, it is used to control the NFC and the IOT device. USART is a serial communication of 9600 bps. The receiver gets the information from the NFC tag and the transmitter sends the information to the IOT.

For the IOT transmission, two MAX232 IC's are used. One for the connection from PIC controller to the IOT interface's MAX232. Two IC's are used because of the variation in the operating voltage. IC provides 5 V and the IOT operates on 3.3 V. To compensate these conversions these IC's are interfaced.

PSP: The Parallel Slave Port is used for the interfacing of LCD display to see the status of the kit.

LCD:LCD is used here for displaying the current progress of the system. Here used is the 16*2 character display of 5*7 Dot-matrix board.

4.CONCLUSION

Bus tracking system is very useful and important mainly in rural areas as we can't predict the time of the arrival of the bus. This system has many advantages like user-friendly, wide coverage area, easy to implement in vehicles, cost is very less, more effective, huge capacity of bus inputs, etc. This system was made of a tracking module containing GPRS modem to access dynamic vehicle location and send it to server. Then people can access this information from their mobile phones.

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ADVANCED BABY MONITOR

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Abstract
The baby monitoring system gives a reliable and efficient baby monitor that can play a vital role in providing better care and protection for any infant. This paper presents the design of an Advanced Baby Monitoring System using Raspberry Pi. This system monitors parameters such as temperature and humidity surrounding the infant, movements made by the infant and also would automatically log the activity and sleep cycles of the latter and act as a means by which parents could monitor their child remotely. For this it uses a camera in order for parents to view their child and it also sends a real time video to the webpage by which it provides reminders to the caretaker or rather parent. This system architecture consists of sensors for monitoring vital parameters such as temperature and humidity sensor, PIR sensor and sound sensor which would incorporate a microphone. Measurements of these parameters can be done and conveyed to the parents with an alarm triggering the system to initiate proper actions.

1. Introduction

In today's current scenario, with the arising difficulties, it has become necessary for both the parents to participate in the workforce and remain as active participants. This is done because with the increasing amount of expenses, meeting the daily requirements becomes hard. In such situations, mother's in particular find it hard to move about and leave their child alone. To reason with such situations, the Advanced Baby Monitor has been designed that will be used to ease the pressure that young adults, especially the mothers of today experience. If a system is developed which continuously gives updates a child to the respective infant parent in times of illness or during the general situations, then it will be of great help to parents as they can work in a more relaxed environment by giving a more fruitful output. Also, emergency situations can be quickly noticed and handled efficiently. Usually, when an infant cries, they are generally experiencing some form of discomfort. Hence we have developed a system which can monitor the activities of a child along with finding one of the above causes and thus give this information to the respective parent.

This proposed system can be used to provide reassurance to parents with infants. Several baby monitoring systems have been developed in the recent past. However the proposed system would not only include the already existing features but also include several additional features in order to help parents in the process of parenting and make this process simpler and much easier. This system can automatically send out emergency signals, and have other functions. However, the care giving methods for infants are not the same. Children require different forms of help and sufficient care in order to nurture their growth and look after their general wellbeing. Since they are unable to communicate, infants express their discomfort by crying. Hence, a home-care system specially designed for infant's is today's need which would substantially lighten a parent, especially a mother's burden.

The system monitors the temperature and humidity conditions in the surrounding environment of the infant, specifically near its crib. It also informs the parents through email notifications, if the child is awake and sobbing on a continuous basis. The reason for the child to weep can be linked to various other factors that this system will provide. It detects the movement of the baby and also sends notifications to the parents through email which can be viewed through any means of a smart device as well as through a personal computer. Through the means of video streaming, the parent can obtain live feeds of their child when they want and at any point of time. The system architecture consists of several sensors which are placed near the crib such as a temperature and humidity sensor, PIR sensor and sound sensor which consist of a microphone which transmits sounds of the sobbing infant to the respective parent.

2.Architecture

The figure given below indicates and architectural overview of the proposed project. The major components are the caretaker, raspberry pi, various sensors such as PIR sensor, temperature and humidity sensor, various LED's, camera module for video and audio streaming and a display.

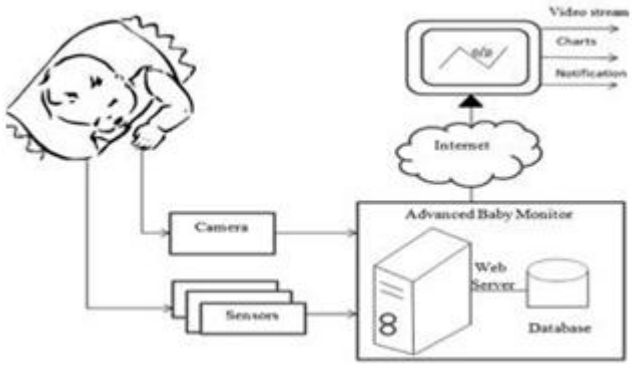

Figure 1. Architecture of baby monitoring system

2.1. Temperature and Humidity Sensor

The temperature and humidity sensor, on connection to the raspberry pi is used as an enhanced tool that would help determine the variations in the temperature and humidity in the surrounding environment of the infant. This sensor would regularly detect the temperature and humidity in the room where the infant's crib resides and plot it on a graph which would be displayed on the webpage. We make use of a database to store the values and hence display the values. The graph shows variations in temperature and humidity plotted against time and the date on the x-axis. On refreshing the webpage the graph would show newer values and hence help parents understand the temperature and humidity conditions in the surrounding area of the baby and determine if there is any discomfort caused due to the same.

2.2. PIR Sensor

The PIR sensor on connection to the Raspberry Pi would be used to detect any movement of the infant. It would track regular movements of the infant to determine its activity levels and also in order to inform the parents of the awakening of the infant. A real time graph would be plotted of the same and hence displayed on the webpage to keep the parents up to date with the movement cycle of the infant.

2.3. Notification Alarm System

This system has been developed in order to alert the caretakers of the infant in case of certain criteria such as vaccination dates that are approaching or even feeding time. The initial dates would have to be fed into the database to be stored and then as the day comes by, the parent would receive an email notification reminding the parent that they would have to take their child for their next vaccination. In the case of feeding time, the initial date and time would be entered and the interval too for the reminder. Given the stipulated interval, the reminder in the form of email notifications would be sent to the parent reminding them to tend to their infant and feed it. This system also alerts the parent if the infant's cry has been detected for a prolonged period of time.

2.4. Camera Module for Video Streaming

The product uses camera for surveillance of the baby and sends a real time video and audio to a webpage so that they can monitor their infants remotely and react based on the alerts provided by the system.

2.5. LED's

The system consists of a smart sound sensor that would detect when the baby is crying and inform the parents through a set of LEDs. This would be beneficial to the parents with hearing disabilities.

2.6. Display

Display can be a phone display for laptop display where all the notifications is sent and fed for future reminders and also streaming can be done.

3. Operating System

Raspbian is a free operating system based on Debian optimized for the Raspberry Pi hardware. An operating system is the set of basic programs and utilities that make your Raspberry Pi run. However, Raspbian provides more than a pure OS: it comes with over 35,000 packages; pre-compiled software bundled in a nice format for easy installation on your Raspberry Pi. The initial build of over 35,000 Raspbian packages, optimized for best performance on the Raspberry Pi. However, Raspbian is still under active development with an emphasis on improving the stability and performance of as many Debian packages as possible. The new Raspberry Pi configuration allows you to enable and disable interfaces, tweak performance and configure internationalization options, such as time zone and keyboard.

4. Proposed System

On getting the Pi, the SD Card is needs to be written with its desired OS. After doing the above, insert the SD Card into the Raspberry Pi. DC power is to be supplied to the Pi either though a Power bank or a power socket. Finally the Raspberry pi is connected to a laptop though an Ethernet LAN cable. Once PuTTY is installed, through an IP address it can access command window of pi. Though this command window various programs are executed.

4.1. Video Streaming

For this first we need to connect USB camera to the raspberry pi through the USB port. We use a MJPG streamer to continuously stream the live video to the website. MJPG streamer is a command line application that copies JPEG frames from one or more input plug-in to multiple output plug-in. The parents can view the live video of their baby through web interface using various devices like laptop, mobile phones, etc.

4.2. Cry Detection

For this a Noise sensor is first connected to the raspberry pi with its out pin connected to a specific gpio pin. When the sensor detects a noise, it outputs a low signal. This value is accessed in the program though the specified gpio pin. For each low signal detected, a counter is incremented and when this counter reaches a preset value, it is considered as continuous cry from the baby and an email notification is sent to the users. Current temperature of the room is also noted as it can be one of the reasons for baby being uncomfortable and crying. As a way of calming the baby soothing music is played using the speaker.

4.3. Movement Detection and Graphing

Similar to the noise sensor, here PIR sensor is connected to the pi. This sensor first adjusts itself to the infrared signals emitted by the baby in front of it. When baby moves around resulting in change in the infrared values the PIR sensor returns a high signal. Again this value is accessed in the program and a counter is incremented. This counter value specifies the number of movements detected from the baby. For every preset period of time, the counter value and the current time are stored in an array which is then passed to a plotting function. This function draws a graph with time in x-axis and the counter value in y-axis. Over time when graph is populated with values of movements, analysis is done about how much time baby was in deep sleep showing no movement, and how much is the average movement of baby, finally too much movement denoting that baby is probably uncomfortable because of some reason.

4.4. Temperature and Humidity Detection and Graphing

The temperature and humidity sensor is connected to the raspberry pi similar to other sensors. However this time value read is not just high or low, instead the actual temperature and humidity values are read, these values are converted into a correct format by the adafruitdht package. Again for every pre-set time the temperature and humidity values with corresponding time are stored in two arrays and passed as parameters to the plotting function. The graph produced shows the variation of temperature and humidity over a period of time. By analyzing this data and comparing against the movement graph and also cry detected data, it could be found as one of the possible reason for the baby to be uncomfortable.

4.5. Reminder System

Using this feature, parents or caretakers can set reminder about feeding time and vaccination date. Here first they would have to enter the date and time when they want to get the reminder, then this data is stored in

database and is continuously checked against current date and time. When a match is found email notification is sent to the users.

The proposed system's UI has been made very interactive in order to help the used visiting the webpage, such that they find their task of operation simple. Hence a certain level of simplicity has been made to help users figure out the whereabouts easily. Once the user has registered with the respective system password, the user will only then be permitted to login successfully. On logging in, the user enters the home page. The home page, a very attractive one, has several buttons in order to redirect the user to a whole new page on clicking a specific button. Hence each button would be used to provide redirection to a whole new page with some functionality that the user would require. There are a total of 4 buttons. They are used to navigate to the pages showing the temperature and humidity graph, movement graph, video stream and lastly notification. On moving the mouse over each of them, a pop up would appear giving a description on what each button would imply. Lastly there exists the sign out button which would lead the user back to the login page.

5. Results

Thus we have introduced an Advanced Baby Monitoring System. This system is capable of sending a live video stream of the baby using the camera to a webpage, accessible through both mobile phones and laptop. The system also provides an important functionality of listening to baby's cry though a sound sensor and then alerting the parents with an email notification. On detecting the child's cry, the LED's blink and a lullaby would play simultaneously in order to help train the child to self soothe. Additionally this system logs the baby's movements detected using a PIR sensor and produces a graph which show variations of movements with respect to time. Using temperature and humidity sensor it produces another graph which shows varying temperature and humidity values in the room. Finally the system also sends reminders to the parents about approaching vaccination dates and feeding time.

5.1. Temperature and Humidity

The figure shows a graph of temperature and humidity plotted against the time. It shows the variation in temperature and humidity in the environment surrounding the infant over a period of time.

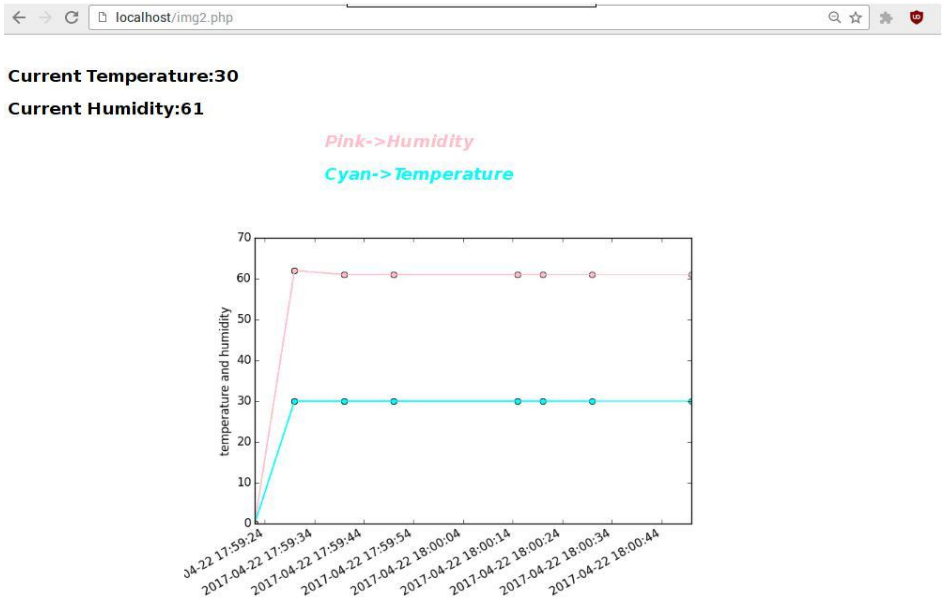

Figure 2. Graph for temperature and humidity values

5.2. Notification System

When infant's cry is detected parents are notified by sending an email notification. This helps parents to quickly respond and take care of the infant. Other than this, parents can set notification for vaccination date and feeding time and get corresponding alert on those days.

Figure 3. Cry detected notification on phone

5.3. Activity Levels

The infant's movements in its sleep are recorded using a PIR sensor and plotted against time. Many points in graph at level 0 indicate that infant is in deep sleep.

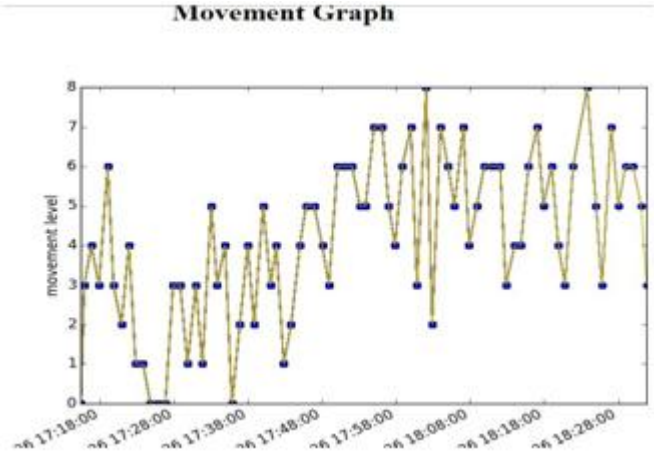

Figure 4. Graph for activity levels

6. Applications

6.1. At Home

This system helps the parents and caretaker to monitor their baby without actually being at the baby's bedside. Video streaming helps them to get the live stream of the baby's activities. The Temperature and humidity sensor displays the temperature and humidity of the baby's environment. The PIR sensor used in this system regularly detects the baby's movement. Graphical representation of temperature and humidity as well as movement values helps the parents to analyze the data more easily. Notifications received on detection of the infant's cry helps the parents understand that their child is experiencing some level of discomfort. Notifications on approaching feeding times and nearing vaccination dates helps to keep the parents up to date and be punctual in feeding their baby at appropriate times.

6.2. Hospital Purposes

This system helps them to check the discomfort of the newborn in various temperature and humidity conditions. For premature babies, during the initial treatment, parents are not allowed to be present near the baby physically as germs and infections could transmit easily since they have a low immunity tolerance. Thus in such situations video streaming would help the parents to see their baby without actually being in the room where the baby is physically. When the babies are present in NICU, the video streaming and notification on cry detection helps the nurses, doctors and other staff in charge to take immediate action.

7. Conclusions

It shows the variation in temperature and humidity in the environment surrounding the infant over a period of time. The Advanced Baby Monitor is a project developed to touch the lives of parents and ease their ways of operation. It has been pumped with several functions sufficient enough to ease the workload of parents. The functions offered by this device will look after the basic wellbeing of the child and thereby provide notifications to parents when their baby is in need of them. Hence setting aside their workload doesn't stand as an option.

This device includes several specifications in order to reassure parents with the safe handling of their child. It monitors the temperature and humidity around the child so as to determine if the child is experiencing some level of discomfort. It also monitors the activity levels of the child and provides streaming. The video received by the parent on the webpage will be a live video. In case the child cries, music will be played to help the child learn to self soothe.

Apart from these specifications several others can be included in order to make the device more interactive and better.

In future, the Advanced Baby Monitor can be used to implement automatic cradling in times when the baby wakes up or if the baby weeps. It can be used to help parents teach their children to self soothe. Another feature that can be implemented is spouting which is a small ankle bracelet worn by the infant that monitors factors like the heartbeat etc. Having a video camera with image processing, it can be used for security purposes to determine if there are any intruders.

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SMART AGRICULTURE

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Abstract
Agriculture plays a crucial role in the economy of developing countries and provides main source of food, income and employment to their rural population. Agriculture is the backbone of the economy of a country. Although we all currently rely on the industrial agriculture to produce the majority of food we consume, this type of agriculture is facing problems. The main disadvantage of agriculture is long hours, poor pay and hard labor. To avoid this we come up with modern technologies and make the work of farmers easier. The internet of things is modifying agricultural industry and enabling farmers to cope with the enormous challenges they face. These technologies include weeding, switching On/Off the water pump, animal and bird scaring, temperature, humidity and moisture detection using appropriate sensors.

1. Introduction

About 70% of population of India lives in villages. The core occupation of people who live in villages is agriculture (farming). Yet India is not self -sufficient in producing enough food. Every year hundreds of tons of food-grains are imported from foreign countries. Agriculture is of extreme importance for the progress of developing country like India. Internet of things has been proving its tenacity across industries. Among the different industries the one sector it is quickly catching up with is, the agriculture. With the idea of smart farming and digitalization, it is gaining popularity like never before, and is coming with the ability to provide high precision crop control, data collection and automated farming techniques. Agriculture is considered as the basis of life for the human species, as it is the main source of food grains and other raw materials. But agriculture in India is mostly depended upon natural resources and weather condition plays an important role. This paper suggests internet of things based sensor network for agricultural use, smart water irrigation, bird and animal scarring methods and robotic grass cutter. The sensors such as temperature and humidity help the farmer monitor the weather conditions and also keep track of the previous conditions.

Knowing the exact soil moisture conditions on their fields, not only are farmers able to generally use less water to grow a crop, they are also able to increase yields and the quality of the crop by improved management of soil moisture during critical times of need. In urban and suburban areas, landscapes and residential lawns are using soil moisture sensors to interface with an irrigation controller. Water pumps can be turned ON/OFF as and when needed. Connecting a soil moisture sensor to a simple irrigation clock will convert it into a "smart" irrigation controller that prevents irrigation cycles when the soil is already wet, e.g. following a recent rainfall event. Golf courses are using soil moisture sensors to increase the efficiency of their irrigation systems to prevent over-watering. The IOT based robotic grass cutter can be used to cut grass in the fields, directions can be changed by passing commands. Monitoring environmental factors alone is not enough and is not a complete solution to improve yield of crops.

2. System Overview

Some operations are meant for field purposes and some can be handled or controlled sitting at home. Here the model is divided into nodes in the figures based on their area of usage.

Part 1-Node 1: Node1 will be the warehouse management which consists of humidity sensors, temperature sensors and the water pump. Temperature and humidity sensor senses the temperature and humididty respectively. These values stored in the database and a graph is plotted, with the values vs the days, for later reference purpose. Node 2 also has the water pump operation, the pump can be switched ON/OFF manually depending on the soil moisture notification we get from node 2.

PART 1-Node 2: In node 2, moisture sensor with voltage comparator is used to detect the soil moisture. The transmitted data is displayed on the LCD, and the user is given notification about it. And then the user can decide if/not to switch on the water pump in node 1, as per the need. There is also the animal and bird scarring PIR sensors, that detect the intruder within a certain bandwidth limit and responds by playing the

scarring voices that are recorded in the playback module, when an intruder is detected. It is to be noted that at the max 8 voices can be recorded in the playback module.

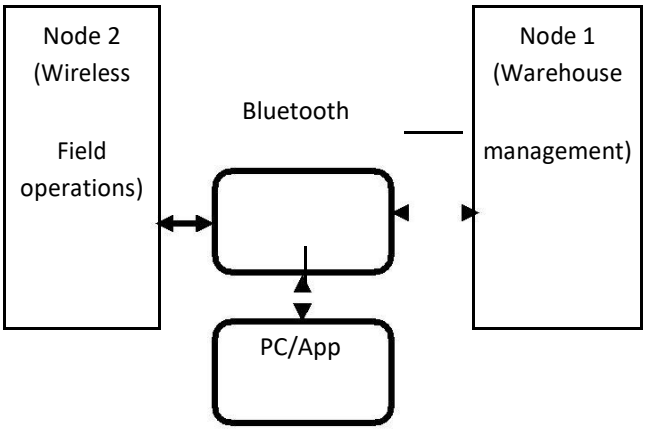

Figure 1. System Overview Part 1

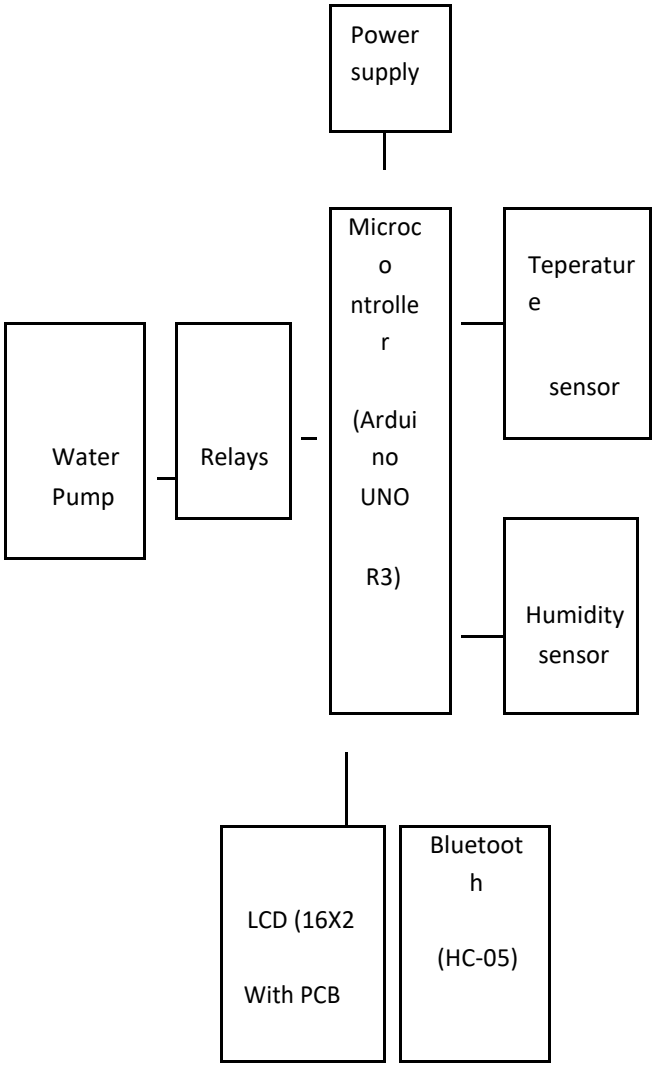

Figure 2. Node

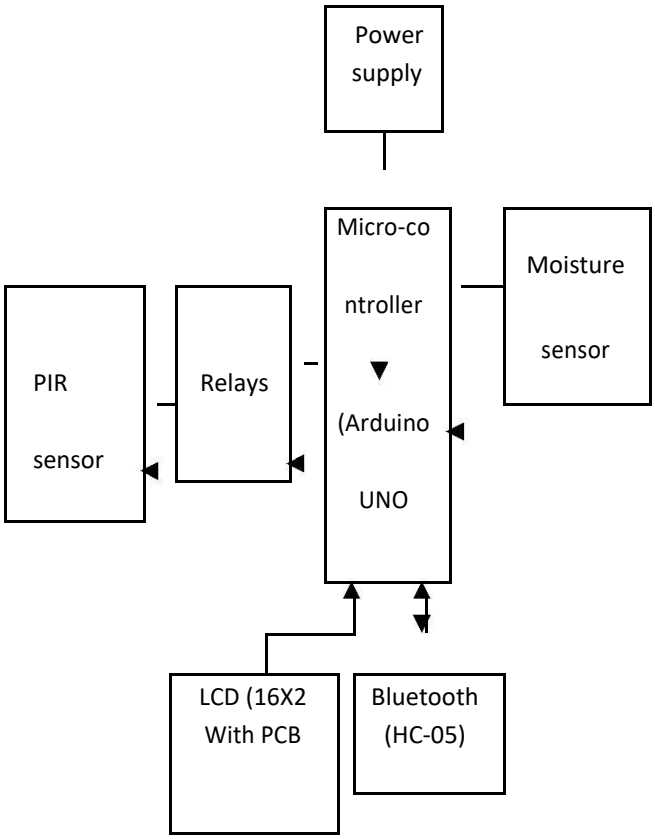

Figure 3. Node 2

Part 2: Node 3: The grass cutter is a robotic moving device, which is connected to our phone or PC through the Bluetooth and then can be operated, by changing the directions as per the users need.

3. Architecture of the System

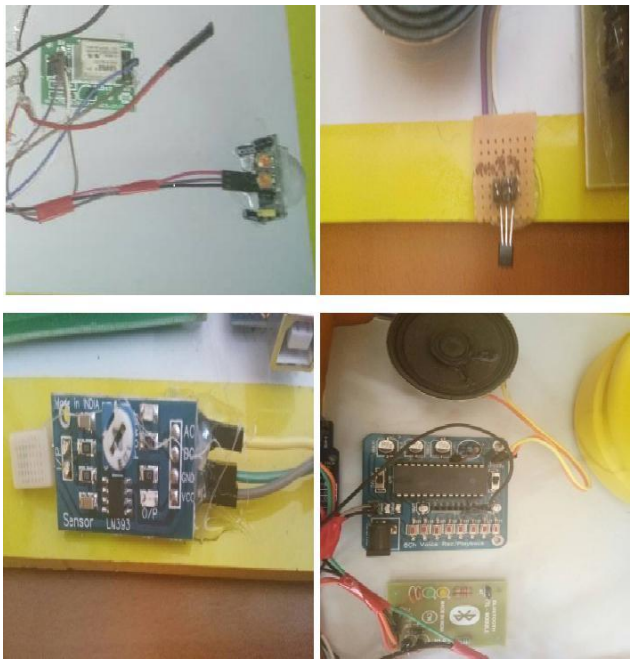

Figure 4. Hardware Components

Hardware used:

a) Arduino Uno- R3: This is the new Arduino Uno R3. In addition to all the features of the previous board, the Uno now uses an ATmega16U2 instead of the 8U2 found on the Uno (or the FTDI found on previous generations). This allows for faster transfer rates and more memory. No drivers needed for Linux or Mac (inf file for Windows is needed and included in the Arduino IDE), and the ability to have the Uno show up as a keyboard, mouse, joystick, etc. The Uno R3 also adds SDA and SCN pins next to the AREF. In addition there are two new pins placed near the RESET pin. One is the IOREF that allows the shields to adapt to the voltage provided from the board. The other is the not connected and is reserved for future purposes. The Uno R3 works with all existing shields but can adapt to new shields which use these additional pins. Arduino is an open source physical computing platform based on a simple I/O board and development environment that implements the processing/wiring language. Arduino can be used to develop stand alone interactive objects or can be connected to software on your computer (e.g. flash, processing, maxMSP). The open source IDE can be downloaded for free (currently for Mac OS X, Windows, Linux.

***b)* LCD (Liquid Crystal Display) 16X2**: LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16*2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on. A 16*2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5*7 pixel matrix. This LCD has two registers, namely, Command and Data. The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc.

c) Relays: *A relay is an* electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid state relays. Relays are used where it is necessary to control a circuit by a separate low power signal, or where several circuits must be controlled by one signal. The type of relay that can handle the high power required to directly control an electric motor or other loads is called contactor. Because relays are much more resistant than semiconductors to nuclear radiation, they are widely used in safety critical logic, such as the control panels of the radioactive waste handling machinery. Electromechanical protective relays are used to detect overload and other faults on electrical lines by opening and closing circuit breakers.

d) Soil Moisture Sensors: Soil moisture sensors measure the volumetric water content in the soil. Since the direct gravimetric measurement of free soil moisture requires removing, drying and weighing of a sample, soil moisture sensors measure the volumetric water content indirectly by using some other property of the soil, such as electrical resistance, dielectric constant, or interaction with neutrons, as a proxy for the moisture content. The relation between the measured property and soil moisture must be calibrated and may vary depending on environmental factors such a soil type, temperature, or electric conductivity.

e) Temperature Sensor: The LM35 series are precision integrated circuit temperature devices with an output voltage linearly proportional to the centigrade temperature. The LM35 device has an advantage over linear temperature sensors calibrated in Kelvin as the user is not required to subtract a large constant voltage from the output to obtain convenient scaling. The device is used with single power supplies, or with plus and minus supplies. The low output impedance, linear output and precise inherent calibration of the LM35 device makes interfacing to read out or control circuitry especially easy.

***f*) Humidity Sensor:**

A humidity sensor senses, measures and reports the relative humidity in the air. It therefore measures both moisture and air temperature. Relative humidity is the ratio of actual moisture in the air to the highest amount of moisture that can be held at the air temperature. Humidity can be used as monitoring and preventive measures in homes for people with illness that are affected by humidity. They are also found as

part of home heating, ventilating, and air conditioning systems. They can also be found in offices, cars, museums, industrial spaces and greenhouses and can be used in meteorology stations to report and predict weather.

g) PIR Sensors:The PIR sensor has two slots in it, each slot is made of a special material that is sensitive to IR. The lens used here is not really dong much so we see that the two slots can 'see' out past some distance. When the sensor is idle, both slots detect the same amount of IR, the ambient amount radiated from the room or walls or outdoors. When a warm body like human or animal passes by, it first intercepts one half of the PIR sensor, which causes a positive differential change between the two halves. When the warm body leaves the sensing area, the reverse happens, whereby the sensor generates a negative differential change, these change pulses are what is detected.

Software requirements:

***a)* Visual Studio 2010:**Microsoft Visual Studio is an Integrated Development Environment (IDE) from Microsoft. It is used to develop computer programs for Microsoft Windows, as well as web sites, web applications and web services. Visual Studio uses Microsoft software development platforms such as Windows API, Windows Forms, Window Forms, Windows Presentation Foundation, Windows store and Microsoft Silver light. It can produce both native code and managed code.

Visual Studio supports different programming languages and allows the code editor and debugger to support programming language, provided a language-specific service exists. Built-in languages include C, C++ and C++/CLI (via visual C++), VBNET (via Visual Basic.NET), C# (via Visual C#), and F# (as of visual studion2010).

b) MySQL: MySQL is the world's most widely used open source Relational Database Management System (RDBMS) that runs as a server providing multi-user access to a number of databases. The MySQL development project has made it source code available under the terms of the GNU General Public License, as well as under a variety of proprietary agreements. MySQL was owned and sponsored by a single for-profit firm, the Swedish company MySQL AB, now owned by Oracle Corporation. MySQL is a popular choice of database for use in web application software stack. LAMP is an acronym for "Linux, Apache, MySQL, and Perl/PHP/Python" Free software – open source projects that require a full feature database management system often use MySQL.

c) ASP.NET:ASP.NET is a set of web development tools offered by Microsoft. Programs like Visual Studio.NET and Visual Web Developer allow Web developers to create dynamic websites using a visual interface. Of course, programmers can write their own code and scripts and incorporate it into ASP.NET websites as well. Though it is often seen as a successor to Microsoft's ASP programming technology, ASP.NET also supports Visual Basic. NET, Jscript.NET and open source languages like Python and Perl.

ASP.NET is built on the .NET framework, which provides an application program interface (API) for software programmer. The .NET development tools can be used to create application for both the Windows operating system and the Web. Programs like Visual Studio. NET provide a visual interface for developers to create their applications, which makes. NET a reasonable choice for designing Web-based interfaces as well. In order for an ASP.NET website to function correctly, it must be published to a web server that supports ASP.NET applications. Microsoft's Internet Information Services (IIS) Web server is by far the most common platform for ASP.NET websites. While there are some open source options available for Linux based systems, these alternatives often provide less than full support for ASP.NET applications.

4. Experiment and Results

As shown in the figure, experimental setup for Node1, consists of smart agriculture with arduino IDE, relays, power supply, battery, voice playback module, display, Bluetooth module and other sensors are interfaced with microcontroller. Test results shows that the model can be controlled using the wireless transmission of PC commands.

The module has two modes of operation, Command Mode where we can send AT commands to it and Data Mode where it transmits and receives data to another bluetooth module.

The default mode is DATA Mode, and this is the default configuration, that may work fine for many applications: Baud Rate: 9600 bps, Data: 8 bits, Stop Bits: 1 bit, Parity: None, Handshake: None, Passkey: 1234,

Device Name: HC-05. In some cases you may want to change some of the configuration setup values. There are two ways to get into Command Mode: Connect the KEY pin high **before** applying power to the module. This will put the module into command mode at 38400 baud. This is commonly used, and needed if you don't know the baud rate the module is set to. You can use the Bluetooth Command Utility for this. Apply power to the module **then** pull the KEY pin high. This will enter command mode at the currently configured baud rate. This is useful if you want to send AT commands from a microcontroller as the KEY pin can be controlled from one of the microcontroller pins. BUT you need to know the currently configured Baud Rate. Commands are sent to the module in UPPERCASE and are terminated with a CR/LF pair.

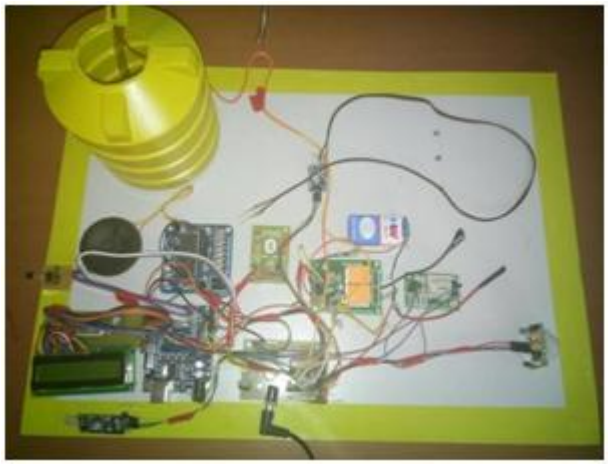

Figure 5. Experimental setup for Node 1

5. Conclusions

As seen in the above benefits, the farming and the agriculture industry overall can really benefit from implementation of such IOT solution of platform. Monitoring and collecting data of soil moisture, temperature and humidity across multiple fields will improve efficiency of water usage and crop yield of large and local farms. As the world population increases, farming and food production will have to increase with it. IoT platforms will enable this efficiency and production. The project can be further extended by implementing a wireless sensor network like WI-FI instead of the Bluetooth, which will be better suited for larger distances. Some additional features that can be added are, extensible features of sensors can be added as per crop specific need. Motion sensors for monitoring behaviour of the animals, robotic sprayers to sprinkle fertilizers and pesticides and much more.

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HOSPITALS USING INTERNET OF THINGS (IOT)

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Abstract
Most of the time, due to negligence of hospital staff, excessive number of patients or inattentiveness of relatives it may happen that saline bottle is not monitored properly and it may lead to cause heart attack due to "AIR EMBOLISM". In a hospital, number of electrical equipments (fan, lights) are more so energy is more. Important to use electricity as per the requirement. Thus, a system which include combination of sensor technology and Internet of Things(IoT).Using this system one can control switch of the electricity and monitor level of the saline bottle from distant position.

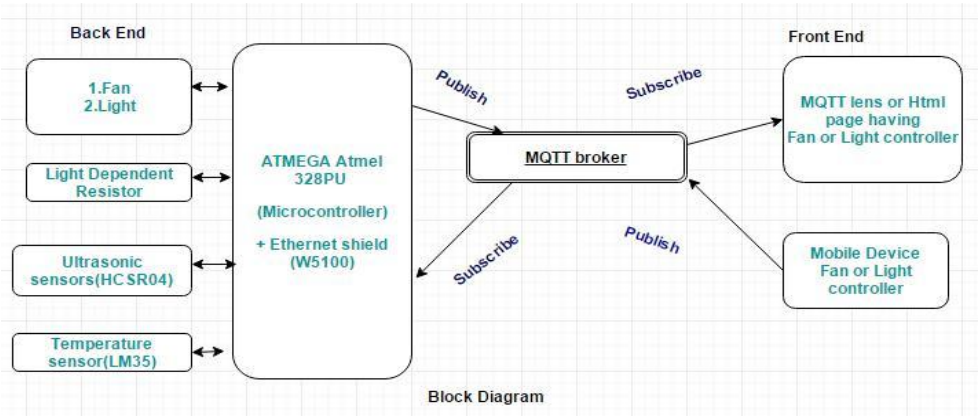
1. INTRODUCTION

The project is based on the Internet of Things by which we can solve the problems related to hospitals. In a hospitals, there is excessive use of electricity used by light, fans and various medical appliances. One of the biggest causes of excessive energy use in hospitals comes from amount of electrical equipment, lighting, and electronics and how often it is left ON when not needed.

The primary environmental effect of energy overuse is an increase in carbon footprint, but there are simple changes we can make to avoid this. For example, if the devices are kept running when they're not in use, the result is an increase in electrical use and, consequently, a bump in the amount of greenhouse gases that enter the atmosphere. This module helps to control consumption of electricity One more important problem related to hospital is nurse or hospital staff need to constantly monitored the level of saline bottle. So ,it may happen that due to the negligence of the hospital staff or due to more number of patients and inattentiveness, saline bottle may not monitored properly which can lead to the death of the patient. This can happen when saline bottle is fed completely to the patient and when it is not removed then due to the pressure difference between the patient's blood flow and empty saline bottle, blood can causes outward flow of blood into saline bottle.

In this system using IoT, one can control switch of the electricity and continuously monitored the level of the saline bottle from the distant position.

2.Block Diagram



Block Diagram

In the above block diagram, there are three parts which as follows:

1.Back End which includes fan,light,ultrasonic sensor etc.

2.Arduino mega (ATMEGA Atmel328PU)+Ethernet shield(W5100)

3.MQTT broker as a cloud server

4.Front end which includes html page or mobile device having MQTT lens application which includes switch controller for fan and light.

In this system, ultrasonic sensor,light dependent resistor and temperature sensor is interfaced with Arduino mega board(ATmega Atmel 328PU). This Arduino mega board is connected to MQTT server via ethernet cable. This will provide connectivity to the server to transmit the data on to the internet. This data then monitored arbitrarily using mobile device or by using MQTT lens application.

3.Working Methodology

Above system will work as follows:

In the above system sensor will acquire the data from the surrounding that is temperature sensor will constantly monitor the temperature of the patient's room, ultrasonic sensor will monitor the level of saline bottle and LDR(Light Dependent Resistor) will monitor the illumination of a light on it in terms of resistance value.

Data acquire by all of the sensors will be transmitted by USB(Universal Serial Bus) which is used for the data transfer to the Arduino mega board. This data is then publishing to the MQTT broker server via ethernet cable.

Whenever one wants to acquired this data then that person has to subscribe to the MQTT server and then hospital staffhe/she can monitor the data received. MQTT platform is used to control to the switch which will ultimately control electrical appliances(fan ,light etc.).

Whenever temperature of the patient's room increases above predefined level, it will send the data to the page and then from the webpage or from the mobile device. In case of saline bottle, level of the saline bottle continuously send on to the server so that hospital staff need not to go to each and every patient's room to monitor it. As soon as the level of liquid in a saline bottle falls below predefined value then nurse can go to the patient's room and change that bottle.

4.Components Required

4.1 Temperature sensor (LM35):

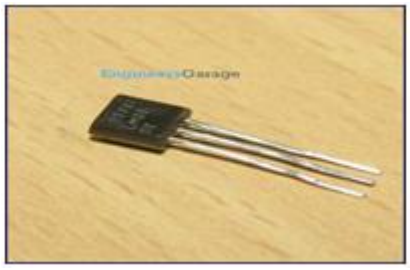


Fig-1: LM35 sensor

The LM35-series devices are precision integrated-circuit temperature sensors, with an output voltage linearly proportional to the Centigrade temperature. The LM35 device has an advantage over linear temperature sensors calibrated in Kelvin, as the user is not required to subtract a large constant voltage from the output to obtain convenient Centigrade scaling. The features of the LM35 make it suitable for many general temperature sensing applications.

4.2 LDR(Light Dependent Resistor):

Fig-2: LDR sensor

The cell resistance will fall with the increasing light intensity. Its application includes smoke detection, automatic lighting control system, batch counting and burglar alarm systems. Light dependent resistors have property to store the lighting conditions in which they have been stored. Light storage reduces equilibrium time to reach steady state resistance values.

4.3 Ultrasonic sensor(HC-SR04):

Fig-3: HC-SR04 sensor

Ultrasonic sensors module includes ultrasonic transmitters, receiver and control circuit. It provides 2cm-400cm non contact measurement function. Ranging accuracy may reach 3mm.

The basic working principle of Ultrasonic sensor is as follows:

a) Using IO trigger for at least 10us high level signal.
b) The module automatically sends eight 40kHz and detect whether there is a pulse signal back.
c) If the signal back ,through high level, time of high output IO duration is the time from sending ultrasonic to returning.

Test distance =(high level time × velocity of sound(340M/S)/ 2)

4.4 ATmega Atmel 328PU

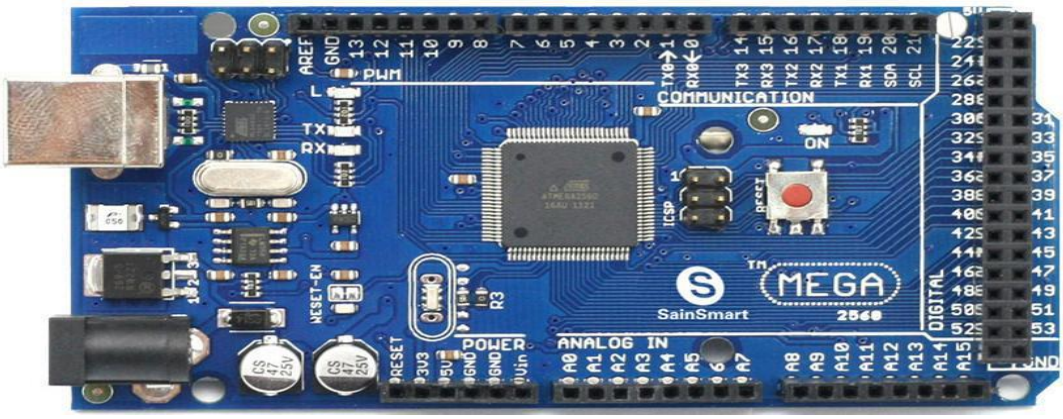


Fig-4: Arduino mega board having ATmega Atmel 328PU Microcontroller

4.5 MQTT protocol

In this system use of MQTT protocol has been used because it has advantages over http protocol. This protocol gives faster response output. It has lower battery and bandwidth consumption. It works efficiently enterprise level applications which includes transfer data to server or to mobile application. It assures data transmission and efficient distribution. It is suitable for constrained environment than http. It is a light weight publish and subscribe protocol and runs on IP. It is open standard protocol.

5. Results and Conclusion:

Smart hospital using Internet of Things (IoT) has been successfully designed. This project is highly energy efficient as it uses radio board having microcontroller(ATmega Atmel 328PU) which having low power utilization. It also uses MQTT networking protocol which is a light weight protocol and helps in power saving. We do not need to manually turn ON or turn OFF the switch of the light. It is possible to control the switch from a webpage or from the mobile application. This system is a time consuming . It will save patient from the risk of " AIR EMBOLISM" .It is user friendly system. Maintenance of this project is not costly.

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TOM (Touch Mouse)

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Abstract
Today's world touch screen technology is playing a vital role in our lives and implementing such a technology in almost everything we use is very important. The application TOM-Touch Mouse, which is used to give the user a touch screen experience on any projected surface. TOM eases the usage of the projected surface by giving a touch screen experience. The user needn't keep moving to the computer that is connected to the projector to navigate or perform some task, instead he can use the projected surface itself as he would use the regular computer to perform required task. Unlike other solutions to convert projectors to touch screen, TOM is freely available; since there is no usage of any hardware. TOM can be used by anyone without any technical knowledge and therefore can be used even in rural areas to provide a smooth and more interesting urban outlook to education or entertainment.

1. Introduction

The touch screen technology has now become an inherent part of our day to day lives. Need for large touch screen surfaces is increasing by the day. The gap between the real and virtual world is filled by this technology. Large touch screen technologies today are in very high demand, to ease the interaction between the user and the computer. Projected surfaces are used in almost all fields such as education, hospitals and entertainment. Hence, the development of projected surfaces to be converted to touch screen surfaces has made it much easier to interact with the projected surfaces. The necessity to move to the PC, every time the user navigates through the computer or performs a particular task, is completely eliminated with this kind of technology.

The existing technologies like IWB (Interactive White Boards) are extremely expensive and can be used only by well-established organizations. Using IR sensors (Wii remote) application is also relatively expensive because of the use of hardware. This is where TOM(Touch Mouse) comes into existence. TOM is an application that is used to convert any projected surface to a touch screen surface. Using TOM the user can get the look and feel of touch screen on any projected surface. TOM can be used on any 64 bit system which has an inbuilt camera or support USB camera. Since it is designed without the usage of any kind of hardware it is completely free. It is also designed with a very simple user interface so that even naive and inexperienced users can use this software. TOM was developed keeping in mind the common man, who cannot afford this kind of existing technology. Installing TOM on all systems in educational institutions enhances the quality of education, making classrooms more interactive and interesting, also giving a very practical approach to usage of computers, thereby instilling interests to pursue careers in the field of technology in the younger generation. Apart from this TOM can be used in offices, shopping centers, hospitals and entertainment industry to make work much easier and convey information in much easier and interactive way.

2. Background

Touch screen technology allows users to interact directly with the screen without the use of any mouse, touchpad or any other such devices. This technology is commonly used in PCs, Tablets, gaming consoles and other such devices. Touch screen technology is very popular because it makes the UI more effective and easy to use. It completely eliminates the usage of external hardware apart from the system that they are using.

Need for large projected surfaces is increasing by the day. Therefore to satisfy this demand, existing touch screen projected surfaces like An Interactive Infrared Sensor Based Multi-Touch Pane, Direct control of the computer through electrodes placed around the eyes , Control units for operation of computers by severely physically handicapped persons were created.

3. Tools for TOM

TOM application does not require any extra hardware, if the system has an inbuilt web-camera. If the system does not have an inbuilt web-camera then the user can use the USB-camera. This application is developed using many of the python libraries, the PyQt library for User Interface, Dlib library for tracking, OpenCV library for drawing and Windows API for controlling the mouse functionality.

PyQt: This is the python binding of cross platform GUI toolkit Qt. It is freely available and contains multiple classes or methods for GUI, accessing SQL database, XML parser, etc.

OpenCV: It is a cross platform freely available library which focuses on real time computer vision. It was originally developed by Intel.

Dlib: This is an open source cross platform library written in C++. However its tools can be used in python applications.

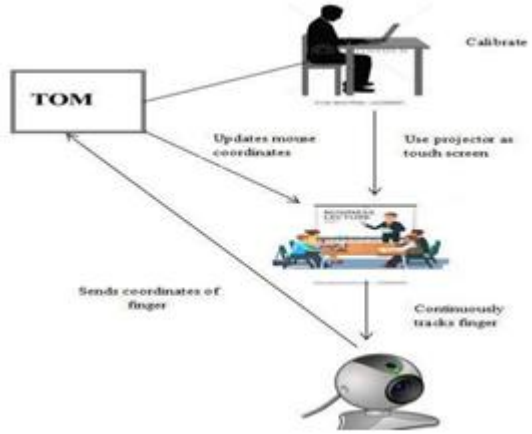
4. Proposed System

TOM is an application used to build a bridge between real and virtual world. It is used to convert any projected screen to touch screen. It is used to convert any projected screen to touchscreen.. The main architectural components of TOM are the camera (either system or USB), user, projected screen and finally the application itself. As shown in the figure, initially user opens TOM and calibrates screen after which he uses the projected screen as touch screen. The camera will continuously track hand movements and send them to TOM, which maps these coordinates to the desktop coordinates and move the mouse pointer there respectively.

5. Methodology

The application TOM continuously processes the movement of the human hand and moves the cursor accordingly. The user initially after launching the application must calibrate the window with respect to the projected surface size, and then user can use the projected surface as touch screen and can control the mouse. Fig.2 shows the sequence of interaction between different major components. Initially user reads instructions present on the app.

The user then presses begin which then opens the calibration module. On clicking the endpoints of the screen to be matched, the ends are sent to the application. The ends are then sent to system for cropping and straightening the frame to match ends of projected screen. The user can now touch the projected surface and use it as touch screen. The app continuously monitors the hand movements and maps the coordinates of the hand to the projected surface. The mouse cursor position is also moved with respect to the hand movements. If the cursor position is constant for a period of 3 seconds, the system initiates an appropriate click with respect to the foreground application. Once the click is initiated the cursor moves back to the centre of the screen and continues tracking the hand.



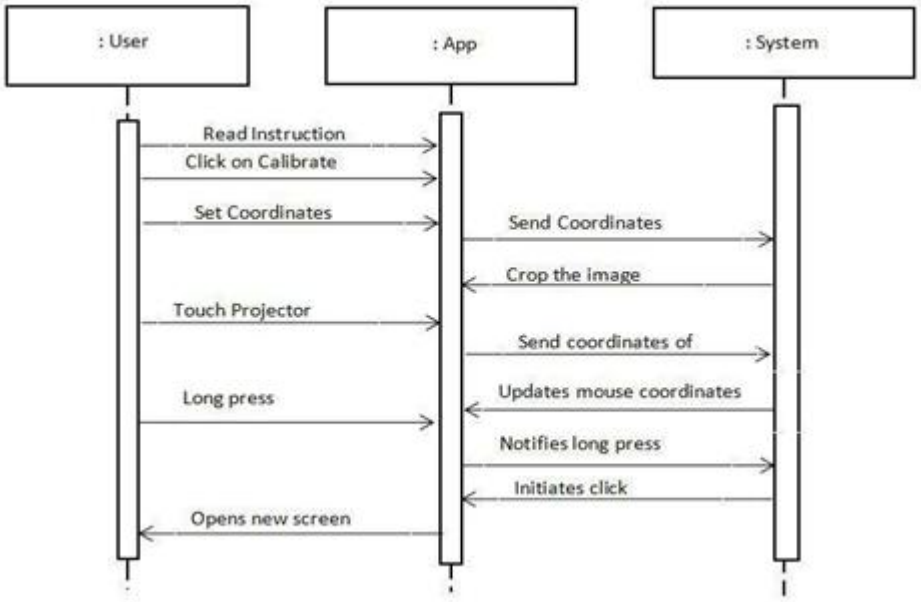
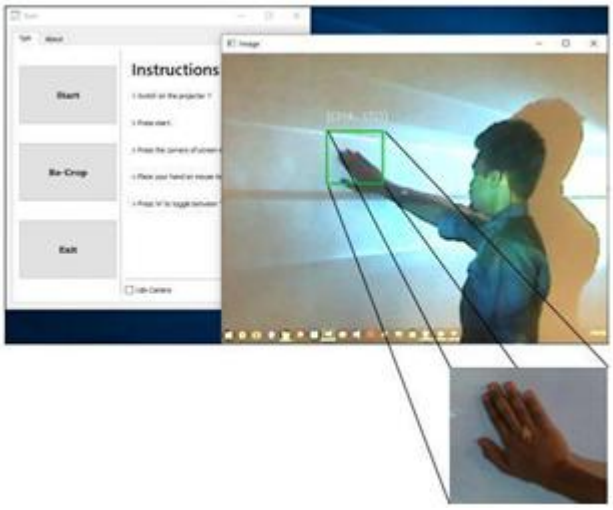


Figure 2. Sequence Diagram for TOM

6. Implementation

The application TOM is designed such that it works differently for specific foreground processes. TOM is able to recognize the foreground process opened and initiates the appropriate click with respect to the foreground application.



If windows explorer is running in foreground then the initiated click will be always be a double-click. TOM follows similar behavioural pattern for the desktop application. If foreground process is paint application, it works as follows. The window is divided into two parts: top part (the toolbar) and bottom part (the drawing area). Whenever the cursor is in top part it allows user to select the tools using a single click. Whenever the cursor is in bottom part it allows drawing. Keeping the hand still for 3 second initiates mouse-down operation. Now as the hand moves so does the cursor and tools can be used to draw, erase, etc on the paint application. Keeping the hand still for 3 seconds again will now execute mouse-up operation. Cursor can now be moved to the new position to draw something else.

For a power-point application the working of TOM is as follows. When the slide show is in progress, moving the hand from the centre of screen to the right and placing at the end for 3 seconds will prompt it to move to next slide. On moving the hand from the canter of screen to the left and placing at the end for 3 seconds will prompt to previous slide. Taking the hand to upwards and placing the hand for 3 seconds will exit the

slideshow. On regular usage of application single click is initiated.

7. Conclusions

This paper proposes a new application called TOM(Touch Mouse) to convert any projected surface to touch screen. TOM was developed keeping in mind the users need for large touch screen surfaces at low costs. Using TOM a single person can operate the computer using just the projected surface and this provides seamless interaction between computer and projected screen. TOM application can be used in educational institutes or business environments especially when the inter-active boards are not affordable.

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REAL-TIME HANDS DETECTION IN DEPTH IMAGE BY USING DISTANCE WITH KINECT CAMERA

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Abstract
Hand detection is one of the most important and crucial step in human computer interaction environment. This paper presents a distance technique for hand detection based on depth image information get from Kinect sensor. Distance was used as the method of this study for hand detection. First, Kinect sensor was used to obtain depth image information. Second, background subtraction and iterative method for shadow removal applied to reduce noise from the depth image. Then, it used the official Microsoft SDK for extraction process. Finally, two hands could be segmented based on different color in specific distance. The experiment result shows that hands and head can be detected in a different position with good accuracy.

Introduction

Recently, the hand detection is being widely applied to many applications. One of the interesting research area is replacing control device with vision based Natural Human Interaction (NHI). Vision based methods are non-invasive, and many algorithms have been proposed using intensity or color images from one or more video camera. The difficulties of gesture recognition of using regular camera include following.

(a) Noisy segmentation of hand from complex background and changing illumination.
(b) Simple feature extracted from images produce ambiguities.
(c) Hand tracking methods suffer from initialization and tracking failures.

Thus, low computational-efficiency and lack of robustness motivate researchers use Microsoft Kinect camera for practical gesture recognition.

Fig. 1 shows a Kinect with the cover removed (Miles, 2012), included: infrared projector, infrared camera, RGB camera and microphones.

Infrared camera to detect environment space depth output for 640×480 resolution video (low frame rate can be up to 360 gaming platform

is connected, the available range of 1.2 ~ 3.5 meters, the maximum range reaches six square meters. Kinect sensor field is design with 57° level angle, 43 ° vertical angle, and 27 ° of elevation. Kinect depth image of map formats: an unsigned 16-bit 1 channel (grayscale) image, among them low 12 bits is effectively information. The actual distance has been converted into grayscale.

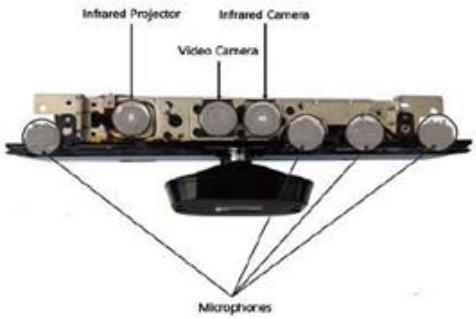


Figure 1. Kinect Camera

2. Literature Review

There is large body of information about hand detection. In recent years, there are many method has been developed for hand detection using depth by different devices such as Kinect and Zcam .some of researcher worked on hand segmentation, hand counter, color distribution, etc.

Kd- tree structure is used (Suau, Ruiz-Hidalgo, & Casas, 2012) to obtain color candidate cluster.Blue and yellow cluster can be merged since Hausdorff distance between them is small enough. (Park, Hasan, Kim, Chae, 2012) proposed adaptive hand detection approach by using 3-dimentional information from Kinect and tracks the hand using GHT based method. 3D hand model with label vertices was proposed by (Yao & Fu, 2012). During the training stage both RGB and depth data used as a input variable and produced two classifier such as random forest and Bayesian classifier. Per-78pixel hand part classification was obtained by forest classifier. (Chen, Lin, & Li, 2012) used hand region growing techniques which includes 2 steps. In the first stage, hand position detection was obtained by using hand moving with a velocity. In second stage tried to segment entire hand region by using region growing technique on 3D point. Hybrid RGB and TOF were proposed (Ren, Meng, Yuan, & Zhang, 2011) and (Van den Bergh & Van Gool, 2011). They used skin color segmentation based on two methods. a) Gaussian mixture model (GMM), was trained offline and it was able to detect skin color under lighting condition. b) Histogram-based method which was trained online. Hybrid method can be obtained by multiplying the GMM-based skin color probability with histogram based skin color probability. Representing hand in box used by (Frati & Prattichizzo, 2011). They used threshold approach to compute bounding box. Depth data which is too close and too far from Kinect are considered as zero with fixing lower and upper thresholds. The function "cvFindContours ()" was used to find the counter for the object. Combine both a training stage and estimation stage was used by (Yao & Fu, 2012). RGB and depth images used as an input in training stage and generate random forest classifier and a Bayesian classifier. The former is for the per-pixel hand parts classification; and the latter is employed as an object classifier to locate hand. Threshold Method is a simple method of depth which was used to isolate the hand by (Mo & Neumann, 2006) and (Breuer, Eckes, & Müller, 2007) and (Liu & Fujimura, 2004) and (Biswas & Basu, 2011). Depth thresholding determines the hands to be used to those points between some near and far distance thresholds around the Z (depth) value of the expected centroid of the hand – which can be either predetermined and instructed to the user, or determined as the nearest point in the scene. (Hamester, Jirak, & Wermter, 2013) perform foreground segmentation on depth images to reduce the region of interest. After that, edge detection in the foreground depth image provides a set of candidate contours. Randomized Decision applied this method for accurate hand detection and pose estimation with great accuracy result. (Keskin, Kıraç, Kara, & Akarun, 2012) introduced novel method to tackle the complexity problem. The idea is to reduce the complexity of the model by dividing the training set into smaller clusters, and to train PCFs on each of these compact sets. Most of researcher tries to detect hand and head by using Kinect skeleton which can detect and track hand and head easily. (Xiao, Mengyin, Yi, & Ningyi, 2012) and (Zainordin, Lee, Sani, Wong, & Chan, 2012) used skeleton model for hand detection. They usually crop hand based on coordinate x, y which obtains from the skeleton. However, when the subject's hand is far from the sensor, the captured hand is small in the captured image.

3. Shadow Modeling

Shadow modeling is basically model of a shadow proposed by (Khoshelham & Elberink, 2012). The Kinect is organized sensor consisting of 3 parts which are one infrared laser emitter, one infrared camera and one RGB camera. Firstly, the laser source emits a constant pattern of speckles into the scene. Secondly, infrared camera try to captured speckles are reflected. This measurement is called triangle process. Based on this structure, a model is built to present the cause of shadow in this section and a mathematical expression for shadow offset is also explained.

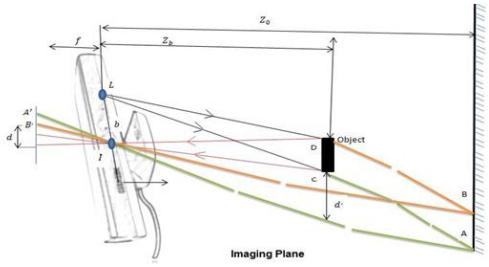


Figure 2:Imaging Plane

3.1. Cause of Shadow

Figure. 2 presents the cause of the shadow. It illustrates a simple scene consisting of one object and one background. Their distances to the sensor are z_o and z_b, respectively. L denotes the laser emitter and I denote the infrared camera. Suppose a number of speckles are projected onto the scene, as is shown in Figure 2 by solid lines. Some of the speckles hit the background directly while some are blocked by the object. We extend the line LC and LD to background and get a region marked as AB. Obviously, region AB is not reached by any speckles. As a result, A´B´, its corresponding region on imaging plane, receive no speckles from the scene. In other word, depth in region A´B´ is not measured and shadow is formed. From the projection model bellow, we conclude that the shadow is an area of the background where the speckles from the laser emitter cannot reach due to obstruction by an object. In other word, shadow is the projection of the object on the background. This model also explains why shadow is always presented on the right side of the object.

4. Methodology

This research was conducted to identify human hands in exact area .Given a collection of videos, we focused on the problem of interpreting the output of human hand model in order to identify with different color. The proposed approach is illustrated in Fig. 3

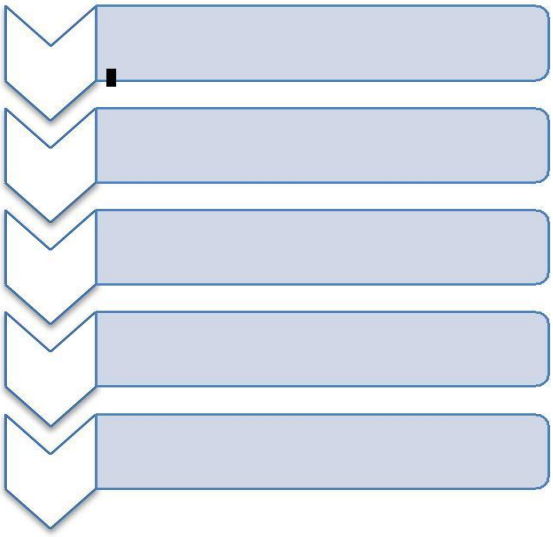


Figure 3. Overview of the proposed Work

4.1. Background Subtraction

Depth images, as they are provided by a Kinect, suffer from quite unusual noise. The best way was to calculate distance. In this method, by determining the minimum and maximum distance, the background can be removed. For Mindepth and Maxdepth, fix value were used as following statement.

Mindepth = Fix value

Maxdepth = Fix value

By comparing Figure 4 and 5, it can be seen that the pixel intensity was clustered in the middle of Figure4 while the pixel intensity in Figure 5 is discrete.

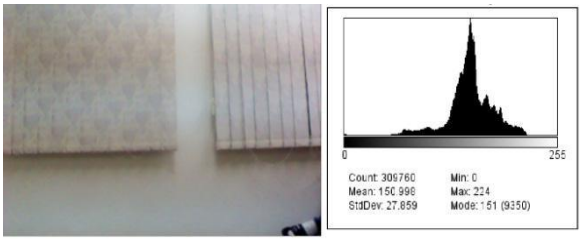


Figure 4. Original RGB image

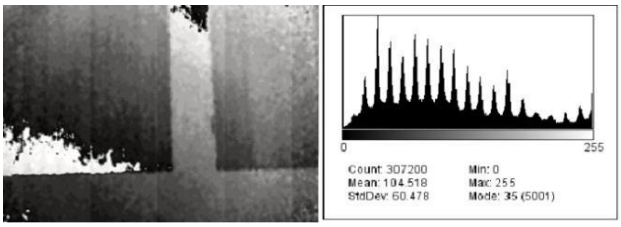


Figure 5. Depth Map of the image

Finally, all pixels from the background were removed as shown in Figure 6. Figure 7 shows more consolidated step by step results of all redundant data that has been removed from the scene.

Figure 6. Background Subtraction

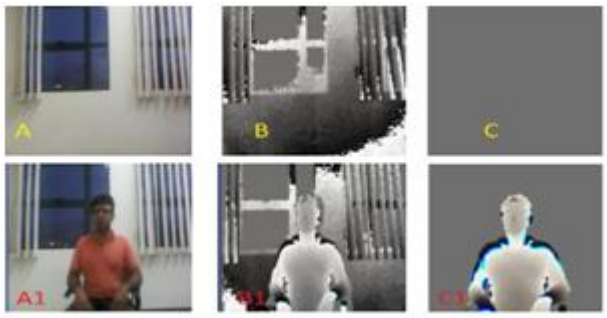
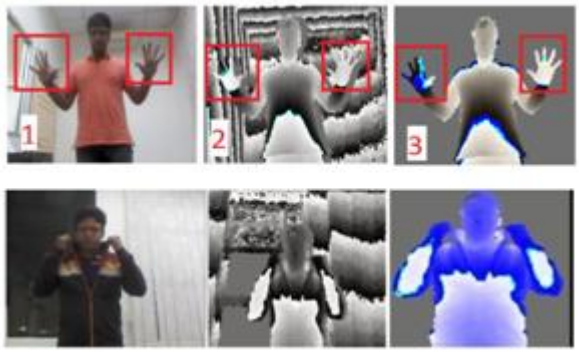


Figure 7. Steps of background subtraction

4.2. Shadow Removal

The shadow removal is one of the main contribution to this paper. This technique uses an iterative process that propagate values from known depth values to unknown depth values in the same segmented cluster. This solution provides a unique and novel. A bin is considered missing if its depth value is bellow MinDepth = 500 mm, and, after experimenting with a few values, we chose MaxDepth = 2500 mm; and K = DepthLength. The source code performed very well, and with the exception of the image corners, it was able to get sensible estimates in depth. Because this process is related to a diffusion, the results automatically have the depth information interpolated. Figure 8 shows the result of denoising step by step in using this technique.



Color Map *Depth Map* *Denoising*

Based on the Figure 8, we compared the pixel capacity of noising and denoising data given in the graphs shown in Figure 9. This result was based on 640 x 480=307200 depth resolution. It can be seen that the pixel capacity of depth map was around 160000 pixels, while under denosing process, this pixel capacity has decreased to around 60000 pixels values. Overall, this technique reached the best shadow removal and could successfully enhance the depth denoising by using Kinect 360 camera.

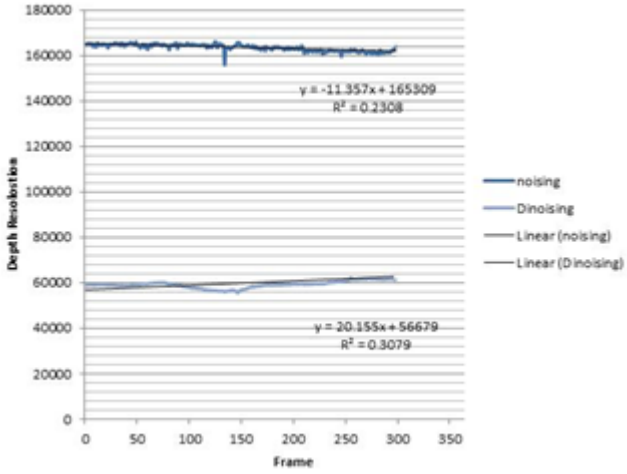


Figure 9. Comparison the pixel capacity of noising and denoising data

4.3. Hand Detection

Robust hand detection is the most difficult problem in building a hand gesture-based interaction system. There are several cues that can be used: appearance, shape, color, depth, and context. In problems like face detection, the appearance is a very good indicator. The eyes, nose and mouth always appear in the same configuration, with similar proportions, and similar contrasts. Unfortunately, this is not the case for hand detection; due to the high number of degrees of freedom, and the resulting shapes and shadows, the hand appearance can change almost indefinitely.

For hand detection user need to make sure that the hand is the front most objects facing the sensor. The hand region is cropped on the basis of centroid coordinate of hand obtained from skeleton model. The following algorithm shows the step involves in hand detection with different color for each contour.

```
DepthImagePixel[] depthPixels = new (depthPixels) DepthImagePixel[depthFrame.PixelDataLength];
byte[] colorPixels = new(colorPixels) byte[depthFrame.PixelDataLength * 4];
depthFrame .CopyDepthImage PixelData To (depthPixels);
int minDepth = 500;
int maxDepth = 2500;
int colorPixelIndex = 0;
for        int i = 0;
i < depthPixels.Length          ++I;
short depth = depthPixels[i].Depth; intensity = ( byte)
(depth>= minDepth) &&
(depth <= maxDepth ? depth : 0);
intensity1 = 0;
intensity2 = 255;
intensity3 = 255;
End for
If         (depth<1500)
If          1000<Depth <1200
intensity1 = 0;
```

```
intensity2 = 200;
intensity3 = 155;
If   depth <1000   then
intensity1 = 250;
intensity2 = 200;
intensity3 = 0;
else
intensity1++;
intensity2++;
intensity3++;
End If;
If        (depth < 1450) & (depth > 1200)
intensity1 = 0;
intensity2 = 100;
intensity3 = 155;
End If;
colorPixels[colorPixelIndex++]   =   intensity1;   colorPixels[colorPixelIndex++]   =   intensity2;
colorPixels[colorPixelIndex++] = intensity3;
Bitmap bitmapFrame
ArrayToBitmap (colorPixels, depth Frame.Width, depth Frame. Height, Pixel Format. Format32bppRgb );
```

5. Experimental Result

This tested on 7 videos, including detecting right hand beside the body (video 1), right hand front of the body (video 2), Left hand beside the body (video 3), left hand front of the body (video 4), both hand beside the body (video 5), both hand close to body (video 6), both hand front of the body (video 7).

These 7 videos show that background subtraction and denoising are removed completely. This is parallel with sign language recognition [2012] where she detected head and hands by RGB camera.

6. Conclusions

A real time hand detection algorithm on depth images was proposed. it is tried to remove background subtraction and shadow completely, based on distance method also hands with different coulters has detected.

The findings from this study will help researchers to detect hands for human computer interaction (HCI). In addition, the study is significant to researchers who work in sign language area.

7. Future Work

Present study has some limitation based on situational restriction. Moreover, when the colored hand moves out of the defined boundaries, it cannot be detected by Kinect. So in future work, this limitation should be investigated further and solved by other researcher.

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FIGURING OUT DISTRACTION DEGREE FROM WORKING MEMORY CONSUMPTION FOR PEDESTRIAN SAFETY

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Abstract
This paper proposes a method to estimate the distraction degree of pedestrians, using the acceleration and the angular velocity while walking. This method uses an acceleration sensor attached on the back of the pedestrian. The acceleration and the angular velocity are obtained while the pedestrian is walking. In addition to that, walking features are calculated based on the obtained data. Some studies point out distraction of the pedestrian relates to consumption of working memory. We assume considering the relationship between consumption of working memory and walking behavior suggests the effectiveness to estimate distraction of the pedestrian. When each pedestrian is walking while consuming working memory, for example thinking about something, their walk changes. A machine Learning method, Random Forest, is applied to classify whether the pedestrian is distracted using features of walking. An experiment suggests the method estimates the distraction degree of the pedestrian with 20% error. The result indicates the method can find distracted pedestrians whose working memory is consumed. We discuss why we can estimate the distraction degree of the pedestrian from walking feature components with the variable importance. We found some features appeared in the middle and high frequency bands. Finally, we discuss the feasibility of our proposed method.

1. Introduction

Traffic accidents kill more than 270,000 pedestrians every year in the world according to the announce of World Health Organization. Two kinds of negligence affect traffic accidents involving pedestrians. One of them is drivers' problem. For example, phone-call during driving causes a traffic accident. The other is pedestrians' negligence. One of the pedestrians' negligence is attention deficit. While walking, if they do some other tasks, such as thinking about specific things, they distract their attention.

To prevent traffic accidents caused by drivers, Geographic Information System (GIS) is proposed. GIS is a technology which visualizes and manages pluralistic data in real environment. It leads drivers deep analysis and rapid preventive decision. In the field of transportation, GIS reflects some statistical information such as traffic accident history and sudden braking cases on an actual map. Some applications utilize the information in GIS. Safety Map is one of the systems which visualizes traffic accident history to reduce the number of traffic accidents. Waze depends on user's comments, which are shared with bothusers and drivers. However, the current systems only utilize statistical information or user's comments. They do not consider the current states of pedestrians on the street and in the intersection.

We propose a method which finds distracted pedestrians to prevent traffic accidents involving pedestrians. To prevent traffic accidents, pedestrians need to pay attention to the surroundings. This study finds the pedestrian who is doing several tasks at the same time. The method distinguishes whether he/she is distracted. In addition, it calculates the degree of the distraction to provide the suitable alerts to the pedestrian. To find a distracted pedestrian, this method measures the walking of pedestrians using acceleration sensors. When the system finds distracted pedestrian, the rough position is reflected to GIS to be shared with drivers, for example, through a car navigation system. The driver recognizes the road where pedestrians are distracted. At the same time, the system calls attention to the distracted pedestrians according to the distraction degree. This method can prevent traffic accidents so that people should enjoy a safe and secure society.

In the paper, section 2 introduces existing works. Section 3 explains our method to calculate the feature of pedestrians' walking behavior. In Section 4, we indicate the experiment and evaluation. In Section 5, the paper discusses significant features of pedestrians' walking behavior.

2. Existing Works

Several studies are proposed to grasp the distraction of persons. Hamaoka et al. detected whether a pedestrian confirms an approach of right/left-turning vehicles or not using acceleration sensors . Since the sensor is attached on the head of the user, it is a large burden for the user. Music et al. detected texting while walking from the standard deviation of meter readings from acceleration sensors However, all pedestrians are not necessarily distracted because of texting while walking. Gallahan et al. estimated the distraction of the car drivers using Kinect . Kinect needs a place to install. We cannot assume such an environment in the outside. Mizoguchi et al. estimated distracted drivers while driving based on the eye-movement

It is difficult to measure the eye-movement of the pedestrian in the outside. Zaki et al. detected distracted pedestrians based on the video analysis using cameras Cameras are poor at shielding by obstacles such as vehicles and other pedestrians. Killane et al. grasped the distraction of the user while walking using the Electroencephalogram (EEG) However, EEG is expensive. In addition, we can apply it to only limited environments. Therefore, we need a system which realizes the low burden for the user, the low cost to install. We must also avoid the problems above. There are no study that estimates the distraction degree as a continuous value.

3. Estimating Degree of Distraction

3.1. Method Overview

We aim at achieving a system to estimate degree of distraction of a pedestrian. The method considers gait changes using an acceleration sensor, and estimates degree of distraction accordingly. When pedestrians are distracted while walking, their walking features differ from normal [9]. For example, when pedestrians are thinking about something deeply, they lose their consciousness about walking, then their walking pace gets changed. The service which utilizes the method is shown in Figure 1.

The small circles and the big circles represent each pedestrian and dangerous area, respectively. Degree of distraction is shown light and shade of red color. Deep red means “highly distracted”, and white means normal state. When the system finds a distracted pedestrian based on the walking, the rough position of the pedestrian, which protects his/her privacy, is reflected to a GIS. The position is regarded as a dangerous area and shared with drivers. To consider the road information, drivers can drive more safely. In addition, the system alerts the pedestrian who is distracted. The alerts depend on degree of distraction. This procedure prevents traffic accidents. Moreover, by storing long-term histories, it is possible to find localized reasons of such as urban design. distraction. It can be utilized

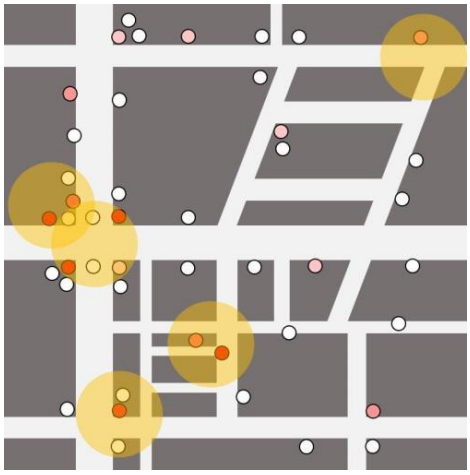


Figure 1. Service overview

The system estimates degree of distraction of a pedestrian based on the walking conditions using an acceleration sensor. The conventional method which classifies whether the user stays in a distracted state, conducts high dimensional machine learning. In this study, we assume the method is applied to many pedestrian in real time at the same time. Therefore, high dimensional machine learning has a heavy load on computers. This study performs dimension reduction. The method to estimate degree of distraction is shown in Figure 2.

The method follows the procedure below.

1. The acceleration sensor grasps acceleration and angular velocity periodically.
2. The system calculates feature components which represent walking conditions.
3. Dimension reduction is applied to feature components, and generate key components.
4. The system constructs a classifier based on key components.
5. The system estimates degree of distraction of the user.

A new user's degree of distraction is estimated based on the acceleration and the angular velocity while walking.

3.2. Grasping Gait Features using Acceleration Sensor

An acceleration sensor grasps 3-D acceleration and 3-D angular velocity. Some existing works introduce the method to grasp walking features. Kurihara et al. estimated walking exercise intensity based on the values of 3-D acceleration sensors Gafurov et al. constructed a system for gait authentication using acceleration sensors . These existing works grasps features of body movement using acceleration sensor. Typical smartphones and some wearable devices contain acceleration sensors, and are widely used all over the world. Their utilization prevents users from additional devices, which achieves cost reduction. In this study, the user attaches the acceleration sensor on his/her

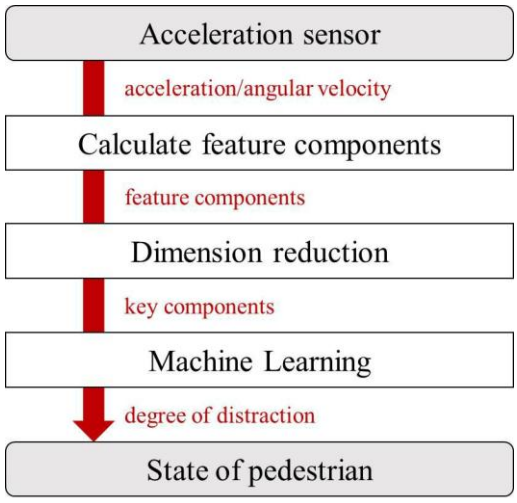


Figure 2. Method overview

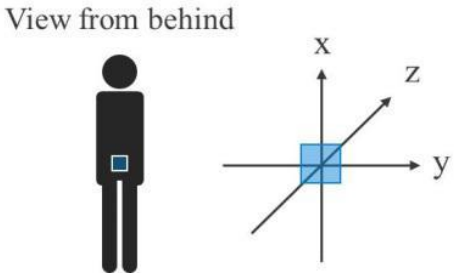
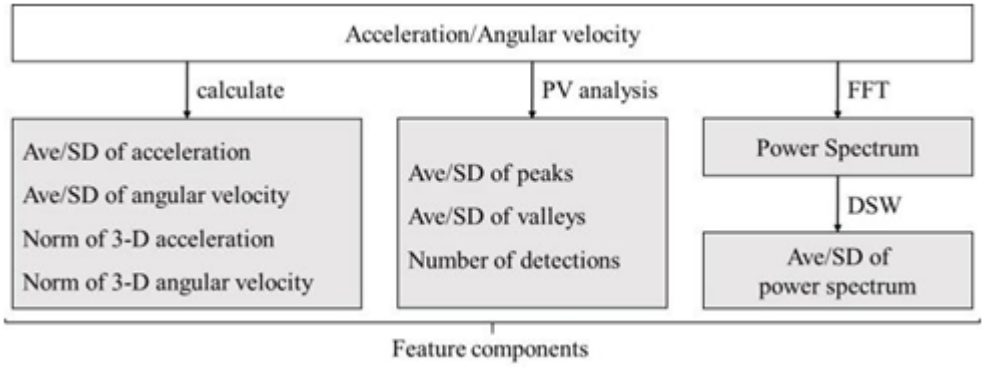


Figure 3. Acceleration Sensor attached by user

When the user walks, the acceleration and the angular velocity are obtained periodically. At this time, the sample rate of the acceleration sensor is 10 ms per detection. The general walking speed is about 4.0 km/h [4], and the stride which is the distance between the current step and the next one is about 120 to 180 cm. When dividing the stride by walking speed, the time per stride is calculated to be about 1.1 to 1.6 seconds. Therefore, we assume that walking can be sufficiently detected with this sample rate.



It is said persons use their working memory (WM), when they consider something in their minds. WM is a pseudo memory, consumed when people do something. Its capacity is limited. Its utilization is managed by their brain. The capacity of WM depends on each person. When it is highly consumed, people face trouble. For example, by talking with a mobile phone during driving, the driver cannot concentrate on driving and accidents occur easily. Besides, standing a pot on a fire while talking with a neighbor for a long time causes fire. Figure 4 shows Baddley's working memory model [14].

The internal structure of the working memory is divided into four parts, Phonological loop (PL), Visuo-spatial sketch-pad (VSSP), Episodic Buffer (EB), and Central Executive (CE). PL, VSSP, EB are short-term processing mechanisms responsible for the processing of voice information, visual information and stored information, respectively. These depend on the actual human behavior and are controlled by the CE. The CE also controls the attention at the same time [14]. Therefore, if processing requests to PL, VSPP, EB are excessive, that is, requests to process various operations at one, the CE loses control of the attention. That means, the person falls into distracted. Therefore, in this study, we estimate the degree of consumption of WM and define its degree of consumption as degree of distraction. Some studies refer to the relationship between working memory and distracted state.

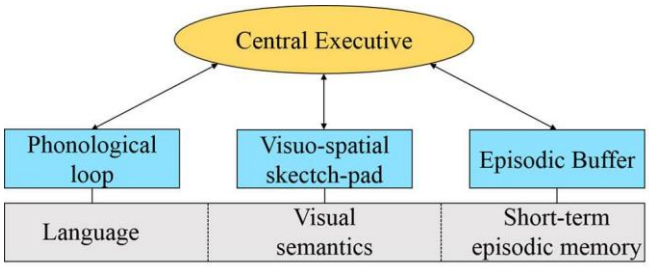


Figure 4. Baddley's Model of Working Memory

3.4. Generation Feature Components of Acceleration and Angular Velocity

A distracted pedestrian is expected to have a different walking pace than a normal pedestrian. This is because attention to other things, such as thinking about something, prevents them from being conscious about the walking. In order to acquire such features, we define feature components shown in Figure 5.

Ave and SD in the figure refer to average and standard deviation, respectively. We obtain 3-D acceleration and 3-D angular velocity in a fixed interval. We assume the proceeding direction of the user is the positive direction of the z-axis, and based on the z-axis, the direction of up-down is the x-axis, the direction of right-left is the y-axis. We refer to acceleration vector as a grasped acceleration, as a grasped angular velocity

(Equation 1, 2). Each components of the feature component represents acceleration/angular velocity of the x-axis, y-axis, and z-axis, respectively.

The average and standard deviation of these components are defined as the feature components. In addition to these walking features, the following features are calculated.

- Power spectrum of each element of the acceleration vector, each element of the angular velocity vector
- Peaks and valleys of each element of the acceleration, each element of the angular velocity

Acceleration and angular velocity acquired rapidly change due to body movement. In order to acquire this change, this study applied peak/valley analysis (PV analysis) on each acceleration and angular velocity (see Figure 6). The method detects peak and valley based on difference of adjacent acceleration and angular velocity. When this difference is greater than the threshold, it is detected as peak or valley. To calculate the threshold, let *diff* be the difference from the maximum value of the feature components and the minimum one. Letting vary 25, 50, 75, and 100, the threshold is derived in Equation 5. The average, the standard deviation, and the number of detection of these factors are generated as feature components.

In order to take the characteristics of the waveform data into consideration, power spectrum is calculated based on each element of the acceleration vector, each element of the angular velocity vector using Fast Fourier Transform (FFT). We assume that the change in walking pace when it the pedestrian becomes distracted appears in the power spectrum of a specific frequency band. The power spectrum represents the intensity of the wave in a specific frequency band in the waveform data. The power spectrum is calculated based on the input acceleration and angular velocity, respectively. To consider the characteristics on a specific frequency band, 3 sizes of windows are prepared and slid from low frequency to high frequency (see Figure 7). In this time, the frequency band for calculating the power spectrum is 0 to 4.0 Hz and the window sizes are 0.1 Hz (small), 0.5 Hz (medium), 1.0 Hz (large). The slide size is a half of the window size. In each window, average and standard deviation of the power spectrum are calculated as feature components.

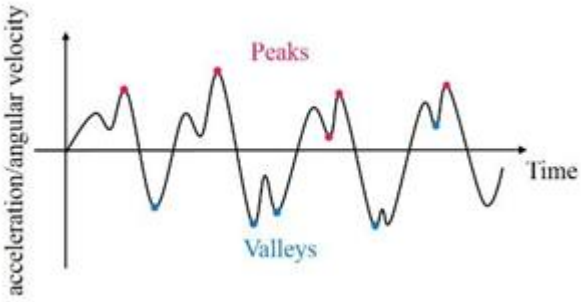


Figure 6. Peaks and Valleys of walking features

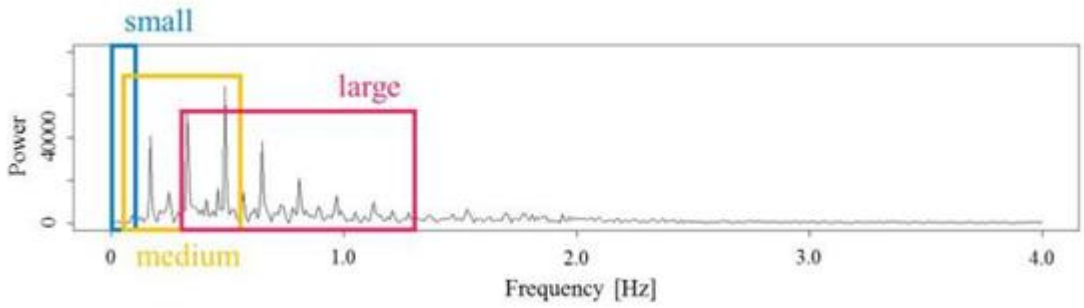


Figure 7. Dynamic Sliding Window (DSW)

3.5. Dimension Reduction

This method generates a total of 1968 dimensional feature components. As shown in Figure 2, the degree of distraction is estimated using a machine learning method. For such high dimensional data, when applying machine learning, the load on the computer is large. Therefore, this study proposes a real-time attention

degree estimation method considering the load on the computer. To consider the load, the method performs a dimension reduction method. Principal component analysis is mentioned as a method of dimension reduction Principal component analysis calculates n-dimensional principal components from n-dimensional data representing a certain objective variable. Each of the principal components has a contribution rate indicating how much the objective variable is expressed. Dimension can be reduced by extracting the principal component with high contribution ratio. In addition, since the noise is eliminated, there is a possibility that the identification accuracy is improved. Therefore, in this study, principal component analysis is applied to the computed 1968 dimensional feature components to reduce the dimension and construct a system with a lower load on the computer.

3.6. Learning and Identification

We examine relationships between walking features (gait vector) and distracted state. Among various machine learning methods which are widely used, this paper uses the Random Forest (RF). RF computes multiple decision trees during the training of the data. It predicts the class, taking the node of the individual trees. Some studies introduce RF provide high generalization capability. This method has two steps; the learning step and the identification step. In the learning step, it creates models from a pair of a gait vector and the states of the user (distracted or not) presented as an instruction signal. In the identification step, it identifies whether the user is distracted corresponding to a new gait vector through the model generated in the learning step. The identification step is only applied, only when the new person uses the system.

4. Possibility of estimating Degree of Distraction

4.1. Experimental Purpose and Overview

An experiment was conducted to estimate the degree of user distraction in Section 3 from the acceleration and the angular velocity while their walking. We used a 3-D acceleration sensor, and its communication frequency is 10 ms. Subjects were 14 males and 6 females whose age ranges from 21 to 25. Each of them wore an acceleration sensor on the point 5.0 cm upper from the coccyx. The acceleration sensor attached to the user was connected to a laptop PC with Bluetooth. The walking range was 14.0 m × 3.0 m as Figure 8 shows.

A subject starts walking from the position of the figure and goes straight ahead 14 m. At the start of walking, the tester loads the subtask presented in Section 4.2. The subject continued to respond to his/her subtask until the walking ended. We acquired the number of responses. Each trial was repeated 20 times. Every subject took a rest for about 5 minutes after 10 trials to prevent fatigue from affecting on a specific person.

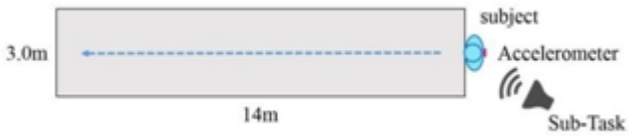


Figure 8. Experimental Environment

4.2. Uniform Distraction

To artificially make subjects run into a distracted state, uniformly in each trial, we imposed a sub-task on them. Calculation tasks and reading tasks are proposed as a sub-task [18]. However, since the subject is walking, it is difficult to send visual information to the walking subject. Lundin-Olsson et al. presented that some subjects stopped walking when a recalling task are imposed. It suggests that the subject's attention resources are greatly consumed by the task so that he/she cannot continue walking [19]. Therefore, in this study, a recalling task is loaded as a sub-task. The tester gives one specific topic to the subject at the start of walking. The subject starts to walk, at the same time, he/she mentions something applicable for the topic as many as possible. For example, when a topic is "White Flower", the subjects answer "Lily", "Chamomile", and so on, while their walking. At the same time, the following features appear.

- Subject repeats the word "White Flower" given by the tester in his/her mind many times. It means PL described in Section 3.3 is used.
- VSSP is used to envision the image of "White Flower" in his/her mind.

- In order to remember what the tester said, EB which controls short-term memory is consumed.

As a result, the CE gets busy. Since the CE is also responsible for controlling attention resources, its control function gets weakened, which makes the subject distracted. We regard the fewer number of answers applicable to the topic, the more distracted the subject.

4.3. Experimental Result

This study refers the number of responses to the recalling task to the distraction degree. This is because subjects concentrate on responding when they cannot find any answer. The number of responses in the recalling task is normalized from 0 to 1, considering individual differences. The normalized responses are taken as the response variable of RF. Using 20 data sets, each of which is acquired from an individual subject, we take 20-fold cross-validation in estimations. This study only considers data acquired when
the subject walked around the central of the walking range, to prevent noises around the start point and the end point. RF is trained with 19 groups, while its performance is measured with the remaining group. We evaluate estimation error calculated.

Table 1: Estimation Error in each subject

	80	90		BC	Diff
1	0.2168	0.2106	0.2012		0.0156
2	0.1506	0.1431	0.1336		0.0170
3	0.1951	0.1935	0.1995	90	0.0060
4	0.2453	0.2313	0.2511	90	0.0198
5	0.1584	0.1654	0.1692	80	0.0108
6	0.2304	0.2089	0.2166	90	0.0215
7	0.1590	0.1555	0.1666	90	0.0111
8	0.1960	0.2181	0.1923		0.0258
9	0.2432	0.2346	0.2427	90	0.0086
10	0.1363	0.1349	0.1479	90	0.0130
11	0.2099	0.1960	0.1880		0.0219
12	0.1429	0.1576	0.1454	80	0.0147
13	0.2454	0.2324	0.2655	90	0.0331
14	0.2651	0.2676	0.2988	80	0.0337
15	0.1504	0.1609	0.1510	80	0.0105
16	0.2380	0.2432	0.2447	80	0.0067
17	0.2607	0.2584	0.2536		0.0071
18	0.2238	0.2363	0.2294	80	0.0125

Even when the principal component analysis is applied to reduce the dimensions, the estimation error is less than the same as before the reduction ( ). Table 2 shows the average value of the estimation error between the male subjects. We tested the null hypothesis as “there is no difference in the estimation error between males and females” with Mann–Whitney U test, and the null hypothesis was not rejected. Therefore, we cannot say error difference between males and females.

Table 2. The Estimation Error between Males and Females

	80	90		BC	Diff
Men	0.2048	0.2006	0.2036	90	0.0042
Women	0.2096	0.2104	0.2154	80	0.0058

5. Discussion

Let us discuss what components strongly affected the estimation. We consider the variable importance (VI) of top 10 feature components shown in Table 3.

Table 3. Top 10 Significant Feature components

Size	Frequency [Hz]	Ave/SD	Element	VI
Small	2.55~2.65	Ave		5.316
Small	2.40~2.50	Ave		4.151
Small	3.10~3.20	SD		3.759
Large	1.50~2.50	SD		2.775
Small	2.40~2.50	Ave		2.736
Small	3.50~3.60	SD		2.514
Small	2.35~2.45	SD		2.375
Small	1.30~1.40	SD		2.082
Small	3.70~3.80	SD		1.885
Medium	1.50~2.00	SD		1.750
Small	3.55~3.60	SD		1.679
Ave				0.256
D				0.287

All of these components are average and standard deviation of the power spectrum generated with FFT. Differences appear during periodic motion within a certain walking interval. Fig 8 shows the summary of frequency bands. The darker the red color band, the more significant components appear.

Features appear in the middle frequency band or in some parts of the high frequency band. In other words, it is implied that another minute movement appears in their walking when pedestrians are distracted. In order to confirm it, we consider and as representatives of 3D acceleration and 3D angular velocity, respectively.

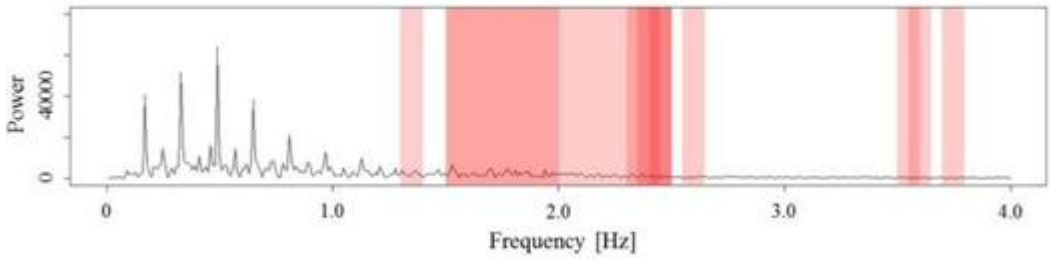


Figure 9. Important Frequency

Table 4: Feature of Acceleration and Angular Velocity

	High	Middle	Low
	609.54	538.14	1117.0
	1076.7	762.49	1213.1

Mainly represents the movement in the direction of walking, includes the movement of some body parts. The table has revealed the following features.

- When the distraction degree is high, the acceleration is moderate, but the angular velocity becomes increased. That is, the body is deviated. It implies that the subject needs to recall something with great efforts, which changes the movement of some body parts in walking motion.
- When the pedestrian walks with middle level of distraction, the acceleration and the angular velocity are both moderate. Therefore, it is comparatively stable walking compared to the case of High and Low. It implies that, when the environment provides fair prospects, the subject only concentrates on the recalling tasks, switching off the CE.
- When the degree of distraction is low, the acceleration and the angular velocity gets higher. In other words, the gait becomes faster and the body gets deviated. It implies the subject increases walking speed because the task is simple. It affects him/her so that their body movement gets deviate.
- performing multiple tasks. To reflect this, we have constructed the model that assumes the distraction degree gets high when the consumption of working memory is high. For the estimation, Random Forest, a machine learning method, has been applied. Through the experiment, we have proved the method estimates the distraction degree with an error of about 20%. As a result, GIS can show the rough position of distracted pedestrians, which is helpful to avoid traffic accidents. In addition, the system alerts the pedestrians who are distracted. The alerts depend on the degree of distraction.

Conclusions

This paper has proposed the method to estimate the distraction degree of the pedestrian for preventing traffic accidents caused by the negligence of pedestrians. In order to find a pedestrian concentrating on other task at the same time as their walking, we have focused on the gait of pedestrians which is obtained using an acceleration sensor attached on their back. We have focused on the working memory consumed when they engage in concurrently.

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SECURE DOOR LOCK SYSTEM USING NFC ENABLED SMARTPHONE

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Abstract

Smart phones have become very popular and versatile devices. An emerging trend is the integration of smart phones into security systems and applications, particularly access control systems to unlock doors. Smartphone based security solutions promise to greatly enhance the user's experience by providing advanced features far beyond the conventional dedicated tokens/transponders. The generic security architecture protects the electronic access tokens on the smart phone and provides advanced features such as context-aware access policies, remote issuing, and revocation of access rights and their delegation to other users. Various approaches to instantiating the security architecture based on different hardware-based trusted execution environments and elaborate on their security properties are discussed here. The door lock system is implemented based on the latest Android-based NFC-enabled smart phone.

1. Introduction

Today, smart phones are high-performance platforms providing a wide range of features and have become an integral part of daily life. The increasing computing and storage capabilities, the vast number and variety of apps available on app stores and new communication interfaces, such as Near Field Communication (NFC), provide many deployment possibilities for smart phones, including electronic ticketing, payment and access control. In this context, an emerging trend is the integration of smart phones into modern automotive systems and applications such as access control to lock and unlock and also configure the system. In particular, the NFC interface is well-suited for such applications due to its short nominal communication range (of a few centimeters) providing basic assurance of the user's physical proximity. In this paper, the focus is on smart phone-based NFC-enabled door lock systems. An electronic door lock is an anti-theft device that prevents an unknown person from entering the house unless the corresponding access token is (physically) present and authenticated. Currently, this access token is a transponder (i.e., an NFC chip) embedded into the NFC smart phone. They do not require users to obtain a physical transponder but allow them to use their smart phone to remotely obtain electronic door lock access. Moreover, access rights can be delegated to other users, revoked or bound to specific policies. Despite the mentioned advantages for users, the core challenge concerns the security aspects of smart phone based door lock systems.

Smart phones are complex devices and appealing targets of attacks (e.g., by malware), especially when they are used in security-critical applications. The traditional locks used in practice are closed and proprietary systems and suffer from various security vulnerabilities. The reasons are conceptual protocol design flaws as well as the deployment of insecure or weak cryptographic schemes. On the other hand, a commercial smartphone-based NFC enabled door lock systems have been introduced recently, but without providing technical details or information on their security properties.

Goal and contribution: An open smart phone-based lock system architecture and the underlying security framework, which provides enhanced functional and security features and overcomes the security issues of the conventional door lock systems. In particular, the contribution is as follows:

Framework for smart phone-based door lock systems:

Framework considers the functional and security requirements on the protocols and the system architecture of a smart phone based solution under realistic adversary models.

Evaluation of existing security hardware: This paper evaluates and discuss various instantiations of security architecture using different approaches to establishing trusted execution environments on smart phones. It discusses which security guarantees can be provided by these instantiations, under which assumptions, and how some of these assumptions can be fulfilled by leveraging the features of security hardware currently available on recent Smart phones.

Implementation: It shows show that it is feasible to implement a secure NFC-enabled and smart phone based door lock system. In particular, the paper discusses the conditions for the secure integration of enhanced features such as delegation under a strong but realistic adversary model, where the adversary has full control over the software on the smart phone platform. Hereby, it takes the technical limitations of currently available security hardware for smart phones into account.

Outline: The paper presents the framework for smartphone based door lock system systems, an overview of related work in Section 2 and the proposed system in Section 3. The security requirements are defined in section 4 and the implementation and evaluation of solution in Section 5. Finally, conclude in Section 6. References are presented in Section 7.

2. Related Work

In this section, existing door lock system systems in practice and in literature are discussed. Further, it gives an overview of related work regarding access control with smartphones.

NFC-based Door lock system: NXP Semiconductors presented the prototype of an NFC-based door lock system. The security of this approach relies on the secure element of the smart phone. However, it is unclear how this secure element is instantiated and whether this approach requires new phones with special security hardware.

Transponder-based Door lock system: Lemke et al present a system model and requirement analysis for electronic door lock system systems that use dedicated hardware tokens. The proposed model does not capture advanced use cases such as delegation and thus cannot be applied to the system.

Delegable Access Control with Smart phones: The work is along the lines of the Smart Token system by Dmitrienko et al. which enables NFC-enabled smart phones to maintain electronic access control tokens that can be delegated to other users. Specifically, the project adapt the protocols of the Smart Token scheme to the door lock system use case and provide a tool-based security verification of these protocols.

3. Proposed System

A. System Model

The system and involves a Security Technician, a Home, an owner, and a user.

The technician produces lock equipped with door lock system, which are electronic control units that prevent unauthorized users from starting the house. Moreover, Technician also represents service stations authorized by the Interior Designer. An owner is a private person who received an electronic access control token T_O from Technician. The token is securely deployed and stored on the mobile platform of Owner. A guest user is a person who is authorized by Owner to use. This can be a friend or a family member of the owner. The authorization is given by means of issuing a delegated access control token which grants the User access to the home.

Figure 2 shows the operational flow chart of the proposed system. The setup is powered up and initializations of modules are done. The owner of the house sends a message to a person of NFC mobile holder and to the door. When a person taps NFC mobile on NFC reader which are installed on the door, it compares SMS data with data received from NFC mobile when it matches the door unlocks.

B. Objectives

As in traditional door lock systems, the main objective is to prevent unauthorized access:

Access control: Only authorized entities, namely Owner authorized by Technician and User authorized by Own, should be able to unlock the door. Further, the performance, i.e., the time needed for authentication is a significant usability aspect, which is essential for a positive user experience:

Performance: Authentication of Owner or User to Door should be performed within an unnoticeable time interval. Moreover, the compatibility to existing smartphones is important to ensure the applicability of the solution in practice:

Compatibility: An important requirement is a compatibility with commodity mobile platforms. The door system should be compatible with existing hardware and require no or only minor changes to the mobile

operating system. A smart phone-based door system should enable new appealing features, such as the remote issuing and revocation of electronic tokens, remote replacement of electronic keys in case of loss or theft of the mobile device, or provide mechanisms to ensure access revocation of former owners in case of House re-sell.

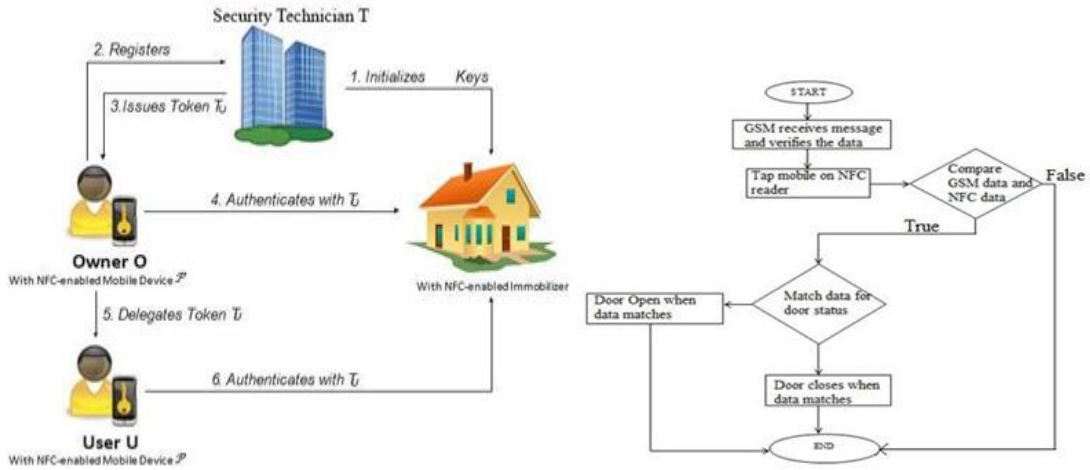

Figure 2. Operational Flowchart

Remote issuing: The Security Technician should be able to remotely (e.g., via the Internet) issue and deploy the electronic access token to the Owner.

Remote revocation: Technician should be able to remotely revoke access tokens issued. Moreover, revocation of the token by Technician should automatically revoke all delegated tokens issued by Owner. Some other desirable enhanced features include token delegation and support for context-aware access policies:

Delegation: An Owner should be able to securely delegate her access rights to a third party User.

Policy-based access control: An owner should be able to restrict access to delegated users are based on contextual information such as time and location. Off-the-shelf smartphone platforms and security hardware can be used to achieve objectives. However, due to the technical constraints of available security hardware and the limitations posed by some security hardware manufacturers, objectives Delegation, and Policy-based access control cannot be realized with the currently available commodity hardware.

4. Security Requirements

Protocol-specific requirements:The main security objective of a door lock system is the secure authentication of the owner (or the delegated user) to the door lock system.

Platform-specific requirements: Mobile platforms typically host a mobile operating system that can potentially be compromised and expose all secrets stored on the platform. Hence, to achieve the objective, the security-sensitive data used in the underlying protocols must be protected against entrusted code. Therefore, it defines the following security requirements on the underlying mobile platform:

Secure storage: Security-sensitive data should not be accessible by unstressed software components while stored on the platform.

Isolation: The system components operating on security-sensitive data must be trusted and isolated from the untreated components. Further, it has to be ensured that the security sensitive operations, such as authentication and delegation, are triggered by the user rather than by malware. Moreover, advanced use cases, such as delegation and policy-based access control, rely on security-critical user inputs, such as passwords and user-defined access-control policies. Hence, for these use cases it needs an additional security requirement:

Secure user interface: The user (the owner or the user) should be able to securely communicate with the trusted components.

5. Implementation

An NFC reader/writer is connected to an Arduino which reads the details of the user from the NFC smart phone. The Arduino then checks if the d is an owner d or a guest d. If it is a guest d, it verifies it with the code provided to the GSM module. For this and the previous condition, if the NFC smart d code matches with the required data. It will send a signal to the servo motor to rotate to either locked or unlocked state. When the servo motor is in the locked state, a red LED will be on and the LCD screen will display that the door is locked, and when the servo motor is in the unlocked state the green LED will be on and the LCD screen will show that the door is unlocked. Android provides an adaptive app framework that allows you to provide unique resources for different device configurations. For example, you can create different XML layout files for different screen sizes and the system determines which layout to apply based on the current device's screen size. You can query the availability of device features at runtime.

Owner sends a message to a person having NFC mobile, Message is received by the person. The message will have the key and person need to take his mobile to NFC reader which is on the door. A person needs to enter the key in the android application and tap on the NFC reader. Based on the key door can be opened or closed.

Performance Evaluation: The performance of the implementation of the authentication protocol running between the smart phone and the door lock system is evaluated. For this purpose, we made the following measurements: the time required to start the authentication mechanism and to get the challenge from the door lock system after the NFC connection has been established, the time required by the phone to send the response to the door lock system. The time required by the door lock system to verify the phone's response, and the time required for the complete authentication protocol.

6. Conclusions

Unlike the conventional, closed and proprietary door lock systems that suffer from various vulnerabilities, this open approach allows the independent evaluation of the solution by the research community. The framework consists of a set of secure protocols and a security architecture for the mobile platform. The security of the underlying protocols using automated formal verification tools is analyzed. Moreover, the paper analyses the security of the architecture and discuss which objectives can be achieved using off-the shelf secure hardware for mobile platforms. The paper shows that available hardware allows remote issuing and remote revocation of electronic tokens, which cannot be achieved with classical (transponder-based) door lock system systems. Further, the project outline approaches to achieve more advanced security features, such as secure delegation and context-aware access control.

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FARMER FRIENDLY DRONE

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Abstract
Drone technology has skyrocketed over the past decade driving costs down and the number of potential applications up, one being agricultural field. This project on Drone is specifically used for agricultural work. It is used for spraying medicinal liquid on agricultural plants and crops. It reduces the work-force required to do the work. As a result, a single user will be able to do a work, standing from particular place and eases the work of the farmer to irrigate his crops with medicinal liquid preventing them from being infected by crop diseases.

1. Introduction

An Unmanned Aerial Vehicle (UAV), commonly known as a drone, is an aircraft without a human pilot aboard. Essentially, a drone is a flying robot. UAVs are a component of an unmanned aircraft system (UAS); which include a UAV, a ground-based controller, and a system of communications between the two . The flight of UAVs may operate with various degrees of autonomy: either under remote control by a human operator or autonomously by onboard computers. The drone that is being implemented here is of quad copter type. Quad copters generally use two pairs of identical fixed pitched propellers; two clockwise and two counter clockwise (CCW). These use independent variation of the speed of each rotor to achieve control. Sprayer. The Aerial Application Agricultural Spray combines new pumps and spray heads designed to be more reliable. The technology and the results obtained by it leave no question that low and ultra-low volume spraying is a viable alternative in today's environmentally aware world. Better results are achieved with fewer chemicals. Some of the benefits of crop spraying with a UAV Sprayers include a significant reduction in application cost by utilizing an UAV aircraft and a notable improvement in coverage and control through consistent application of the best suited droplet size for better penetration of crop canopy, decreased drift potential and evaporation, and greater adherence of chemical to the leaves. The spray system was designed to promote economically and ecologically sound spray methods that are the future of agricultural aviation.

Agricultural unmanned helicopters and multi-rotors can take off vertically which effectively lowers the operation difficulty and the risks. Flying at low altitude of several meters, the spraying effect can be controlled in the active area. It is suitable for all kinds of complex terrain farmlands and the crops and woods of different heights. The spraying operation skills of agriculture UAV Sprayer can be mastered via simple training. Environment-Friendly - The dosage of pesticide is reduced, so it can minimize the pollution of pesticide to the environment and crops. It is not harmful to the operator in the distances when dusting, and the labor intensity is reduced dramatically.

This paper provides details through the design chapter which includes architectural design, functional design of the quadcopter being built and also through the implementation chapter with necessary algorithms that are being used.

2. Related Work

This project is influenced by the work carried out by B. Tech student A. Gopi Raja of KL University Vijayawada. The drone is designed to spray pesticide for crops planted on the ground and spreading seeds across the field . High-tech drones were developed and used by United Nation for security purpose. The Japanese used drone to survey agricultural fields which was not possible by walk. The Indian government uses drone for traffic management. It is used in various countries for providing medical aide through air during road accidents.

3. Design

Design is the first step in the development phase for any engineering product or system. It may be defined as the process of applying various techniques and principles for the purpose of defining the process or a system in sufficient detail to permit its physical relation.

Abstract design is a concept or idea that indicates the creation of something in the mind using a visual language of form, color and line to create a composition which may exist with a degree of independence from visual reference in the world.

The design activity begins when the requirement document for the software to the developed is available. While the requirement specification activity is entirely in the problem domain, design is the first step in moving from the problem of domain to solution domain. The goal of design process is to produce a model or representation of a system, which can be used later to build that system.

3.1. Architectural Design

Design phase starts with the requirement document delivered by the requirement phase and maps the requirements into architecture. Architecture defines the components, their interface and behavior.

Architectural Design is a creative process where user tries to establish a system organization that will satisfy the functional and non-functional system requirements. It contains components that are the building blocks of the system. The interface is the architectural surface where independent components meet and communicate with each other. Interface defines the behavior where one component responds to the stimuli of another component's action.

3.2. Functional Design

Functional design is a level of the design process in which subtasks are specified and the relationship among them is defined, so that the total collection of subsystem performs the entire task of the system. It is the aspect of the system design concerned with system's objective and functions, rather than its specific components

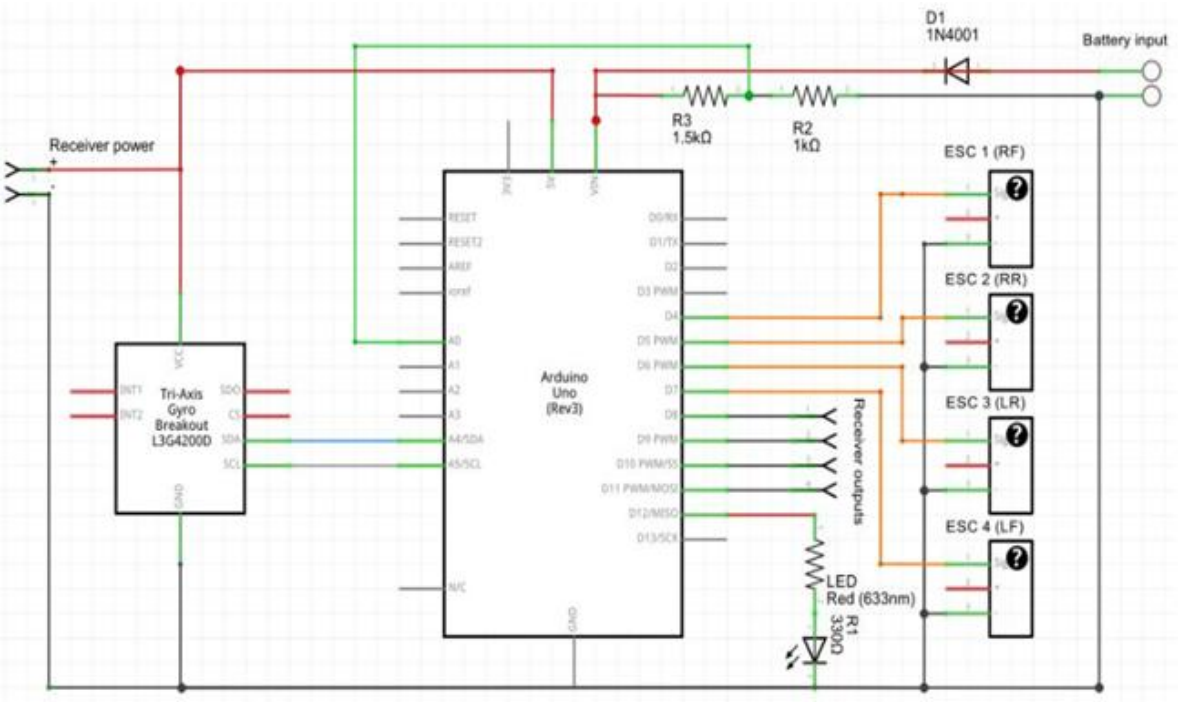

Figure 1. Architectural Diagram of Drone

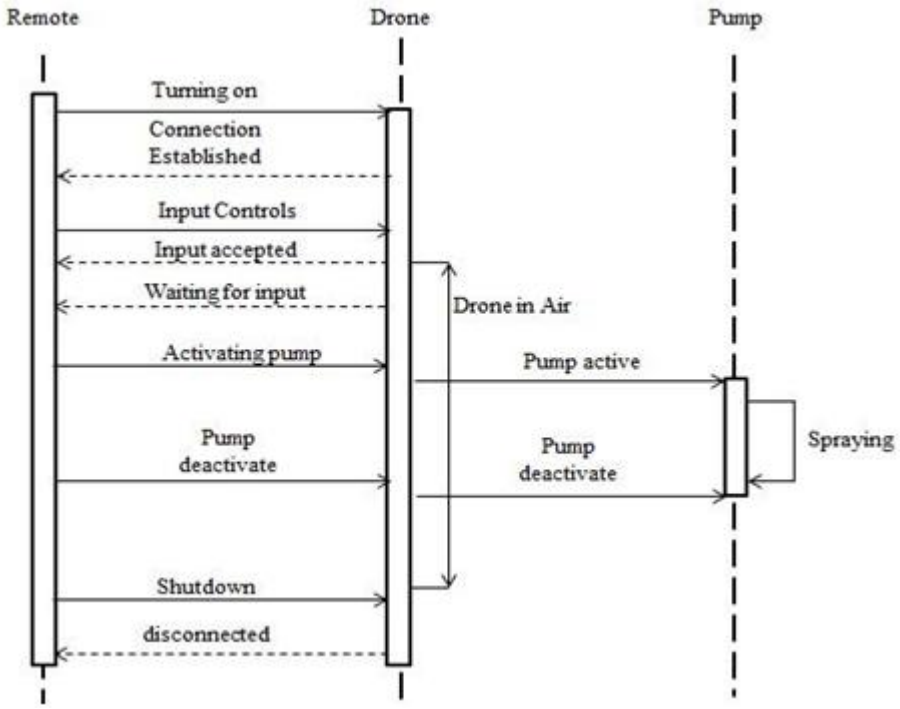

Figure 2. Sequence diagram

A. Sequence Diagram

A sequence diagram is an interaction diagram that shows how processes operate with one another and in what order. It is a construct of a message sequence chart. A sequence diagram depicts the objects and classes involved in the scenario and the sequence of messages exchanged between the objects needed to carry out the functionality of the scenario. Sequence diagrams are typically associated with use case realization in the Logical View of the system under the development. Sequence diagrams are sometimes called Events diagrams, Event scenarios.

A sequence diagram shows, as parallel vertical lines (lifelines), different processes or objects that live simultaneously, and as horizontal arrows, the messages exchanged between them in the order in which they occur, this allows the specification of simple runtime scenarios in a graphical manner.

In order to display the interactions messages are used. These are horizontal arrows with the message name written on them, Solid arrows with full heads are synchronous calls, solid arrows with stick heads are synchronous calls, solid arrows with stick heads are asynchronous calls and dashed arrows with stick heads are return messages.

The following sequence diagram shows sequence of activities among privileged user, app and the dynamic router.

Diagram represents the spraying of medicinal liquid event and hovering of drone. The drone and transmitter is active throughout. The pump-set is active after the button is pressed.

B. Control Flow Design

1) Complete system flow diagram

A flowchart is a type of diagram that represents an algorithm or process, showing the steps as boxes of various kinds, and their order by connecting them with arrows. This diagrammatic representation illustrates a solution to a given problem. Process operations are represented in these boxes, and arrows are implied by the sequencing of operations. Flowcharts are used in analysing, designing, documenting or managing a process or program in various fields.

Flowcharts are used in designing and documenting complex processes or programs. Like other types of diagrams, they help visualize what is going on and thereby help the viewer to understand a process, and perhaps also find flaws, bottlenecks, and other less obvious features within it.

Flow-Chart and Steps for Drone Controlling:

Step 1: Start
Step 2: Input controls
Step3: Motors running
Step 4: If up then
Take Off
Else
If Shutdown then
Go to Step 8
Else
Go to step 5
Step5: Hovering
Step 6: Recording
Step 7: Touch down
Step 8: Shutdown
Step 9: Stop

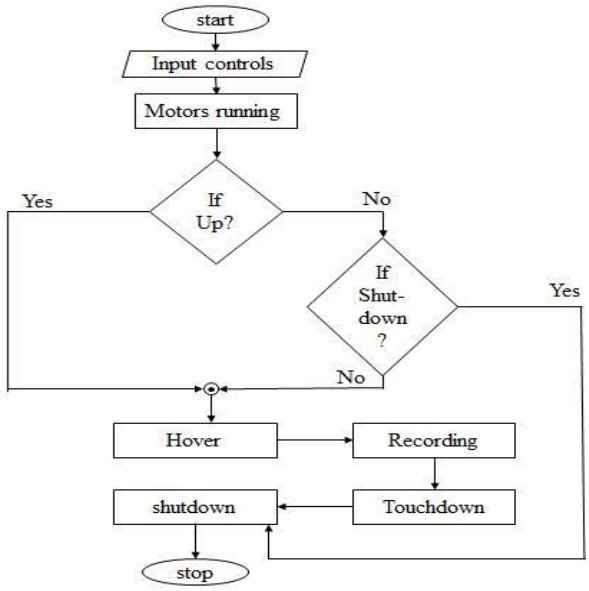

Figure 3. Drone Controlling

Flow-Chart and Steps for the Working of Spray:

Step 1: Start
Step 2: Input controls
Step 3: if liquid in container is empty then LED Indicator is glowed
Else
Liquid is sprayed from container
Step 4: Controls
Step 5: Stop

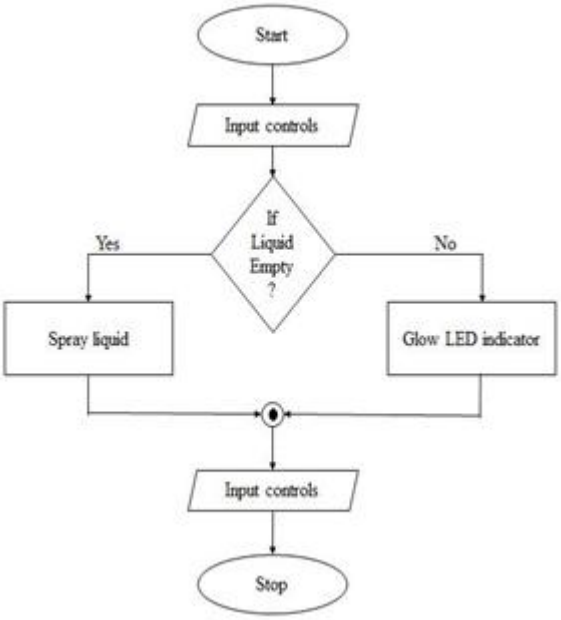

Figure 4. Working of Spray

4. Implementation

Implementation is the carrying out of execution, a method, applying a plan in a practical manner. The implementation plan describes how the information system will be deployed, installed and transitioned into an operational system. The plan contains an overview of the system, a brief description of the major tasks involved in the implementation, the overall resources needed to support the implementation effort (such as hardware, software, facilities, material and personnel) and any specific implementation requirement.

The plan is developed during the Design Phase and is updated during the Development Phase; the final version is provided in the integration and Test Phase and is used for guidance during the Implementation Phase. To implement a system successfully, a large number of inter-related tasks need to be carried out in an appropriate sequence. Utilizing a well- proven implementation methodology and enlisting professional advice can help but often it's the number of tasks, poor planning and inadequate resourcing that cause problems with an implementation project, rather than any of the tasks being particularly difficult. Similarly with the cultural issues it is often the lack of adequate consultation and two-way communication that inhibits achievement of the desired results.

In computer science, an implementation is a realization of a technical specification or algorithm as a program, software component, or other computer system through computer programming and deployment. Many implementations may exist for a given specifications World Wide Web Consortium-recommended specifications, and software development tools contain implementations of programming language.

System implementation generally benefits from high levels of user involvement and management support. User participation in the design and operation of information system has several positive results. First, if users are heavily involved in systems design, they move opportunities to mold the system according to their priorities and business requirements, and more opportunities to control the outcome. Second they are more likely to react positively to the change process. Incorporating user knowledge and expertise leads to better solutions.

4.1. Hardware and Software Requirements Hardware requirements:

Quad-copter 4 axis Frame-1
Propeller (8 inch)-4
Drone motor-4
ESC-4
Arduino UNO

Gyroscope 3 axis-1
Battery-11.1V
USB cable
Pump motor-1
Wires and connectors
Radio Frequency 4-Channel Board and Remote Software requirements:
Arduino Ide 1.8.2

The Arduino project provides the Arduino integrated development environment (IDE), which is a cross-platform application written in the programming language Java. It originated from the IDE for the languages Processing and Wiring. It is designed to introduce programming to artists and other newcomers unfamiliar with software development. It includes a code editor with features such as syntax highlighting, brace matching, and automatic indentation, and provides simple one-click mechanism to compile and load programs to an Arduino board. A program written with the IDE for Arduino is called a "sketch" [5].

The Arduino IDE supports the languages C and C++ using special rules to organize code. The Arduino IDE supplies a software library called Wiring from the Wiring project, which provides many common input and output procedures. A typical Arduino C/C++ sketch consists of two functions that are compiled and linked with a program stub main () into an executable cyclic executive program:

- setup (): a function that runs once at the start of a program and that can initialize settings.
- loop (): a function called repeatedly until the board powers off.

After compiling and linking with the GNU tool chain, also included with the IDE distribution, the Arduino IDE employs the program to convert the executable code into a text file in hexadecimal coding that is loaded into the Arduino board by a loader program in the board's firmware [6].

IP Webcam

IP Webcam is an application which involves a client and a server device. The server device starts the recording; the client device enters the IP address provided by server.

IP Webcam turns the phone into a network camera with multiple viewing options. View the camera on any platform with VLC player or web browser. Without internet access streaming of video can dine by using Wi-Fi network. Two-way audio supported in tiny Cam Monitor on another android device.

Use IP Webcam with third-party MJPG software, including video surveillance software, security monitors and most audio players.

Features include:

- Video recording in WebM, MOV, MKV or MPEG4 (on Android 4.1+)
- Audio streaming in wav, opus and AAC (AAC requires Android 4.1+)
- Motion detection with sound trigger, Tasker integration.
- Date, time and battery level video overlay.
- Extensive baby and pet monitor features: night vision, motion detection, sound detection
- Gyroscope (MPU-6050 Three-Axis)
- The MPU-6050 parts are the world's first Motion Tracking devices designed for the low power, low cost, and high-performance requirements of smartphones, tablets and wearable sensors.
- The MPU-6050 incorporates InvenSense's Motion Fusion and run-time calibration firmware that enables manufacturers to eliminate the costly and complex selection, qualification, and system level integration of discrete devices in motion-enabled products, guaranteeing that sensor fusion algorithms and calibration procedures deliver optimal performance for consumers.
- The MPU-6050 devices combine a 3-axis gyroscope and a 3-axis accelerometer on the same silicon die, together with an onboard Digital Motion Processor (DMP), which processes complex 6-axis Motion Fusion algorithms. The device can access external magnetometers or other sensors through an auxiliary master I^2C bus, allowing the devices to gather a full set of sensor data without intervention from the system processor.

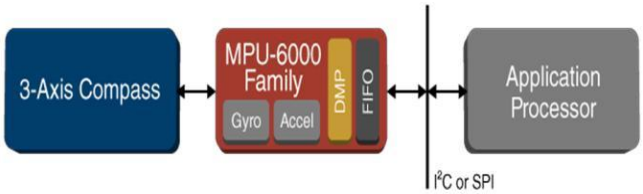

Figure 5.MPU-6000 Family Block Diagram

The Inven Sense Motion Apps Platform that comes with the MPU-6050 abstracts motion-based complexities, offloads sensor management from the operating system, and provides a structured set of APIs for application development.

For precision tracking of both fast and slow motions, the parts feature a user-programmable gyro full-scale range of ±250, ±500, ±1000, and ±2000 °/sec (dps), and a user-programmable accelerometer full-scale range of ±2g, ±4g, ±8g, and ±16g. Additional features include an embedded temperature sensor and an on-chip oscillator with ±1% variation over the operating temperature range.

Radio Frequency 4-Channel Remote

The 4CH Wireless relay module is a smart module with 4 mechanical relays providing an easy to control large AC and DC loads and device. With the 315MHz RF receiver integrated in, it can be directly remote controlled by the matching transmitter controller, which make it easy to use in home automation and industry controls. The relay receiver board must be provided with 12 DC supply to get it work, the transmitter controller has its own battery.

Features:

(a) 4 channel output
(b) Small size
(c) 60 Meters of range in ideal conditions

4.2. Pseudocode/Algorithm

Pseudo code is a kind of structured English for describing algorithms. It allows the designer to focus on the logic of the algorithm without being distracted by the details of language without being distracted by the details of entire logic of the algorithms that implantation becomes a mechanical task for translating line into source code.

The purpose of using the Pseudocode is that it is easier for a human to understand than conventional programming language and is a compact and environment dependent description of key principle of an algorithm.

Algorithm/Pseudocode used in the implementation Pseudocode of Interfacing

/* code showing the interfacing of remote, drone and pump */
//on the power button of remote
//transmitter and receiver connection establish
//on moving the hawk present in the left and right If left stick moved up /* initializing the flying */
Motors start running Continue /* process goes continues */ While right stick in movement /* providing the direction */ If right stick up
Hover to the upward direction Else if right stick down
Hover to the downward direction Else if right stick left
Hover to the left direction Else if right stick right
Hover to the right direction
Else
Remain in the center End if
End while
//to stop the process of flying
Else if left stick moved down

Motor speed starts decreasing and comes to halts Else
Remain idle /* remain in the ground itself */ End if

5. Conclusions

Drones will soon take on to be an imperative existence in the coming future. They will be seen taking up larger roles for a variety of jobs including business in the immediate future. They could become a part of daily lives, from smallest details like delivering groceries to changing the way farmers manage their crops, to revolutionizing private security, or maybe even aerial advertising. Today, quadcopters are capturing news video, recording vacation travel logs, filming movies, providing disaster relief, surveying real estate and delivering packages.

This project aims at providing ease of work in agricultural field by reducing time and work force. The model is built in a way that it can be modified to stand up to changes in the technology world. Hence quadcopters have an exemplarily bright future. The success lies upon the users whether they productively use it or destructively use it.

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ROBOTIC VACUUM CLEANER

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Abstract

In this present era, people live a very busy life. People in cities have irregular and long working times. In such a situation a person will always find ways of saving time. Household chores are the ones that are most dreaded upon. And cleaning a home tops the list. It is not only time consuming, but also its very tiring. Especially for working women it becomes difficult to handle both home and office work together. A new service robot designed for cleaning tasks in home environments is introduced. System has three subsystems: electrical, software and mechanical of which sensors (opponent and light) and motors are the electrical and mechanical subsystems respectively and the Lab VIEW-my RIO module is the software subsystem which is the brain of the robot. My RIO is programmed to accept inputs from the sensor and thereby control the wheels of the robot by a motor driver to avoid collision. The vacuum cleaner performs the cleaning process.

1. Introduction

In recent years, robotic cleaners have taken major attention in robotics research due to their effectiveness in assisting humans in floor cleaning applications at homes, hotels, restaurants, offices, hospitals, workshops, warehouses and universities etc. Basically, robotic cleaners are distinguished on their cleaning expertise like floor mopping, dry vacuum cleaning etc. Some products are based on simple obstacle avoidance using infrared sensors while some utilize laser mapping technique. Each cleaning and operating mechanism of robotic floor cleaners has its own advantages and disadvantages. For example, robots utilizing laser mapping are relatively faster, less time consuming and energy efficient but costly, while obstacle avoidance based robots are relatively time consuming and less energy efficient due to random cleaning but less costly. Countries like Pakistan are way back in manufacturing robotic cleaners. Importing them from abroad increases their costs. The main objective of this work is to provide a substantial solution to the problem of manufacturing robotic cleaner utilizing local resources while keeping it low costs.

2. Block Diagram

2.1. DC Power Unit

This block consists of a 12V rechargeable battery and a voltage regulator. The LM7805 IC connected to the output of the battery, provides a constant output of 5V regardless of the load in the circuit. Thus the power requirements of the system are strictly met without putting the system at risk during high loads.

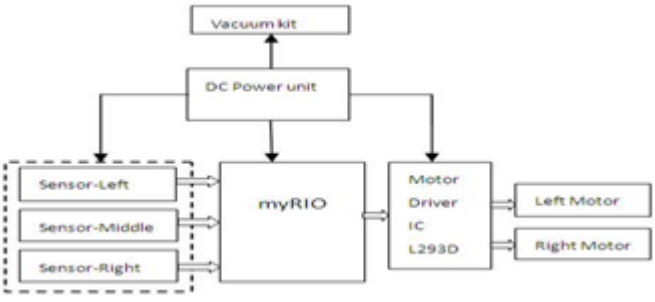


Figure 1. Basic block diagram

2.2. My – RIO

MyRIO is real time embedded evolution board made by national instruments. It is a real time data acquisition and data interfacing device. It has inbuilt FPGA processor, ADC, DAC, filters, timers and counters. It is WIFI compatible and hence it can be used as a wireless data acquisition device. It is the heart of the system which makes our robot automatic. It reads the signals from three IR sharp sensors. It then processes this data and controls the movement of robot by giving signals to the motor driver

Figure 2. My RIO image

2.3. IR Sharp Sensors

The GP2Y0A21 sharp IR sensor used in our project provides great way to add obstacle avoidance and motor control feature to our robot. In this project it operates at 5V and current consumption is about 30mA with a distance of 10cm to 80cm. Ananalog voltage indicating distance is the output of the sensor which is fed to MyRIO.

Figure 3. IR Sharp Sensor

2.4. Motor Driver Circuit

A motor driver is used to control the two geared DC motors. It can make a motor rotate in either clockwise direction or in anti-clockwise direction according to the control inputs given to it. MyRIO provides the control signals to the motor driver IC L293D according to the output of IR sensors. Direction of the rotation of the motor is decided as per the input pins of the L293D.

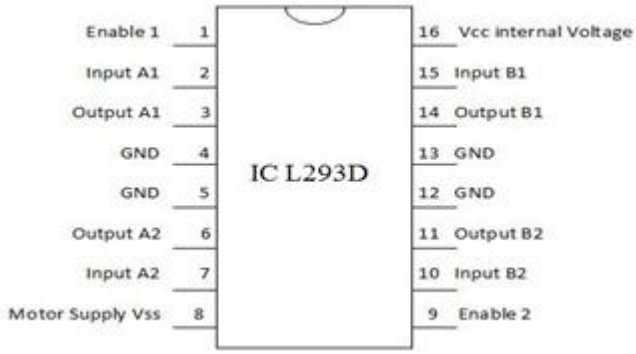
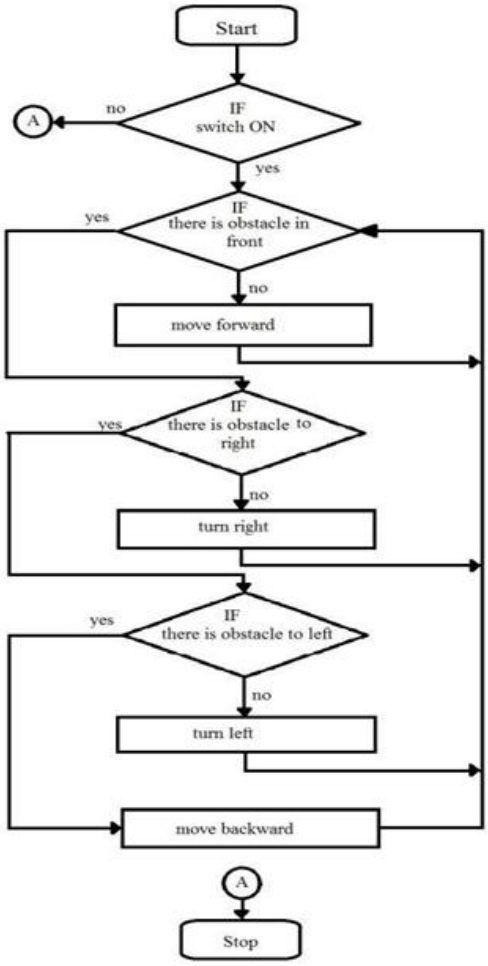


Figure 4. Pin diagram of ICL2 93D

Table 1. Direction of motor rotation according to IC input

A1	A2	Direction of Rotation
0	1	Clockwise
1	0	Anticlockwise
0	0	Idle
1	1	

3. Flowchart



4. Description

Overall designing of the proposed vacuum cleaner revolves around Shape, Sensors, Batteries, Suction, and Motors. Developed vacuum cleaner robot is a square of side 10 inch and height of 4 inch. All robotic vacuum cleaners that are out in the market today are disk shaped. The problem with that is that they cannot clean the corners of rooms very well. Since our main objective was to improve the overall cleaning efficiency, we decided to change the shape from a circle to a square with rounded edges. The rounded edges will allow the vacuum to have the effective mobility to work its way through tight spots and the square shape is for effective cleaning of corner. This robot is robust enough and made to work on normal environment. Base of the vacuum is made of aluminium plank. It is selected such that can carry its required weight. Aluminium is used to make light, rigid and is known for its resistance, toughness and required modification is made to provide electrical insulation.

Two dc geared motors are used as the robot base motors which is driven by motor driver IC L293D. The L293D is a quadruple high-current half-H driver. The L293D is designed to provide bidirectional drive current of up to 600mA at voltages from 4.5V to 36V.

MyRIO is the heart of our project for interfacing the robot. This unit recognises the data from the sensors processes the signal and thereby executes the program depending on the data and guide the motor driver and other unit to perform the intended task and control the complete functioning of the unit. It will send appropriate data to each and every unit requested by the user and will enhance the robot to take the appropriate function. Sensors are mounted at left, right and front of the robot, which detects the obstacle in its way and moves in defined path.

Vacuum suction to collect dust is an important part of our project. 12V dc 0.25A exhaust fan is used as sucking unit with conical shaped structure in front. Conical shape is chosen so as to reduce pressure near fan and in rise pressure in pipe fixed to suck debris falling on floor. Two flat brushes are provided concentrating towards opening of pipe for effective cleaning.

5. Operation

The vacuum cleaner can be operated by manually carrying it to the room to be cleaned and pressing the 'start' switch. When switch is turned on 12v dc battery provides power to MyRIO. MyRIO being the controller of the vacuum cleaner receives input from GP2Y0A21 sharp IR sensor. IR sensors are mounted at front, right and left of the robot and input is fed in parallel to MyRIO. If the IR sensor senses an obstacle, then it gives a maximum output and a low output otherwise. Hence obtained analog input is converted to binary, then into decimal and the movement of the robot is decided.

Table:2

Left	Middle	Right	A	B	C	D
0	0	0	0	1	0	1
0	0	1	0	1	0	1
0	1	0	0	1	1	0
0	1	1	1	0	0	1
1	0	0	0	1	0	1

When dc supply is turned on fan of the vacuum cleaner gets energised. As robot move forward flat brush connected in front of the robot gathers dust lying on the floor vacuum suction unit sucks it up and is collected inside conical structure. Mean while in water dropping unit motor brings water to the water dropping channel and water is spread and mopped using roller bush connected at the back of the robot.

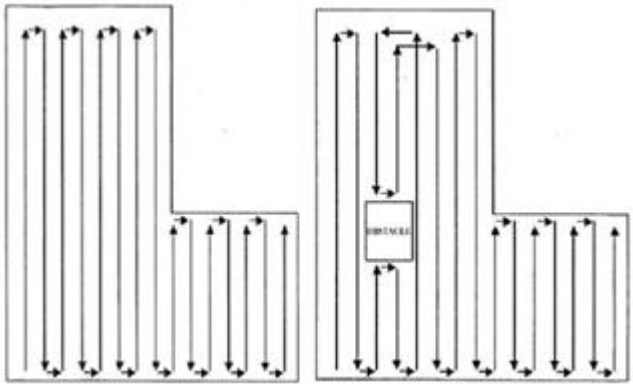


Figure 5. Movement of Robot

6. Application

1) Home automation is one domain that has been target of all robotics companies, large and small. Soon a time could come when you clean your home using a robot just like the one we've given life here. These could make the tiresome task of cleaning all those rooms, into a few minutes work. Cleaning your home would no longer be the same.

2) The robotic cleaner enhances the technology of cleaning and can be further used to integrate features of fast and effective cleaner by different other methods. As we can observe that development of comfort systems has found a new market for themselves and if these systems can be remotely operated, i.e. in the click of just one single button we have an entire smart home for us.

3) Gadgets like these prove instrumental in designing homes having all the facilities, and with the inclusion of more and more features like that, a new sound picture of future begins to develop.

4) Places like hospitals, restaurants and retirement homes can take the advantage of these devices where not much dirt is accumulated and can be cleaned easily with these devices.

7. Conclusions

The concept has proven to be an efficient way of saving time and helping physically disabled people. This system is especially beneficial to working women. As specified the user can switch on the device and go for any other work and the robot will automatically clean the floor by detecting and avoiding the obstacles on its way. my rio can be easily used to modify and enhance the various capabilities of any robot evolving its capabilities to explore new pathways of working efficiently. The IR sharp sensors and ir are effective in movement of robot around cliff and boundaries of the room. These sensors, with, greater resolution can give the correctness of movement to degrees which lead to smooth cleaning of the room. Nonetheless, there are still new ideas to improve the developed system and to add new functionality to it. Gsm module can be used to send message that, the robot has done the cleaning task. Camera can also be used for navigation purposes.

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