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RESEARCH ARTICLE

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MEMS ACCELEROMETER BASED NONSPECIFIC - USER HAND GESTURE RECOGNITION

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ABSTRACT

This paper presents three different gesture recognition models which are capable of recognizing seven hand gestures, i.e., up, down, left, right, tick, circle, and cross, based on the input signals from MEMS 3-axes accelerometers. The accelerations of a hand in motion in three perpendicular directions are detected by three accelerometers respectively and transmitted to a PC via Bluetooth wireless protocol. An automatic gesture segmentation algorithm is developed to identify individual gestures in a sequence. To compress data and to minimize the influence of variations resulted from gestures made by different users, a basic feature based on sign sequence of gesture acceleration is extracted. This method reduces hundreds of data values of a single gesture to a gesture code of 8 numbers. Finally, the gesture is recognized by comparing the gesture code with the stored templates. Results based on 72 experiments, each containing a sequence of hand gestures (totaling 628 gestures), show that the best of the three models discussed in this paper achieves an overall recognition accuracy of 95.6%, with the correct recognition accuracy of each gesture ranging from 91% to 100%. We conclude that a recognition algorithm based on sign sequence and template matching as presented in this paper can be used for nonspecific-users hand-gesture recognition without the time consuming user-training process prior to gesture recognition.

KEYWORDS: MEMS accelerometer, gesture, handwritten recognition, Zigbee

I. INTRODUCTION

The increase in human-machine interactions in our daily lives has made user interface technology progressively more important. Physical gestures as intuitive expressions will greatly ease the interaction process and enable humans to more naturally command computers or machines. The proposed applications of recognizing hand gestures include character-recognition in 3-D space using inertial sensors gesture recognition to control a television set remotely enabling a hand as a 3-D mouse and using hand gestures as a control mechanism in virtual reality. In our work, a miniature MEMS accelerometer based recognition system which can recognize seven hand gestures in3-D space is built. The system has potential uses such as a remote controller for visual and audio equipment, or as a control mechanism to command machines and intelligent systems in offices and factories.

There are mainly two existing types of gesture recognition methods, i.e., vision-based and accelerometer and/or gyroscope based. Our current system is based on MEMS accelerometers only and gyroscopes are not implemented for motion sensing.

Existing gesture recognition approaches include template-matching, dictionary lookup, statistical matching, linguistic matching, and neural network. In this paper, we present three different gesture recognition models, which are:

- sign sequence and Hopfield based gesture recognition model
- velocity increment based gesture recognition model
- sign sequence and template matching based gesture recognition model.

In these three models, in order to find a simple and efficient solution to the hand gesture recognition problem based on MEMS accelerometers, the acceleration patterns are not mapped into velocity, displacement or transformed into frequency domain, but are directly segmented and recognized in time domain. By extracting a simple feature based on sign sequence of acceleration, the recognition system achieves high accuracy and efficiency without the employment of HMM.

EXISTING METHOD: The Existing method is uses the Bluetooth technology and with less accuracy.

PROPOSED METHOD: The proposed method is based on Zigbee technology and it increases the distance and accuracy

II. ANALYSIS AND DESIGN

In this section we briefly describe about the design and implementation of hand gesture recognition system with the help of MEMS based Accelerometer. Different hand gestures are being recognized by the portable device and sent to the Computer wirelessly using Zigbee technology.

1. BLOCK DIAGRAM

This project consists of 2 modules.

a) Portable Device b) Application system

a) Portable Device: Portable device consists of Microcontroller, MEMS Accelerometer, Zigbee Transmitter and LCD.

Hand gesture is being sensed by MEMS Accelerometer. MEMS detect the movement of a device in the 3-dimensional plane (X-Y-Z). Its output consists of displacement of sensor from the current position in the 3 axes. That is X-displacement, Y-displacement, Z-displacement is sent to the microcontroller through SDA Pin of the Sensor.

This Sensor uses I2C communication Interface. The microcontroller reads the data from the SDA pin and detects the gesture based up on an algorithm and sends the gesture name Up, Down, Right, Left, Tick, Circle and Cross to the Computer using the Zigbee Wireless Transmitter.

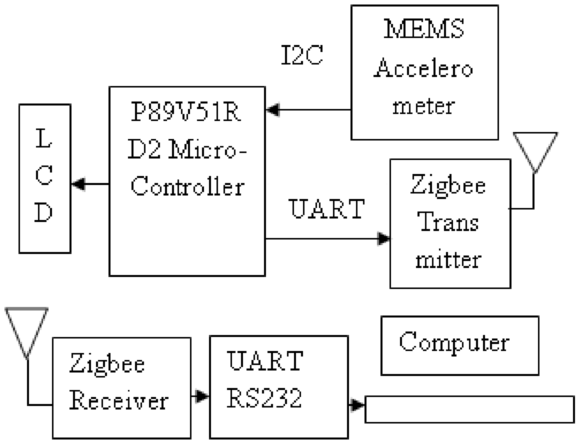

Fig. 1: Block diagram of portable device

b) Application system: In this module Zigbee receiver receives the data sent by the portable device (module 1) and through the serial cable it send the received data to the Computer. Finally we can see the movement (gesture recognition) of the Hand (Portable device) on the computer.

III. HARDWARE REQUIREMENTS

1. MICROCONTROLLER

The P89V51RD2 is 80C51 microcontrollers with 64kB Flash and 1024 bytes of data RAM.A key feature of the P89V51RD2 is its X2 mode option. The design engineer can choose to run the application with the conventional 80C51 clock rate (12 clocks per machine cycle) or select the X2 mode (6 clocks per machine cycle) to achieve twice the throughput at the same clock frequency. The Flash program memory supports both parallel programming and in serial In-System Programming (ISP). Parallel programming mode offers gang-programming at high speed, reducing programming costs and time to market. ISP allows a device to be reprogrammed in the end product under software control. The capability to field/update the application firmware makes a wide range of applications possible. Port 1 is dedicated to I/O port. Port 2 may be used to provide the high-order byte of the address bus for external program memory or external data memory that uses 16-bit addresses. Port 3 is a dual-purpose port, the specification is similar to that of port 1.

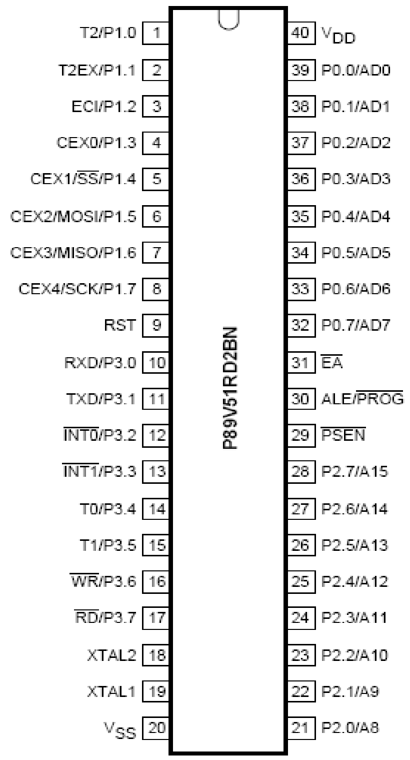

Fig. 2: Pin diagram of the micro controller.

2. UART: The UART operates in all standard modes. Enhancements over the standard 80C51 UART include Framing Error detection, and automatic address recognition.

3. I2C: The I2C-bus supports any IC fabrication process (NMOS, CMOS and Bipolar). Two wires, serial data (SDA) and serial clock (SCL), carry information between the devices connected to the bus. Each device is recognized by a unique address whether it's a micro controller, LCD driver, memory or keyboard interface and can operate as either a transmitter or receiver, depending on the function of the device. Obviously an LCD driver is only a receiver, whereas a memory can both receive and transmit data. In addition to transmitters and receivers, devices can also be considered as masters or slaves when performing data transfers.

Term	Description
Transmitter	The device which sends the data to the bus
Receiver	The device which receives the data from the bus
Master	The device which initiates a transfer, generates clock signal and terminates a transfer
Slave	The device addressed by a master
Multi-master	More than one master can attempt to control the bus at the same time without corrupting the message
Arbitration	Procedure to ensure the, if more than one master simultaneously tries to control the bus, only one is allowed to do so and the message is not corrupted
Synchronization	Procedure to synchronize the clock signals of two or more devices

4. LCD

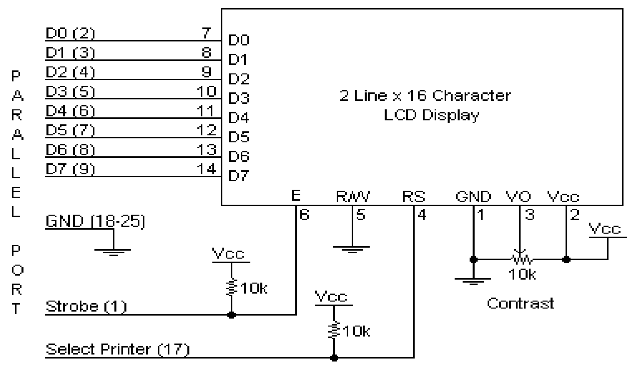

Fig.3: 16x2 line LCD

In this project we using 16x2 line lcd which is provide a relatively simple interface between a processor and LCD. This interface is a parallel port, allowing simple and fast reading/writing of data to and from the LCD.

5. ZIGBEE transmitter and receiver: ZigBee is a new wireless technology that looks to have applications in a variety of fields. Zigbee is a technological standard based on the IEEE 802.15.4 specification for low data rates in the Industrial, Scientific, and Medical (ISM) radio bands. This technology allows for devices to communicate with one another with very low power consumption, allowing the devices to run on simple batteries for several years. Zigbee is targeting various forms of automation, as the low data rate communication is ideal for sensors, monitors, and the like. Home automation is one of the key market areas for Zigbee.

6. MEMS Accelerometer

Here we have used *MPU 6050 3-AXIES GYRO/ADXL*

Description: The MPU-6050 is a serious little piece of motion processing tech! By combining a MEMS 3-axis gyroscope and a 3-axis accelerometer on the same silicon die together with an onboard Digital Motion Processor™ (DMP™) capable of processing complex 9-axis Motion Fusion algorithms, the MPU-6050 does away with the cross-axis alignment problems that can creep up on discrete parts.

a) Accelerometer Features

The triple-axis MEMS accelerometer in MPU-60X0 includes a wide range of features:

- Digital-output triple-axis accelerometer with a programmable full scale range of ±2*g*, ±4*g*, ±8*g* and ±16*g*
- Integrated 16-bit ADCs enable simultaneous sampling of accelerometers while requiring no external multiplexer
- Accelerometer normal operating current: 500µA

b) Motion Processing

- Internal Digital Motion Processing™ (DMP™) engine supports 3D Motion Processing and gesture recognition algorithms
- The MPU-60X0 collects gyroscope and accelerometer data while synchronizing data sampling at a user defined rate. The total dataset obtained by the MPU-60X0 includes 3-Axis gyroscope data, 3-Axis accelerometer data, and temperature data. The MPU's calculated output to the system processor can also include heading data from a digital 3-axis third party magnetometer.
- The FIFO buffers the complete data set, reducing timing requirements on the system processor by allowing the processor burst read the FIFO data. After burst reading the FIFO data, the system processor can save power by entering a low-power sleep mode while the MPU collects more data.
- Programmable interrupt supports features such as gesture recognition, panning, zooming, scrolling, tap detection, and shake detection
- Digitally-programmable low-pass filters
- Low-power pedometer functionality allows the host processor to sleep while the DMP maintains the step count.

IV. RESULTS AND ANALYSIS

1. Gesture Codes

	X-axis	Z-axis
Left	1 -1 1 0	0 0 0 0
Right	-1 1 -1 0	0 0 0 0
Up	0 0 0 0	1 -1 1 0
Down	0 0 0 0	-1 1 -1 0
Tick	-1 1 -1 0	-1 1 0 0
Circle	1 -1 1 -1	-1 1 -1 1
Cross	1 -1 1 0	-1 1 -1 1

2. Gesture Recognition Accuracy (%)

Up	down	left	right	tick	circle	cross
94.8	91.1	96.7	100	94.4	97.7	94.4

3. ADVANTAGES & APPLICATIONS

A. Advantages

- More reliable
- Low cost
- Low power consumption
- Less heat dissipation
- Less space on board
- Less complex circuitry

B. Applications

- Mobile phones
- Computers
- Televisions
- Gaming consoles
- Cameras

4 Work flow chart

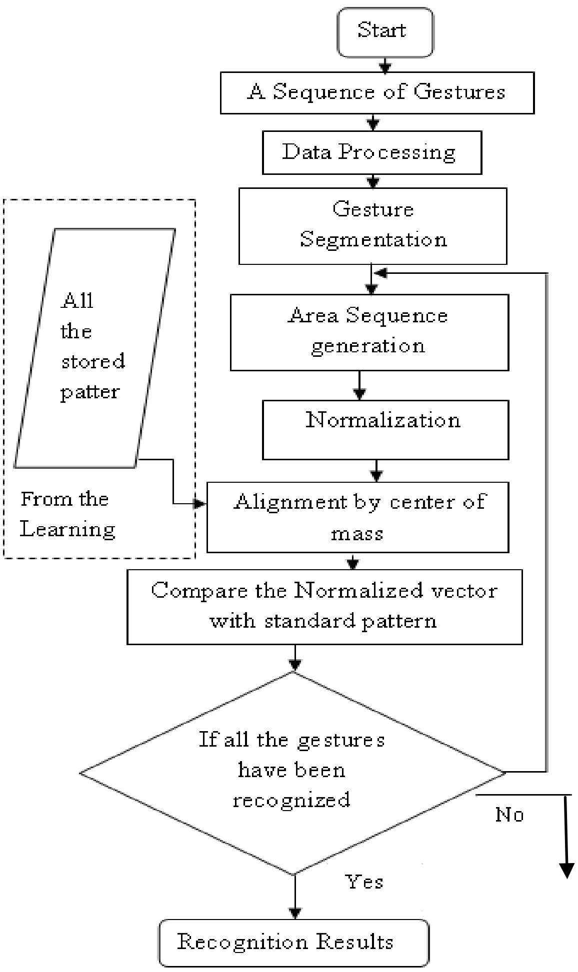

Fig.4: Flow chart of the Gesture codes table

VI. CONCLUSION

This paper describes a nonspecific person gesture recognition system by using MEMS accelerometers. The recognition system consists of sensor data collection, segmentation and recognition. After receiving acceleration data from the sensing device, a segmentation algorithm is applied to determine the starting and endpoints of every input gesture automatically. The sign sequence of a gesture is extracted as the classifying feature, i.e., a gesture code. Finally, the gesture code is compared with the stored standard patterns to determine the most likely gesture.

VII. FUTURE ENHANCEMENT

Since the standard gesture patterns are generated by motion analysis and are simple features represented by 8 numbers for each gesture, the recognition system does not require a big database and needs not to collect as many gestures made by different people as possible to improve the recognition accuracy. We note here, however, to enhance the performance of the recognition system; we will need to improve the segmentation algorithm to increase its accuracy in finding the terminal points of gestures. Moreover, other features of the motion data may be utilized for pattern classification, i.e., more recognition methods will be investigated in our future work.

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