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REVIEW ARTICLE

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4 LEGGED WALKING ROBOT USING 8 BAR MECHANISM

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ABSTRACT

Four leg walking robot, with a certain level of comparable complexities and similarities to its biological counterpart. A four-phase walking strategy inspired from four legged animals has been proposed and implemented in the robot. Four parallel Subsumption Architectures and a simple Central Pattern Generator are used in the robot for physical implementation. Experimental results demonstrate that the robot employs the proposed walking strategy and can successfully carry out its walking behaviors under various experimental terrain conditions, such as flat ground, incline, decline and uneven ground. Control buttons are used to control the movement of the robot. In this project we are using control buttons for the user to choose the direction mode in which the robot should operate whether forward, backward or left, right directions. Using control buttons we can select the particular direction of operation of the robot. The DC motor generates torque directly from DC power supplied to the motor by using internal commutation, stationary permanent magnets, and rotating electrical magnets. DC motors are employed to control the direction of the robot. Robot movement can be controlled using controlled buttons.

Keywords: Four legged robot, 8 bar mechanism, Dc motor, Peaucellier

1. INTRODUCTION

The advent of new high-speed technology and the growing computer Capacity provided realistic opportunity for new robot controls and realization of new methods of control theory. This technical improvement together with the need for high performance robots created faster, more accurate and more intelligent robots using new robots control devices, new drivers and advanced control algorithms. This project describes a new economical solution of robot control systems. The presented robot control system can be used for different sophisticated robotic applications. The objective of this project is to build a new mechanical robotic walker using 8 bar link mechanism. The system uses a Robot which is Capable of walking towards the object according to the user remote control.

The main aim of this project is to fabricate a Mechanical walker robot using the wireless remote. As it is a wireless Robot it can be easily mobilized and can be controlled.

An eight-bar linkage is a one degree-of-freedom mechanism that is constructed from eight links and 10 joints. These linkages are rare compared to four-bar and six-bar linkages, but two well-known examples are the Peaucellier linkage and the linkage designed by Theo Jansen for his walking machines.

This project makes use of an on-board computer, which is commonly termed as micro controller. It acts as heart of the project. This on-board computer can efficiently communicate with the output and input modules which are being used. The controller is provided with some internal memory to hold the code. This memory is used to dump some set of assembly instructions into the controller. And the functioning of the controller is dependent on these assembly instructions.

In this project we use micro controller, which is programmed to control the input and output modules interfaced to it. The controller makes use of a remote, which is used to control the robot. The project consists of micro controller based motherboard is present with the Robot itself. It is interfaced with some DC motors for moving the robot, and a RF for receiving the instructions from the remote.

2. LITERATURE REVIEW

Swadhin Patnaik conducted research on four legged walking machines and published a journal on IOSR Journal of Engineering (IOSRJEN) ISSN (e): 2250-3021, ISSN (p): 2278-8719 Vol. 05, Issue 07 (July. 2015), ||V4|| PP 43-52 After researching about mining and excavation industries I came across with these data. The statistics suggests that about 50% of mining cost is spent on roadway and rail transports in the vicinity of the mines (haul roads & side rails). Haul roads cause a great damage to tyres of transporting vehicle requiring frequent and regular replacement. Maintenance cost of haul roads is also high and it needs a separate wing. Weight distribution is uneven in haul roads causing higher stress problems in transport vehicles. On a rough terrain legs have advantage over tyres so I came on Klann Mechanism. After researching through this mechanism on internet and going though few reports and watching its motion in the YouTube videos I found that Klann Mechanism has its own demerits which include steering and stability. After crossing out the Klann Mechanism from the list I stumbled on Theo Jansen Mechanism. This mechanism gave me the smoothest motion and is able to carry loads without much high forces applied to it. With the inspiration from Jansen's walking mechanisms, I began searching for various applications of the Jansen leg mechanism. I found several images and videos on the Internet showing different applications of this design large and small that helped me identify what I wanted my design to look like. The appropriation of the Jansen mechanism has ranged from tiny motorized robots to large multi-legged two-seater vehicles. This mechanism is very simple to build and it requires very less energy to run itself. But the only drawback found about this mechanism is its speed. How fast can it run? Except for that one point the Jansen design is incomparable with any other leg mechanism with such simplicity.

AbdAlsalamSh.I. AlsalamehShamsudinstudied on the movement of robots in surfaces. In this paper the emphasis is given towards the mechanical structure of a quadruped robot able to walk on ground, climb on vertical walls, and perform the ground wall-movement automatically. The overview of the robot is shown, the configuration, number of DOFs, and the actuation system of the leg is analysed. Biologically inspired gaits of the robot are discussed. The movement of the leg from the ground to the wall is analysed. The integrated leg movement-trunk regulation sequences are simulated. And the trajectories of specific points on the trunk are traced, showing the limits for safe movement inside meandrous chimneys or zigzag tubing.

KazumaKomoda and Hiroaki Wagatsumastudied on linkage mechanism of robots and proposed an extension mechanism of the Theo Jansen linkage for climbing over bumps. The linkage is useful to mimic animal locomotion, we hypothesized that an additional up-and-down motion in the linkage centre provides different motion patterns from the original internal cycle. Our results demonstrated that the lifting up of the linkage centre alters the leg's orbit upward and the combination of a cycle and up-down motion provides a new elliptic orbit to climb bumps with about 10 times height of the original. This analysis may shed light on the future expandability of the linkage mechanism in bio-inspired robots.

M.F. SILVA and J. A. TENREIRO MACHADO investigated on the optimization of legged robots. During the last two decades the research and development of legged locomotion robots has grown steadily. Legged systems present major advantages when compared with "traditional" vehicles, because they allow locomotion in inaccessible terrain to vehicles with wheels and tracks. However, the robustness of legged robots, and specially its energy consumption, among other aspects, still lag being mechanisms that use wheels and tracks. Therefore, in the present state of development, there are several aspects that need to be improved and optimized. Keeping these ideas in mind, this paper presents the review of the literature of different methods adopted for the optimization of the structure and locomotion gaits of walking robots. Among the distinct possible strategies often used for these tasks are referred approaches such as the mimic of biological animals, the use of evolutionary schemes to find the optimal parameters and structures, the adoption of sound mechanical design rules, and the optimization of power-based indexes.

M. H. Raiberthad Early research efforts in legged locomotion focused on statically stable gaits in which robot's centre of gravity is always kept over the polygon formed by the supporting feet Raibert, around 1985, set the stage with his ground-breaking work on dynamic legged locomotion , which resulted in one of the most advanced quadrupeds, Boston Dynamics' Big Dog that can control its forward speed, and although it moves with static stable gaits, it can achieve a dynamically balanced trot gait when moving at human walking speeds . Boston Dynamics' statically stable Little Dog, is a quadruped walking robot with 12 degrees of freedom, used as an algorithm test bed. A different design and control approach is followed in Scout II and in the NTUA Quadruped Robot, which use only one actuator and a spring per leg to realise dynamically stable running with speed control. While the Scout requires a time-consuming trial-and-error controller parameter determination to achieve a given speed, the NTUA quadruped control algorithm does not need empirical gain tuning. Quadruped robots like Kotetsu that employ Central Pattern Generator (CPG) based controllers and KOLT that uses a fuzzy controller are different approaches towards achieving dynamic stable gaits. Recent research efforts by the Autonomous System Lab at ETH and the Advanced Robotics Department at IIT are aiming at making a step forward from Little Dog and Big Dog respectively. Generally, the tendency for the new robotic quadrupeds is to aim for very fast, rapidly accelerated, able to make tight turns robots with flexible spine, articulated legs, possibly including head and tail, such as the Boston Dynamics' Cheetah concept.

Wiss, Martijn Dept. of Mech.Engg, from Delft Univ. of Techno Investigated on How to keep from falling forward elementary swing leg action for passive dynamic walkers for robots. Stability control for walking bipeds has been considered a complex task. Even two-dimensional fore-aft stability in dynamic walking appears to be difficult to achieve. In this paper we prove the contrary, starting from the basic belief that in nature stability control must be the sum of a number of very simple rules. We study the global stability of the simplest walking model by determining the basin of attraction of the Poincare´ map of this model. This shows that the walker, although stable, can only handle very small disturbances. It mostly falls, either forward or backward. We show that it is impossible for any form of swing leg control to solve backward falling. For the problem of forward falling, we devise a simple but very effective rule for swing leg action: "You will never fall forward if you put your swing leg fast enough in front of your stance leg". In order to prevent falling backward the next step, the swing leg shouldn't be too far in front.

Yujiang Xiang, Jasbir S. Arora studied on a review of human walking modelling and simulation is presented. This review focuses on physics-based human walking simulations in the robotics literature. it is mainly based on Physics-based modelling and simulation of human walking a review of optimization-based and other approaches. Features of various methods are discussed, and their advantages and disadvantages are delineated. The modelling, formulation, and computation aspects of each method are reviewed.

José A. Tenreiro Machado Investigated on the optimization of legged robots the robustness of legged robots, and especially their energy consumption, among other aspects, still lag behind mechanisms that use wheels and tracks. Therefore, in the present state of development, there are several aspects that need to be improved and optimized. Keeping these ideas in mind, this paper presents the review of the literature of different methods adopted for the optimization of the structure and locomotion gaits of walking robots. Among the distinct possible strategies often used for these tasks are referred approaches such as the mimicking of biological animals, the use of evolutionary schemes to find the optimal parameters and structures, the adoption of sound mechanical design rules, and the optimization of power-based indexes.

Martin Buehler conducted research on the Scout 2 quadruped which was primarily to ascertain the passive dynamics on quadrupedal bounding and also stable running using two control strategies. According to these experiments, it was reconfirmed that stability improves at higher speeds. The group earlier conducted experiments on understanding the galloping-gait of quadrupeds with compliant legs followed by attempts at understanding its natural gaits Roland Siegwart and the ASL group in ETH Zurich initiated research into the stability analysis in a quadruped]. This numerical simulation examined the influence of various parameters on the stability and locomotion speed. This was followed by attempts at understanding the walk and trot gait of quadrupeds that would allow a unified model to be applied for both these gaits together Scout 2 a quadruped robot by McGill University Furthermore, his group conducted research into spring-leg systems for quadrupeds that exhibit passivity as well. The efficiency of running gaits in nature results from a passive elastic oscillation on springy legs. They applied this principle to robotic systems by endowing them with high compliance series elastic actuators in which the electric motors are decoupled from the joints by elastic elements. Further improvisations were done using springs in ankles to reduce energy lost due to damping and during impact with the ground .It also simultaneously allowed for a natural-looking stance configuration wherein actuator input and ankle spring properties were 25 optimized. This work was then carried forward by incorporating torsional springs at the hip wherein two compliant robotic legs were compared, that are able to perform precise joint torque and position control, enable passive adaption to the environment, and allow for the exploitation of natural dynamic motions. Recently, their group has experimented with the newly designed Alofs and Starlet robots, wherein a practical implementation of the principles propounded was sought in order to minimize energy consumption and increase robustness. Starlet is an upgraded version of Alofs that uses high compliant series elastic actuators. Also, legged-robot walks on irregular terrain such a damaged area or collapsing footholds have been simulated. In this strategy, a locomotion method has been proposed in which the quadruped robot does not stumble on weak and irregular slopes.

3. SELECTION OF DEGREES OF FREEDOM

The number of joints in a robot roughly translates to the degrees of freedom. In the design process three different possibilities were considered. A leg with one degrees of freedom using indirectly driven joints in a shoulder and elbow configuration yields motion at the tip of the leg. The foot of the leg is constrained to a spherical surface. However the up-down and forward-back motion is approximately linear and provides a method to propel forward or backward while adjusting to some uneven terrain. A two degree of freedom leg offers very limited capabilities and produces legs which act similar to uneven wheels. Legs with two degree of freedom also prevent the robot from adjusting its step sizes to compensate for the environment rendering one degree of freedom inadequate. A three degree of freedom design offers superb manoeuvrability allowing the robot to adjust too many situations.

However, the three degree of freedom design significantly increases the cost of the robot. A one degree of freedom leg was chosen since two degree of freedom does not offer the required capabilities and three degrees of freedom is costly

Actuators in robots are like muscles in the human body. Without the actuators, the limbs of the robot cannot move. There are many types of actuators available but only certain types suit the needs of the project. Below is a comparison of some common actuators. Following the comparison a decision was made on the method of actuation for the robot legs.

- Pneumatics and Hydraulics
- DC motors
- Stepper motors

Pneumatics and Hydraulics

Pneumatics and hydraulics run on the basis of a pressurized fluid driving a piston or motor mechanism. The system requires a pump or compressor to provide the necessary pressure to drive the piston or motor. This setup is large, noisy, and expensive.

DC motors

DC motors are commonly found in wheeled robots. DC motors rotate as long as power is applied and stops when power is removed. A continuous rotation at a constant speed can be achieved by applying a constant voltage. However, extra support circuitry including a sensor for feedback is needed for position control.

Stepper motors

A stepper motor is a very simple DC motor. Because it has no brushes or contacts, it operates by having its magnetic field electronically switched to rotate the armature magnet. This setup allows the motor to rotate and halt at specific angles. There are two types of stepper motors bipolar and unipolar. The bipolar stepper motor consists of two coils. The current direction is reversed in each coil to achieve four separate positions. The unipolar stepper motor consists of four coils. When each coil is energized individually and working in proper sequence, the motor shaft turns the inherent number of degrees per step. Regardless of the type of stepper motor used there is no closed loop feedback unless an external position sensor is used.

RC Servo Motors

An RC servo motor is a DC motor combined with position sensing parts. RC servo motors have 3 wires running out from the motor. Two lines are for power and the third line is for the control input. A pulse width signal applied to the input indicates to the motor the desired position. The exact relation of pulse width to output shaft location varies by motor model; but as a standard all RC servos moves to the centre position with a 1.5 Ms input pulse. Inside the RC servo motor, the components consist of a DC motor, a gear train, limits stops, a potentiometer for position feedback and some control circuitry. RC servo motors serve as an easy to implement open loop control system for robots. They remove complexity from the control system hardware and software and also reduce the total part cost and design time. The diagram shown in Figure 1 serves as reference to the control of an RC servo:

Actuator Used in Project

Pneumatics and hydraulics increase the cost and weight of the robot without offering any functional benefits. To reduce weight the pump or compressor can be taken off the robot and a tether can be extended to the robot to provide the pressurized fluid. Unfortunately this means the robot would have a tether and a limited walking range. Although DC motors are inexpensive they lack position control and are not directly suitable for this robotic application. Stepper motors have an open loop position control and can easily skip steps resulting in poor correlation between expected and actual position. RC servos were chosen because of their relatively low cost and their ease of control. The main drawback of an RC servo was the loss of feedback position control to the external device providing the control pulse.

4. Windshield Wiper Motors

Wiper Operation:

There are three major components to a wiper motor:

- Motor
- Rotary to linear motion converter mechanism
- Parking switch

The mechanism to convert rotary motion to linear motion is very straight forward, and its functionality is apparent from a visual inspection of a disassembled motor assembly. This article, therefore, will discuss only the operation of the motor and the park switch. Although written specifically for a TR6, it is typical for many later model British cars. A separate description is provided below for earlier models -- TR2, 3, 4, etc.

A) NORMAL OPERATION:

Refer to Figure 1. In this mode of operation, the dash switch is in the normal, or low speed, position, and internally, terminal 2 of the switch is connected to terminal 3. Current flows through the motor as shown by the dotted red line. The operation of the parking switch has no effect in this mode, as terminal 4 of the dash switch is not connected to any other terminal.

B) HIGH SPEED OPERATION:

Refer to Figure 2. In this mode, the dash switch is in the high speed position, and current flow is as shown. This is basically the same configuration as the normal mode, except the power flows through the high speed brush rather than the normal speed brush. Internally, terminal 2 of the dash switch is connected to terminal 1.

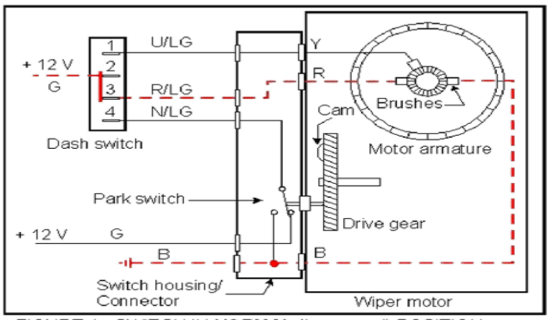


FIGURE 1 - SWITCH IN **NORMAL** (low speed) POSITION

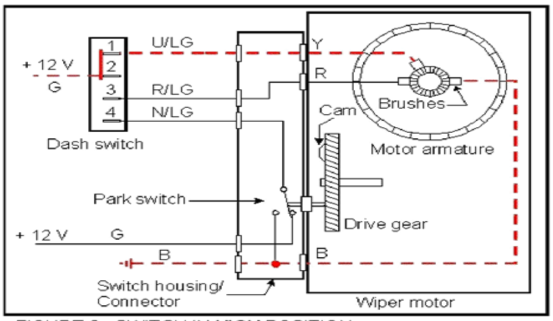


FIGURE 2 - SWITCH IN **HIGH** POSITION

C) WIPERS OFF, BLADES NOT IN THE PARKED POSITION: Refer to figure 3. With the dash switch off, power is supplied to the motor through the contacts of the parking switch, and the motor continues to operate. Until the drive gear rotates to the point where the cam operates the switch plunger, the motor will operate at the normal or low speed, just as if the dash switch were still on.

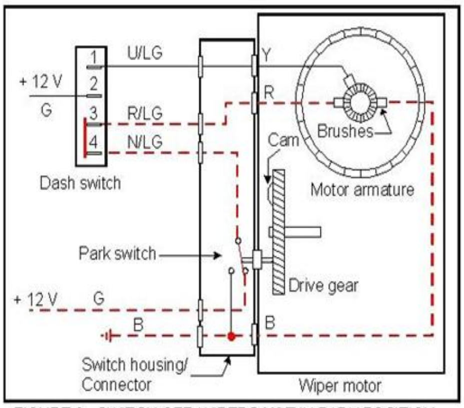


FIGURE 3 - SWITCH OFF, WIPERS **NOT** IN PARK POSITION

D) WIPERS OFF, BLADES IN THE PARKED POSITION: Refer to Figure 4. When the drive gear has rotated to the point that the blades are in their parked position, the cam button on the drive gear depresses the parking switch plunger, operating the switch. Now, rather than the 12 volts as before, ground is applied to the low speed brush, shorting out the armature windings. The magnetic field that had built up in the windings when 12 volts was applied will now discharge through the switch contacts, in very much the same manner as the operation of the primary windings in the ignition coil. This discharge current, shown as a dotted blue line, will be in the opposite direction as the normal current flow, and will tend to reverse the rotation of the motor.Because the windings are now short-circuited, the discharge takes place very quickly, and the reversing energy lasts just long enough to stop the motor. The energy in the discharge is such that the motor will stop immediately! In fact, if you are holding the motor while testing this operation, hold on tight, because it stops so quickly that it will jump out of your hand if you are not careful.

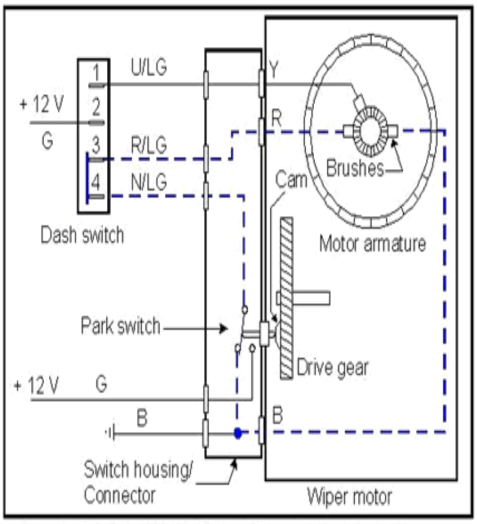


FIGURE 4 - SWITCH OFF, WIPERS IN PARK POSITION

EARLIER MODELS:

Earlier models are a bit simpler than the later models, as you might expect. Power is applied to the wiper motor at all times when the ignition switch is on, and the motor is grounded by the operation of the dash switch. As soon as the wiper blades move to some position other than the park position, the parking switch inside the wiper applies ground to the motor. Thus, when the dash switch is turned off, the motor will continue to operate until the blades reach the park position. There is no field discharge current to assist the parking in this configuration, so the parking is not as crisp as in the later models.

WIPER OPERATION:

A) NORMAL OPERATION:Refer to Figure 5. With the dash switch on, the motor windings are grounded, and the wipers are operating. The position of the insulated segment with respect to the park switch is immaterial, as the motor is already grounded by the dash switch - if the wipers are not in the park position, the park switch just provides an additional ground path. The current path in this condition is shown by the dotted red lines.

Note: The park switch configuration is not as shown in the diagrams. In reality, the grounding plate with the insulated segment is fixed, while the park switch rotates with the drive gear. I just couldn't figure a good way to show that without a complicated drawing.

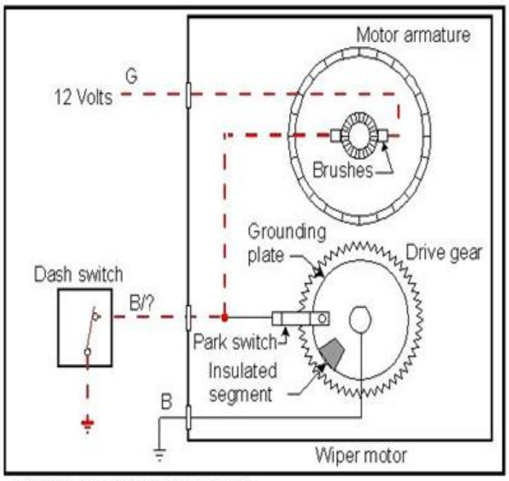


FIGURE 5 - DASH SWITCH ON

B) WIPERS OFF, BLADES NOT IN THE PARK POSITION: Refer to Figure 6. With the dash switch off, the ground path is through the park switch. As long as the wipers are not parked, the motor will continue to run. The current path in this condition is shown by the dotted red lines.

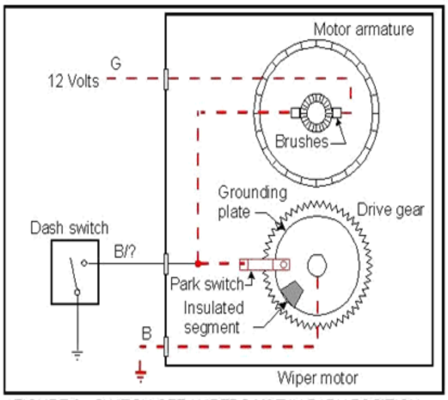


FIGURE 6 - SWITCH OFF, WIPERS NOT IN PARK POSITION

C) WIPER SWITCH OFF, WIPERS IN PARK POSITION.

Refer to Figure 7. With the dash switch off, and the park switch open, there is no ground path for the motor. When the park switch opens, the blade motion stops and the wipers are parked.

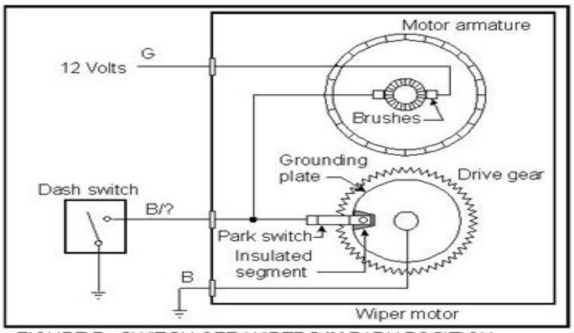


FIGURE 7 - SWITCH OFF, WIPERS IN PARK POSITION

EMERGENCY SWITCH REPLACEMENT: In an emergency, the dash switch can be replaced with a simple switch from Radio Shack, or similar supplier. For the earlier models, a simple on-off switch will do, wired directly as a replacement. For the later models, a SPDT switch is required to implement the parking function. Wire it as shown in Figure 8. Make sure the switches are rated at least 10 amp. For the SPDT switch, don't use the typical switch as found in most auto parts stores, as these nearly always have a "Center off" position, i.e., ON-OFF-ON. The switch required for application has only two positions: ON-OFF. This will only allow low speed operation, but that is preferable to no operation at all.

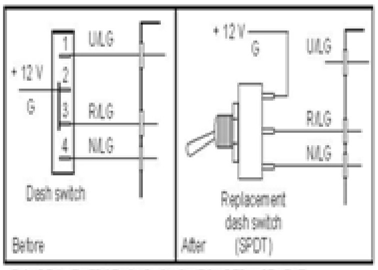


FIGURE 8 - EMERGENCY DASH SWITCH REPLACEMENT

5. DESIGN OF FOUR-BAR LINKAGE BASED LEG

Design of leg the first stage of leg design is the design of a four-bar linkage as shown in figure 10.In support phase, the four-bar linkage OAOB AB is driven by the main actuator OA H only. The foot path should be an approximation of a horizontal straight line. At the end of the stroke, the foot is lifting actuator OBB and moved back to the front by the main actuator with the help of gravity.The foot of the leg was considered to be a rigid body attached to the shank at this stage. The foot profile is circular and the foot reference point is at the centre of the circle. The foot is to roll on the ground during walking. The radius of the foot circle depended on the soil conditions and is to be selected to provide proper contact pressure. The radius of 10mm is selected for a bare foot. Different shoes could be put on when the robot is operating in different soil conditions. The leg of a walking machine serves to provide a desired working volume, which is the three-dimensional reachable work space of the foot reference point. The second is to carry the weight of the vehicle. Also, interference between links and among legs should be avoided. Considering these three aspects, the design specification of the four bar leg is determined.

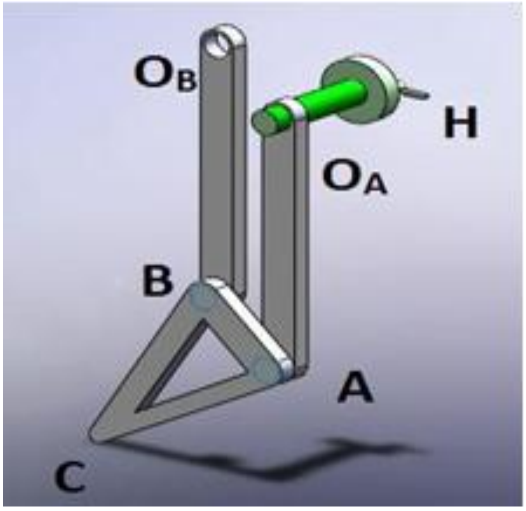


Fig.9-The above figure is the model of legged robot

Leg strokes

The stroke pitch was selected to be 120mm since the predetermined maximum length of the vehicle was 300mm. Hence, the leg stroke was selected to be 80mm in ordered to avoid any interference between the feet. The vertical stroke is originally used to lift the foot in transfer phase only. Hence, a small amount of vertical stroke, such as 14mm, was sufficient. This was suitable for walking on smooth terrain only. Later, the vertical stroke was increased to 40mm in ordered to be able to walk in rough terrain. After the mobility requirement was finally determined, the vertical stroke was increased to 80mm to satisfy the requirement of vertical step crossing ability. While the vehicle is walking in a tripod wave gait, a four foot stroke results in less than one Hertz cycling frequency at cruise speed, which is 170mm/seconds. If the feet contact the ground at different times, the height of each supporting leg will be different due to this vertical variation. This different leg height will contribute to undesired pitching and rolling of the vehicle and will result in energy losses. Therefore the vertical variation should be as small as possible.

Loads

When the centre of gravity is kept in the centre line of the support pattern, the supporting legs on each side bear half the vehicle weight. In an alternating tripod gait at any time, one side of the robot is supported by only one leg. In this case, the maximum vertical load on that leg is half the vehicle weight. Hence, the leg has to be able to take a vertical load of 1/3 in its working volume. The maximum horizontal load was taken to be the longitudinal components of half the weight when the vehicle is walking on a 5% slope. The leg bears lateral load when it is abducted or adducted.

Leg size

The dimension of the leg was determined according to stroke pitch; the maximum width in the longitudinal direction for one leg to move between its two extreme positions is about 99mm in order to avoid interference between legs. The maximal leg height is determined to be 168mm. Since the foot radius is about 10mm, a leg height of 155mm is used for the linkage synthesis. The leg thickness should be as small as possible and the maximum thickness is temporarily determined to be 20mm.

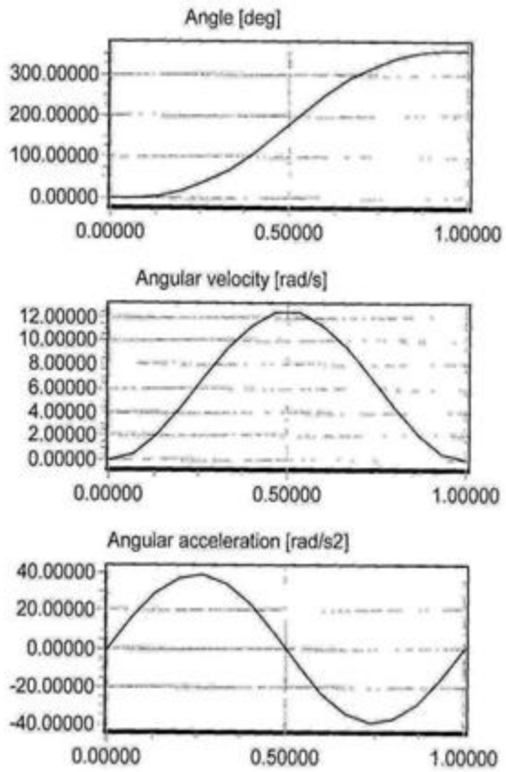


Fig.10- Sinusodial motion

Fig.11- Theo Jansen four leg walking robot by using 8 bar mechanism

Geometric Design

A general construction of a walking machine with four bar legs figure 9 is shown. The entire leg below the hip joint is composed of a four-bar linkage. The thigh is the two cranks and the shank is the coupler. The primary objective was to design a four-bar linkage with a foot point (a point in the coupler) moving along a good approximation to a level straight line relative to the body SAM. Since close approximation of a straight line is required, a large number of design positions should be used. Five position synthesis does not allow the designer to optimizer the solution linkage. Hence, a four position synthesis is proper for this design. Another reason for using four position synthesis is that it results in a relatively symmetric trajectory of the foot point, while a three position specification usually results in an asymmetric foot trajectory.

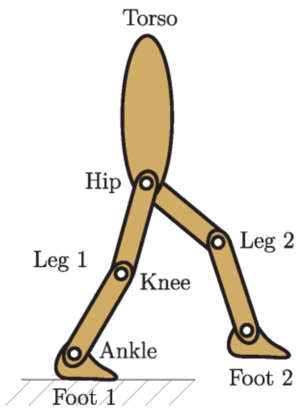


Fig.12- Structure of Walking Robot leg

6. DESCRIPTION ABOUT 8 BAR LINKAGE

An eight-bar linkage is a one degree-of-freedom mechanism that is constructed from eight links and 10 joints. These linkages are rare compared to four-bar and six-bar linkages, but two well-known examples are the Peaucellier linkage and the linkage designed by Theo Jansen for his walking machines.

Classification of eight –bar linkages: Eight-bar linkages are classified by how many binary, ternary and quaternary links that they have. A binary link connects two joints, a ternary link connects three joints and a quaternary link connects four joints. There are three classes of eight-bar linkage denoted (4, 4, 0, 0), (5, 2, 1, 0) and (6, 0, 2, 0), distinguished by the count of binary, ternary and quaternary links, when read from left to right---the final zero is traditionally added to the class label though no eight-bar linkage has a quintanary link.

There are sixteen different topologies of eight-bar linkages which are distinguished by their non-isomorphic linkage graphs. Of these 16 topologies, nine are in class (4, 4, 0, 0), five are in (5, 2, 1, 0) and two in (6, 0, 2, 0).

The peaucellier linkage: The Peaucellier linkage is an eight-bar linkage constructed from hinged joints that traces a pure straight line from a rotary input. It is named after Charles-Nicolas Peaucellier (1832–1913), a French army officer, and Yom Tov LipmanLipkin (1846–1876), a Lithuanian Jew and son of the famed Rabbi Israel Salanter. This linkage clearly consists of eight bars when the ground frame is counted as a bar. The Chebychev–Grübler–Kutzbach criterion shows that an eight-bar linkage must have 10 single degree-of-freedom joints, while the Peaucellier linkage appears to have only six hinged joints. This is resolved by noting that four of the hinged joints each connect three bars. This is considered to be a special case of two joints that are located in the same place. Thus, six plus four provides the 10 one degree-of-freedom joints. The Peaucellier linkage is a (4, 4, 0, 0) eight-bar linkage, which means four of the bars have two joints and four bars have three joint

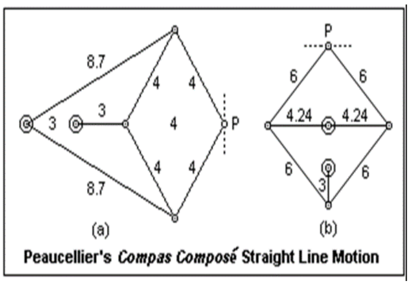


Fig: 13 – Peaucllier's Diagram

The dimensional synthesis of planar eight-bar linkages with a sliding base joint can be accomplished by constraining two RR chains to a parallel robot formed by a serial PRR and 3R chain. The selection of a parallel robot allows the designer to choose the two connections to ground and two connections on the moving workpiece, and a PRR-3R parallel robot provides the structure for prismatic actuation. Due to practical reasons, we choose not to connect any additional links to the prismatic joint and avoid a third ground pivot. Our dimensional synthesis process proceeds in three steps. Given five task poses, we first identify a PRR-3R parallel robot that reaches those poses. Inverse kinematics analysis of the parallel robot yields the configuration of the robot in each of the five poses. This allows us to compute the five relative poses of any pair of links in the chain. The second step is to choose two links in the parallel robot and compute an RR chain that constrains their relative movement to that required by the five task poses. Denote the ground link as B0, the three links of the PRR chain can be labelled as Bi, i = 1, 2, 3 and the 3R chain as Bi, i = 4, 5, 6. Because we cannot constrain two consecutive links within the PRRRRR loop and we choose not to constrain any links to the prismatic joint or to the ground, this leaves three cases: i) B2B4, ii) B2B5 and iii) B3B4. The introduction of this RR chain adds a link to the system that we will denote as B7.The third step consists of adding a second RR chain. The second RR constraint can be attached to the original parallel robot or to the newly formed link. In the first case, we found that four eight-bar structures could be designed this way. Figure 3 shows the various eight-bar structures that result from independent RR constraints to the parallel robot. We label these structures by denoting Bij as the RR constraint connecting Bi and Bj . For example, a B24B25 would have RR constraints between B2 and B4 as well as B2 and B5. We now consider the case where an RR constraint is connected to the new link B7.

7. SYNTHESIS OF MECHANICALLY CONSTRAINED 8-BAR LINKAGES

The planar parallel robot consists of single loop six bar chain which has two fixed links including its base. This system can be mechanically constrained by adding two links and four revolute joints to maintain its degree of freedom. Therefore, the appropriate attachment of two RR chains results in a planar eight-bar linkage with ten revolute joints forming a one degree-of-freedom system. The two RR chains must be added in such a way that the system remains with only two fixed joints and also it should contains no locked chains. The corresponding graph should be modified by adding two vertices and four edges to the initial graph that represents the planar parallel robot.

Graphical Enumeration for 8-bar chains

Considering all ways in which two vertices and four revolute joints may be added. One of the four revolute joints may connect links 7 and 8. The arrangement, in this case, is called dependent link connection. If there is no revolute joint will connect links 7 and 8, the arrangement is called independent link connection.

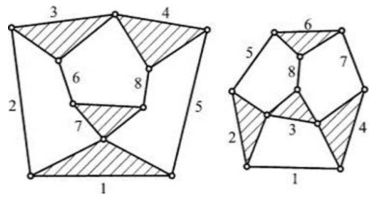
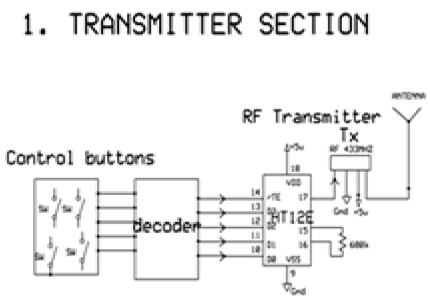


Fig.14- 8 bar Mechanism

8. PROJECT DESCRIPTION:



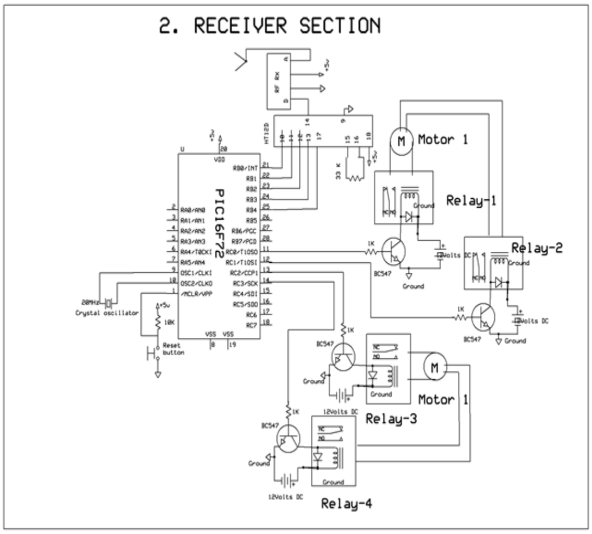


Fig.15- schematic diagram of FABRICATION OF MECHANICAL WALKER ROBOT USING WIRELESS RF REMOTE

The above schematic diagram FABRICATION OF MECHANICAL WALKER ROBOT USING WIRELESS RF REMOTE the interfacing section of each component with micro controller and DC motors module. The crystal oscillator connected to 9th and 10th pins of micro controller and regulated power supply is also connected to micro controller and LED's also connected to micro controller through resistors and motor driver connected to micro controller

The detailed explanation of each module interfacing with microcontroller is as follows:

Interfacing crystal oscillator with micro controller:

Fig 5.2: explains crystal oscillator and reset button which are connected to micro controller. The two pins of oscillator are connected to the 9th and 10th pins of micro controller; the purpose of external crystal oscillator is to speed up the execution part of instructions per cycle and here the crystal oscillator having 20 MHz frequency. The 1st pin of the microcontroller is referred as MCLR ie.., master clear pin or reset input pin is connected to reset button or power-on-reset.

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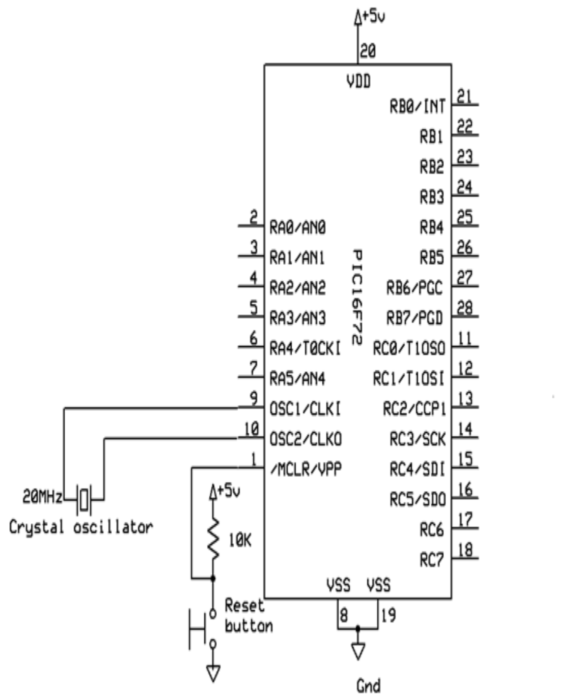

Fig.16- crystal oscillator interfacing with micro controller

Interfacing DC Motor Driver to Microcontroller:

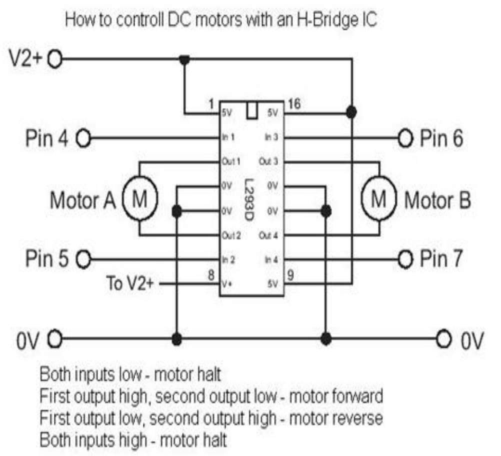

Fig.17- Schematic Diagram of DC Motor Driver for Interfacing to Microcontroller

From the figure we can conclude that the DC Motor is not interfaced directly to the micro controller. It is interfaced through its driver L293D .As shown in the above figure L293D is a 16 pin IC in which the two motors are connected to pins 3,6,11,14of L293D and in turn the L293D is connected to Microcontroller to its Pins 4,5,6,7(Port A). If the both the inputs to the Motor Driver is Low and high the motor is in halt position. If the first output is high, Second output is low then DC Motor moves forward .If the first output is low, second output is high as shown in the above figure then DC Motor moves reverse. Here the pins of motor driver that is four input pins i/p1,i/p2,i/p3,i/p4 and heat sink pin and enable1 and enable2 pins and ground pin and vs pins are connected to micro controller pins c0,c1,c2,c3,d0,d1, ground, vdd respectively, here L293D is the motor driver and its having one 'H' bridge inbuilt to handle two motors by using two enable pins.

9. ADVANTAGES:

1. Wireless controlling of robot.
2. Wireless control of robot directions and movement.
3. Eight bar mechanism for walking robot
4. Fast response.
5. Efficient and low cost design.
6. Low power consumption.

10. DISADVANTAGES:

1. Limited distance using RF wireless.

11. APPLICATIONS:

1. Can be used to detect persons in restricted areas.
2. Can be used in mines.
3. Can be used to detect terrorists in buildings.

12. RESULT: The project "4 LEGGED WALKING ROBOT USING 8 BAR MECHANISM" was designed such that the robot can be operated using wireless RF technology.

13. CONCLUSION:

Integrating features of all the hardware components used have been developed in it. Presence of every module has been reasoned out and placed carefully, thus contributing to the best working of the unit. Secondly, using highly advanced IC's with the help of growing technology, the project has been successfully implemented. Thus the project has been successfully designed and tested.

14. FUTURE SCOPE

Our project "4 LEGGED WALKING ROBOT USING 8 BAR MECHANISM" is mainly intended to control a robot using wireless remote RF. This project has a RF technology to control the robot wirelessly and a robot which are interfaced to the micro controller.

The micro controller is programmed in such a way that the robot can be operated using RF technology. An eight-bar linkage is a one degree-of-freedom mechanism that is constructed from eight links and 10 joints. These linkages are rare compared to four-bar and six-bar linkages, but two well-known examples are the Peaucellier linkage and the linkage designed by Theo Jansen for his walking machines. This project makes use of an onboard computer, which is commonly termed as micro controller. It acts as heart of the project. This onboard computer can efficiently communicate with the output and input modules which are being used. The controller is provided with some internal memory to hold the code. This memory is used to dump some set of assembly instructions into the controller. And the functioning of the controller is dependent on these assembly instructions. This project can be extended using ZigBee technology, which increases operating wireless distance. Also a video camera can be used get the photos of the person being detected. In future we can use this project in several applications by adding additional components to this project. By connecting wireless camera to the robot, then we can see the outer world from our personal computer only by using GPRS and GPS. We can use this robot at so many fields and we can use to handle so many situations. By connecting bomb detector to the robot, we can send it to anywhere i.e (battle field, forests, coal mines, to anyplace) by using our personal computer and we can able to detect the bomb at field, here sensor detects the bomb and gives information to micro controller and it gives the information to transceiver and it sends the information to the personal computer. By connecting temperature sensor to the robot we can get the temperature of dangerous zones in personal computer itself instead of sending human to there and facing problems at field we can send robot to there and sensor will detect the temperature and it gives information to the micro controller and micro controller gives the information to the transceiver from that we can get the data at pc side. By connecting smoke sensor to the robot we can get the information related concentration of smoke or gases in respective field's i.e. (coal mines, dangerous zones, etc.). Sensor sense the information and it give to the micro controller and it gives to the transceiver and from that we get the information in personal computer. By connecting corresponding instruments to the robot we can use it in agriculture for farming purpose. This robot can move either forward and backward and left and right depend upon our instructions so we can do some part of agriculture from pc only by using robot. By connecting firing instrument and wireless camera to the robot we can fire the target from pc. Here by using camera we can see the opposite target and we can fire the target from personal computer by pressing selected button and we can easily handle the situations like Mumbai terrorist's attack without loss of human life's and we can decrease our soldiers effort too.

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