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Design and Construction of Hexapod (Six Legged) Robot

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Abstract - The configuration and control of Hexapod is portrayed as, a force Semi - independent, untethered, consistent legged hexapod robot. This sort of robot has six actuators — one engine situated at every hip — accomplishing mechanical effortlessness that advances dependable and powerful operation in certifiable errands. Experimentally steady and profoundly flexibility motion emerges from an extremely basic clock-driven, open-circle tripod stride. A broad suite of test results reports the robot's noteworthy "inherent portability" — the traversal of rough, broken and impediment ridden ground with no landscape detecting or effectively controlled adjustment. Robot accomplishes quick and strong forward velocity venturing out at rates up to one body length for every second and crossing tallness varieties well surpassing its body leeway. In this paper current condition of numerous strolling robots are looked at and focal points of a legged frameworks against wheeled robots are depicted. In this exploration work a six legged robot is chosen which is organically propelled by bugs. The six legged robot has been intended to explore smooth and sporadic landscape. Mechanical autonomy has acquired from nature with differing degrees of deliberation, from physical appearance to watched practices. This paper depicts the proposed configuration and development for the six legs, typically called as hexapod robot to explore on the uneven territory. This sort of outline will satisfy the necessity of a reconnaissance and security robot, military robot for distinguishing mines and conveying burden, and investigation robot.

Keywords–*Hexapodrobot, design,wireless control, 3d modeling.*

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I) INTRODUCTION

There are a wide range of sorts of strolling robots from bipeds of various joint setups and knowledge, to strolling creature like quadrupeds, numerous legged creepy crawly styles and even snake copying robots. The essential parts of a robot are: 1. Moving parts that perform an activity like arms and legs. 2. An actuator to control moving parts and sensors to distinguish environment. 3. A control framework that settles on choices and neglects the general operation.

A. Sorts of Walking Robots

Strolling robots can be actualized in different designs. Every leg can have 2 degrees of opportunity or more. Likewise, the quantity of hub is specifically identified with the mobility of a robot's headway.

1) Two-legged Walker: A two-legged walker/biped is, by a long shot, the hardest to make. Since at the purpose of step one and only foot will be in contact with the ground, and the focal point of gravity should powerfully move to keep the robot from falling over. Whilst neither as effective nor as straightforward as the wheeled or a followed vehicle, the potential for intersection more troublesome landscape is central. A block can simply be ventured over, go between the legs. In any case, there is no repetition in the legs. In the event that one leg fizzles, the robot can't stroll by any stretch of the imagination.

2) Four-legged Walker: A four-legged walker/quadruped is genuinely regular. An illustration of an economically accessible quadruped is the Sony Aibo. A quadruped is less complex to control then a bipedal robot thus long as stand out leg is ever off the ground no advanced parity is required. In any case, a 4 legged robot does not offer any excess in the legs. In the event that a leg comes up short, the robot loses the capacity to walk.

3) Six-legged Walker: The six-legged walker/hexapod is exceptionally steady. A planner can outline a walk that can take three legs off the floor at any one time leaving a steady tripod. A hexapod is useful for complex landscape, and alongside quadrupeds, it is the most widely recognized legged structure robot.

4) Walker with Over Six Legs: This type of robot offers phenomenal strength and repetition in the components. The primary issue with this robot is just the additional cost brought about from actualizing the extra legs. Legged hexapod robots are programmable robots with six legs connected to the robot body. The legs are controlled with a level of self-governance so that the robot can move inside its surroundings, to perform expected assignments. Hexapod

robots can be suitable for physical and space applications, and OPEN ACCESS Robotics 2014, they can incorporate elements, for example, omnidirectional movement, variable geometry, great solidness, access to differing territory, and shortcoming tolerant velocity. One of the rousing elements frequently given for seeking after the advancement of hexapod robots is that they can move over snags bigger than the proportional estimated wheeled or followed vehicle. Indeed, the utilization of wheels or crawlers restricts the extent of the impediment that can be moved to a large portion of the breadth of the wheels. In actuality, legged robots can overcome hindrances that are practically identical with the extent of the machine leg. Hexapod strolling robots likewise profit by a lower sway on the landscape and have more prominent versatility in normal environment. This is particularly vital in hazardous situations like mine fields, or where it is key to keep the landscape to a great extent undisturbed for experimental reasons. Hexapod legged robots have been utilized as a part of investigation of remote areas and antagonistic situations, for example, seabed, in space or on planets in atomic force stations, and in pursuit and salvage operations. Past this sort of utilization, hexapod strolling vehicles can likewise be utilized as a part of a wide assortment of undertakings, for example, woodlands gathering, in help to people in the vehicle of freight, as administration robots and excitement. [1]

II) DESIGN

The design is inspired from spider. Normally spiders have 8 legs but to make it less complicated, 6 legs have been used and for aesthetic reasons. The design is done using software SolidWorks 2014. The material used is Acrylic sheet instead of metals since metals would have increased the self weight and also the cost factor. Acrylic sheets are lightweight, hard and glass type which is perfect to camouflage in different surroundings if used for defence purposes. And the use of glass type material would add to the future scope of being power by solar. The robot has 3 legs on either side for stability. The Leg consists of 2 joints 1)Hip 2) Knee. A motor is attached to the Hip joint for the to and fro motion or horizontal movement. The Knee joint with a motor helps in lifting the leg or for the vertical movement. To achieve the desired design, softwares used are listed below:

Software Requirements
1)Solid works for designing components
2)Keil for Uc programming
3)Diptrace for PCB layout
4)UcFlash to burn Uc code
5)Arduino c c & embedded c for programming

TABLE I Hardware Components List

Sr no.	Component	Function	Specification	Quantity
1	Micro-controller	Provide control on the remote side	-AT89S52 -CMOS 8bit -8k bytes of flash -256 bytes of RAM -32 I/O lines	1
2	Motor driver	To amplify current and inturn drive the motor	-L293D IC - Dual H-bridge -16 Pin	3
3	Servo motor	For movement of leg joints	-Operating voltage: 4.8 to 6V -speed:0.18 sec/ 60° at 4.8V, no load & 0.16 sec/ 60° at 6V, no load -torque: 15kgcm at 4.8V & 16.1kgcm at 6V - weight: 56 g	12
4	Wireless trans receiver module	To transmit and receive information	-Wireless device -range: 50m -frequency: 2.45GHz	2
5	Arduino Mega	Provide control on the robot side	-operating voltage: 5V -input voltage: 6-20V -digital I/O pins: 54 -Analogue pins: 16 -flash memory: 128KB -clock speed: 16MHz	1

A) Theory of H Bridge [2]

The name "H-Bridge" is derived from the actual shape of the switching circuit which control the motion of the motor. It is also known as "Full Bridge". Basically there are four switching elements in the H-Bridge as shown in the fig.1

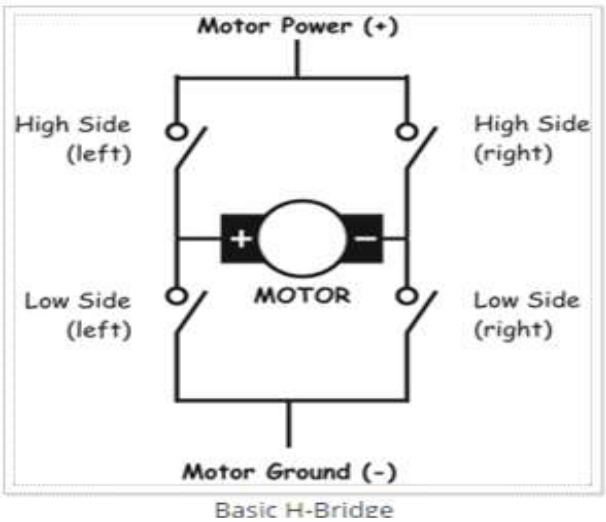

Fig. 1 H-bridge construction

As you can see in the figure above there are four switching elements named as "High side left", "High side right", and “Low side right", "Low side left". When these switches are turned on in pairs motor changes its direction accordingly. Like, if we switch on High side left and Low side right then

motor rotate in forward direction, as current flows from Power supply through the motor coil goes to ground via switch low side right. This is shown in the fig.2

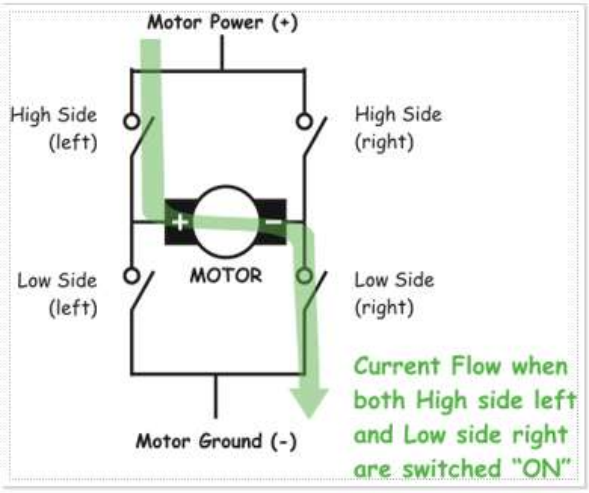

Fig. 2 working of H-bridge

Similarly, when you switch on low side left and high side right, the current flows in opposite direction.And motor rotates in backward direction. This is the basic working of H-Bridge.

B) 3D modelling of components

Having considered the software and hardware requirements, different parts of the hexapod robot are designed using solidworks 2014. The main components that form the body of the robot are as listed below.

1) Tibia: Also known as the shinbone or the shank bone, it is one of the larger and stronger portions of the leg.it are situated below the knee joint. It bears most of the weight of the robot structure. The design of tibia is as shown in fig. 3.

fig.3 Tibia (using solidworks 2014)

2) Femur: Also known as the thighbone, it is the most proximal (closest to the centre of the body) portion of the leg. It is the strongest portion of the body. The design of femur is as shown in fig. 4.

fig.4 Femur (using solidworks 2014)

3) Base: It is the main body of the robot situated on top of the legs. It consists of the the complete circuit board; i.e. it is the brain of the robot. The circuit board is to be sandwiched between two base plates. The outside design structure of the base is as shown in fig. 5.

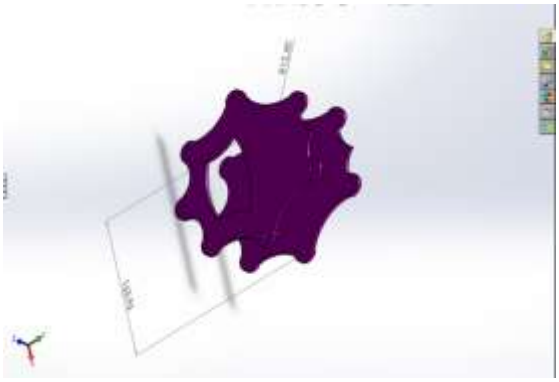

fig.5Base (using solidworks 2014)

4) Assembly of leg: The parts discussed above, namely tibia and femur, are joined together and a motor is attached for movement of legs. The final assembly of leg is as shown in fig. 6.

fig.6 assembly of leg (using solidworks 2014)

III) METHODOLOGY AND WORKING

Hexapod can acquire a large number of capabilities in its behavioural repertoire. In fact, it is the only robot that is

capable of performing such a wide variety of behaviours as a single robot. This performance is due to the significant amount of inspiration from the study of biological systems, leading to a number of principles underlying robot design.The use of legs instead of wheels or tracks opens the way for a large number of behaviours. Passive compliance in the legs overcomes limitations of under actuation and helps simplify mechanical design, yielding robustness. Sprawled posture, inspired from insects, results in passive stabilization of lateral motion.Control is open-loop at the gait level, but closed loop at the task level. Stability comes as a result of passive mechanics, not high-bandwidth active control.[3]

Hexapod can be capable of performing the following, mostly open-loop behaviours

- Running on reasonably flat, natural terrain at speeds up to 5 body lengths per second
- Climbing a wide range of stairs
- Climbing slopes up to 45 degrees
- Traverse obstacles as high as 20cm (about twice RHex's leg clearance)
- Continuously run with an efficient gait
- Successfully traverse badly broken terrain with large rocks and obstacles
- Walk and run upside down
- Flip itself over to recover nominal body orientation
- Leaping across ditches up to 30cm wide
- Support remote control from up to 60m distance

IV) RESULTS

The complete assembly of hexapod robot made in solid works 2014 is as shown in fig. 7. It has 12 servomotors. Each leg has two servomotors. The body and legs of the robot are made from acrylic sheet.

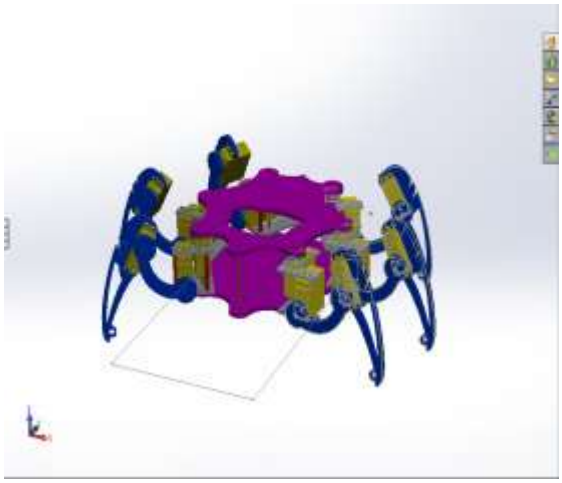

Fig. 7 Assembly of hexapod robot(using solidworks 2014)

The six legged robot has been designed to navigate smooth and irregular terrain. Empirically stable and highly manoeuvrable locomotion arises from a very simple clock-driven, open-loop tripod gait.The hexapod robot is advantageous in many ways. It is a low weight,low cost,low maintenance project. The fabrication time is comparatively less. It can effortlessly climb stairs. Due to having six legs, it can Easily walk on rough terrain surface.

Hexapods are additionally better than wheeled robots in light of the fact that wheeled robots require a consistent, even and frequently a pre-developed way. Hexapod robots however can cross uneven ground, venture over deterrents and pick solid footings to augment security and footing. While wheeled robots are speedier on level ground than legged robots, hexapods are the quickest of the legged robots, as they have the ideal number of legs for strolling speed - considers have demonstrated that a bigger number of legs does not build strolling speed.

Simple pins can be utilized to include different sensors the robot, for instance, it can be utilized for distinguishing mines amid war, subsequently lessening loss of human life. It can likewise be utilized to transport things starting with one place then onto the next inside an industry i.e. picks and place robot. Cameras can be appended to the robot, which can in turn act an observation and security robot. It can be utilized to film areas or investigate places where people can't go. [4][5]

In future, certain changes can be made to the robot, for example, the hexapod ought to have the capacity to recognize even and uneven territory. On even landscape, it ought to utilize tripod step for strolling and on uneven territory, it ought to utilize wave stride. The Arduino Mega ADK board can interface with Android telephones. The hexapod can be controlled from an android telephone or from a tablet by means of Bluetooth or Wi-Fi.

V) CONCLUSIONS

The outline gathering and development of the robot is effectively accomplished. The robot is made simple to program as further movements and sensors can be included expanding the preferences and elements of the robot. The hexapod robot is a naturally motivated robot which emulates the strolling walk of a bug. Robot accomplishes quick and strong forward movement making a trip at paces up to one body length for each second and navigating stature varieties well surpassing its body leeway.

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