# Obstacle Avoidance by Spider

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*Abstract*— The main goal of this paper is to design a hexapod robotic system. This paper also presents a dynamic steering algorithm which ensures that the robot doesn't stop in front of an obstacle. Robot detects an obstacle in front of it and avoiding collision. Hexapod robots are the most typical walking robots that imitate the limb structure and motion control of insects or arthropod animals, and that can walk in unstructured terrain with a high probability of success, even if a limb is lost. These important advantages make it reliable for some autonomous and high-reliability works, like field scouting under water searching, space exploring, disaster areas, rigs, excavations, and many other applications.

***Key words:*** Robotic System Architecture, Field and Service Robotics, GA, GSA, Insect

## I. INTRODUCTION

The aim of this project is to design develop a hexapod robot which can be easily controlled by IR sensor. Robotics is the branch of technology that deals with the design, construction, operation, and application of robots. A machine capable of carrying out a complex series of actions automatically, esp. one programmable by a computers is defined as a robot. And, Obstacle avoidance refers to the ability of a robot to detect obstacles in its way if there are any and thus make its own obstacle free path. The first thing that comes to mind when thinking of a robot ,is a machine that imitates a human - like the robots in comics movies, and many of these robots captured our imagination. People still haven't been able to give robots enough common sense to reliably interact with our world. Robots encounter by humans are the ones that do work which is too dangerous, dirty or even boring. And these types of robots can be found in Auto, Manufacturing, Medical and space industries. And other robots like Mars Rover and Caribou explore places that are too dangerous for humans to reach. While other types of robots are educational and Plain fun like Teckno ,and NAO. There are different types of legged walking robots. They can be roughly divided into groups according to the number of legs they posses. Bipeds have two legs, quadrupeds four, hexapods six and octopods have eight legs. Biped robots are dynamically stable, but statically unstable, such robots are harder to balance, and dynamic balance can only be achieved during walking. Hexapods or six-legged robots, on the other hand, have advantage of being statically stable. The Hexapod is an insect inspired robot which has six legs that enables it to move flexibly on various terrains. The main advantage of this type of robot is its stability. Unlike bipedal robots, this robots is statically stable; therefore they don't have to depend on balance mechanisms. Although it needs feedback and positive reaction to acquire smoother walk.

### *A. Problem Identification*

In this work, we design a virtual prototype model of a obstacle avoidance hexapod robotic system. The merits of this hexapod configuration consist of walking control of a hexapod easier than that of a biped robot, and the model can adjust its gait and leg movements to compensate for changes due to load and obstacles on the surface. Newer gate locomotion will be developed by the analysis of human as well as insect's locomotion. The gaits should be as similar as possible to the biological locomotion of insects, so that this system will walk on any terrain surface as like insects.

### *B. Research Gap*

From the beginning of time scientists looked closely at nature's creatures in order to find solutions that could be implemented in manmade machines. Nature always pro-vided researchers with inspiration and innovative ideas, sometimes simple and effective, sometimes complex and cumbersome. One of the most common locomotion principles in nature is walking. One of the first walking machines was developed in about 1870 by Russian mathematician P. Chebyshev. This walking machine had four legs arranged in two pairs. The first patent for the walking mechanism was given in 1893 by US Patent Office to L.A. Rygg. During last decades research of biologically inspired ways of loco- motion, and biologically inspired robotics in general gained additional interest among scholars. Presently many scientists study different aspects of walking and walking robots around the world. In Oct 1989 J. Borenstein made Real-time Obstacle Avoidance for Fast Mobile Robots A new real-time obstacle avoidance approach for mobile robots has been developed and implemented. This approach permits the detection of unknown obstacles simultaneously with the steering of the mobile robot to avoid collisions and advancing toward the target. In August 1997 Atsushi Fujimori, Peter N. Nikiforuk, and Madan M. Gupta design a local navigation technique with obstacle avoidance, called adaptive navigation, is proposed for mobile robots in which the dynamics of the robot are taken into consideration. The only information needed about the local environment is the distance between the robot and the obstacles in three specified directions.

### *C. Motivation*

The control structure, implemented on obstacle detection and avoidance by six-legged robot, in which the aspects of stability, mobility, ground accommodation, gait generation, and robot heading are integrated in a coherent and simple way. The control of a legged robot walking on difficult terrain demands the development of efficient and reliable algorithms to coordinate the movement of multiple legs according to a diversity of requirements. This type of robot can be used for many application in real life, such as search and rescue application, environment exploration, and also as a CNC machine.

### *D. Objective of Study*

The main objective of this project is to develop Obstacle Detection and Avoidance by Robot, which helps to walk on any terrain surface as well as fault detection of same system.

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The main goal of the work presented in this project is to design a prototype of a hexapod robotic system. Nowadays tasks in which human presence may be avoided are increasing, such as rote and boring activities, work which imply a great danger and, consequently, very strict security rules (e.g. some of the work carried out in nuclear power-plants), and activities which occur in places where the human being can hardly get (e.g. spatial and underwater exploration). Nevertheless, robotic systems can be used in other fields as well. In order to reduce or avoid the human element it is essential to design and develop mobile robotic systems, which are able to undertake tasks that imply a great deal of danger. Therefore, alternative systems to deal with these tasks must be explored.

### *E. Scope of Study*

The Machine construction and components should be in accordance with power consumption and expected weight of the body. Most of the part in machine should be fabricated and electronics component.

## II. LITERATURE REVIEW

### *A. In Oct 1989, J. Borenstein made Real-time Obstacle Avoidance for Fast Mobile Robots*

A new real-time obstacle avoidance approach for mobile robots has been developed and implemented. This approach permits the detection of unknown obstacles simultaneously with the steering of the mobile robot to avoid collisions and advancing toward the target. The novelty of this approach, entitled the Virtual Force Field, lies in the integration of two known concepts: Certainty Grids for obstacle representation, and Potential Fields for navigation. This combination is especially suitable for the accommodation of inaccurate sensor data (such as produced by ultrasonic sensors) as well as for sensor fusion, and enables continuous motion of the robot without stopping in front of obstacles.

### *B. In 1991, J. Borenstein and Y. Koren made Histogramic In-Motion Mapping For Mobile Robot Obstacle Avoidance -*

They introduces histogramic in-motion mapping (HIMM), a new method for real-time map building with a mobile robot in motion. HIMM represents data in a two-dimensional array, called a histogram grid, that is updated through rapid in-motion sampling of onboard range sensors. Rapid in-motion sampling results in a map representation that is well-suited to modeling inaccurate and noisy range-sensor data, such as that produced by ultrasonic sensors, and requires minimal computational overhead. Fast map-building allows the robot to immediately use the mapped information in real-time obstacle-avoidance algorithms. The benefits of this integrated approach are twofold: (1) quick, accurate mapping; and (2) safe navigation of the robot toward a given target.

HIMM has been implemented and tested on a mobile robot. Its dual functionality was demonstrated through numerous tests in which maps of unknown obstacle courses were created, while the robot simultaneously performed real-time obstacle avoidance maneuvers at speeds of up to 0.78 m/sec.

### *C. In Augest 1997, Atsushi Fujimori, Peter N. Nikiforuk, and Madan M. Gupta made Adaptive Navigation of Mobile Robots with Obstacle Avoidance -*

A local navigation technique with obstacle avoidance, called adaptive navigation, is proposed for mobile robots in which the dynamics of the robot are taken into consideration. The only information needed about the local environment is the distance between the robot and the obstacles in three specified directions.

### *D. In 2010 Vitor Matos, Cristina Santos and Ricardo Campos produced Hexapod Locomotion: a Nonlinear Dynamical Systems -*

The ability of walking in a wide variety of terrains is one of the most important features of hexapod insects. In this paper we describe a bio-inspired controller able to generate locomotion and switch between different type of gaits for an hexapod robot. Motor patterns are generated by coupled Central Pattern Generators formulated as nonlinear oscillators. Results from simulation using a model of the Chiara hexapod robot demonstrate the capability of the controller both to locomotion generation and smooth gait transition. The postural controller is also tested in different situations in which the hexapod robot is expected to maintain balance. The presented results prove its reliability.

### *E. In June 2011, Filipp Seljanko by Hexapod Walking Robot Gait Generation Using Genetic-Gravitational Hybrid Algorithm-*

He use the hybrid genetic gravitational algorithm for generation of the gait for the hexapod robot is described. Algorithm utilizes the features of Gravitational Search Algorithm (GSA) with operators from the Genetic Algorithm (GA).

### *F. In June 2011, Carausius morosus and William A. Lewinger made A Hexapod Robot Modeled on the Stick Insect-*

Robot builders have often used insects as a source of inspiration when designing their mechanical systems, due to their ability to easily navigate uneven terrain, overcome or avoid obstacles, and adjust gaits based on traveling speed. The only information needed about the local environment is the distance between the robot and the obstacles in three specified directions. The navigation law is a first-order differential equation and navigation to the goal and obstacle avoidance are achieved by switching the direction angle of the robot.

### *G. In September 2013, Vivek Hanumante, Sahadev Roy, Santanu Maity made Low Cost Obstacle Avoidance Robot -*

This paper deals with a low cost solution to obstacle avoidance for a mobile robot. This paper also presents a dynamic steering algorithm which ensures that the robot doesn't have to stop in front of an obstacle which allows robot to navigate smoothly in an unknown environment, avoiding collisions. The obstacle avoidance strategy has been described. Obstacle avoidance strategy and working of robot is greatly dependent on the detection of obstacles by sensors and corresponding response of robot. Working principle of sensors, limitation of their use and obstacle avoidance algorithm has been discussed in detail.

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## III. BLOCK DIAGRAM

The implementation of proposed system mainly involves two steps, obstacle avoidance and controlling direction of motor using PWM signal coming from arduino board. The block diagram of the system is shown in Fig. 1.

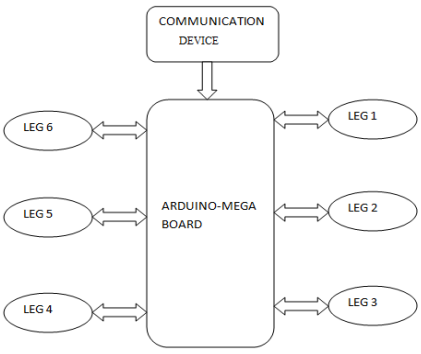


Fig. 1: Block Diagram

## IV. BLOCK DIAGRAM EXPLANATION

### *A. Power Supply Unit:*

When working with electronics, you always need one basic thing: Power. In every electronic circuit power supply is required. The proper working of each and every component, it is important to supply the exact amount of voltage and current. If the power exceeds its limit, it can be fatal.

It is possible to power the whole robot with only one 12v battery for the Arduino mega board as well as for both servo driver boards.

### *B. Servo Motor:*

A servo is a mechanical motorized device that can be instructed to move the output shaft attached to a servo wheel or arm to a specified position. Inside the servo box is a DC motor mechanically linked to a position feedback potentiometer, gearbox, electronic feedback control loop circuitry and motor drive electronic circuit.

Fig. 2: Servo Motor

*1) Specifications:*

- It is a Hitec HS-645MG High torque
- The current is 5mA.
- An operating voltage 4.8 volt or 6 volt.

### *C. Sensors for Obstacle Avoidance*

There are more varieties of sensor available those can be implemented for detection of obstacle. Some of the very most popular sensors are: Infrared sensors, Cameras which can be used as a part of Computer Vision, Sonar, LIDAR which can directly measure the distance Since reduction of cost is an important factor in the design of robot, we opted Infrared sensors for our low cost obstacle avoidance robot.

IR sensors provide the distance of objects directly in front of the sensor beam. An infrared sensor is an electronic device that detects infrared radiation in order to sense some objects of its surroundings. Infrared sensors can measure the heat of an object. This sensor can be used for most useful applications where no important ambient Infrared light is present.

*1) Types of IR Sensors:*

Infrared sensors can be passive or active. Passive infrared sensors are basically Infrared detectors. Passive infrared sensors do not use any infrared source and detects energy emitted by obstacles in the field of view. Active infrared sensors consist of two elements: infrared source and infrared detector. Infrared sources include an LED or infrared laser diode. Infrared detectors include photodiodes or phototransistors. The energy emitted by the infrared source is reflected by an object and falls on the infrared detector.

Fig. 3: IR Sensor

*2) Specifications:*

- Voltage range- 4.2 to 5 v
- Up to 15cm for proximity sensing
- Receives 38 kHz modulated signal
- 940 nm peak wavelength
- Photo detector and preamplifier in one package

### *D.* Arduino Mega Board

This is an open source and open hardware micro controller with an Atmel AVR processor (ATmega uno). The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, 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 a AC-to-DC adapter or battery to get started.

The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega8U2 programmed as a USB-to-serial converter.

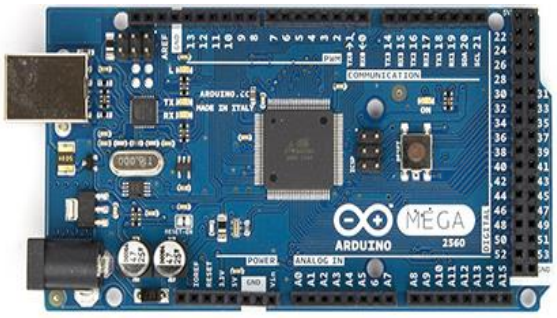


Fig. 4: Arduino Board

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## V. ALGORITHM - WORKING PRINCIPLE

Proper working of each and every component, it is important to supply the exact amount of voltage and current. If the power exceeds its limit, it can be fatal. It is possible to power the whole robot with only one 12v battery for the Arduino mega board as well as for both servo driver boards. Arduino Board is an open source and open hardware micro controller with an Atmel AVR processor (ATmega uno). It has four Tx/Rx pins that provide the proper interface between the microcontrollers. It has 14 PWM pins, 16 Analog input pins and 30 Digital pins. The IR sensor used, basically is of 'always ON' type. The sensor can be divided into two parts: Transmitter and Receiver. Transmitter has an IR LED (Tx), constantly emitting light and hence this sensor is known as always ON type. The second part, Receiver consists of a photodiode (Rx). Transmitter keeps on emitting IR light, when there is any obstacle in the front of sensor, the emitted light get reected .It receives at photodiode. The signal reected back then send to the arduino board and according to that control the direction of servo motor.

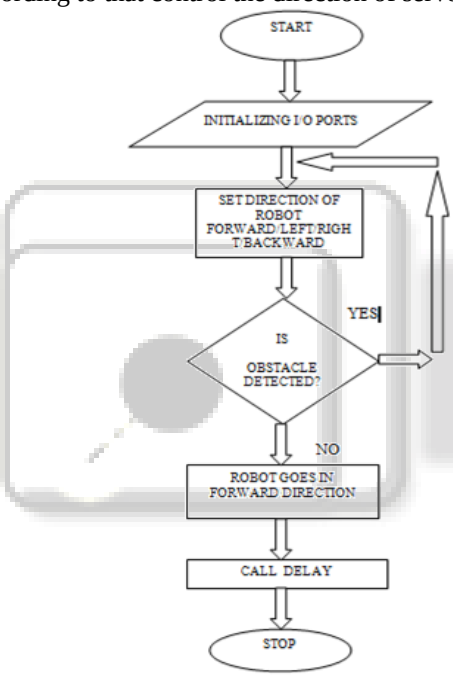


Fig. 5: Flow chart for obstacle avoidance strategy.

### A. *Interfacing of Servo Motor with Arduino Board*

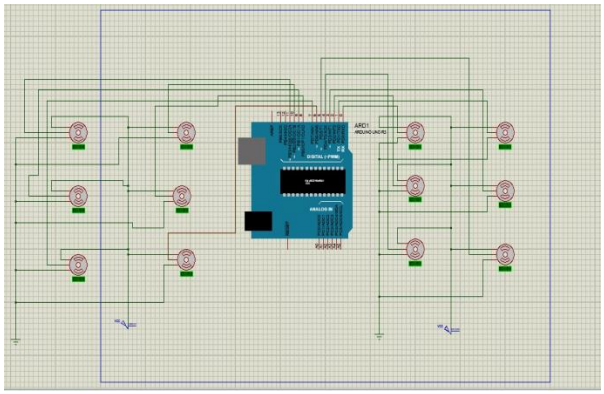

Fig. 6: Circuit Diagram Servo Motor

This is circuit diagram of 12 servo motor with arduino board. In this interfacing initially all servo motors are in zero position.

## VI. SOFTWARE

### A. *Arduino 1.0.6:*

The Arduino Mega can be programmed with the Arduino software The ATmega2560 on the Arduino MEGA ADK comes preburned with a boot loader (the same on Mega 2560) that allows you to upload new code to it without the use of an external hardware programmer. It communicates using the originalSTK500v2 protocol we can also bypass the boot loader and program the microcontroller through the ICSP (In-Circuit Serial Programming) header using Arduino ISP.

The ATmega16U2 (or 8U2 in the rev1 and rev2 boards) firmware source code is available in the Arduino repository. The ATmega 16U2/8U2 is loaded with a DFU boot loader, which can be activated by: On Rev1 boards: connecting the solder jumper on the back of the board (near the map of Italy) and then resetting the 8U2. On Rev2 or later boards: there is a resistor that pulling the 8U2/16U2 HWB line to ground, making it easier to put into DFU mode. You can then use Atmel's FLIP software (Windows) or the DFU programmer (Mac OS X and Linux) to load a new firmware. Or you can use the ISP header with an external programmer (overwriting the DFU bootloader).

## VII. ADVANTAGES AND APPLICATION

### A. *Advantages*

1) Hexapods are the fastest of the legged robots, as they have the maximum number of legs for walking speed.
2) Hexapods are also better than wheeled robots because wheeled robots need a continuous, even and most often a pre-constructed path. Hexapod robots however can traverse uneven ground, step over obstacles and choose footholds to maximize stability and traction.
3) Having maneuverable legs allows hexapods to turn around on the spot .
4) In comparison to other multi-legged robots, hexapods have a higher degree of stability as there are can be up to 5 legs in contact with the ground during walking. Also, the robots center of mass stays consistently within the tripod created by the leg movements, which also gives great stability.
5) Hexapods also show robustness, because leg faults or loss can be managed by changing the walking mechanism.
6) This redundancy of legs also makes it possible to use one or more legs as hands to perform tasks.

### B. *Applications*

- It can used for the army application.
- Obstacle sensing robot can be applied at the toys where small children will play.
- It can used for the army application.

## VIII. CONCLUSION

All navigation robot demands the some of obstacle detection in its path, hence obstacle avoidance strategy is importance. Obstacle avoidance robot is a vast field of application. They can be used as services robot, for the purpose of household work and so many other applications. They have great

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importance in scientific exploration and emergency rescue, there may be places that are dangerous for humans or even impossible for humans to reach directly, then we should use robots to help us.

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