

# Self Guided Adhvik Humanoid Robot

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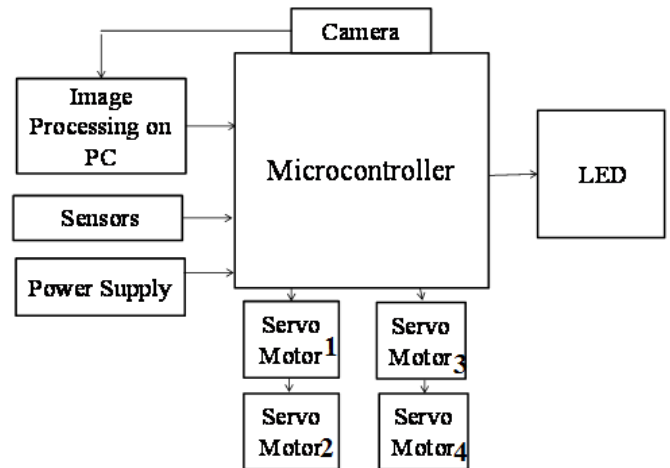
**Abstract:** This paper describes the walking pattern of our humanoid robot namely *Adhvik*. The robot possesses the characteristic of cheapest bipedal motion and is primarily used for object detection and path finding. For this purpose we are using four servo motors operating on the principle of servomechanism which are controlled by an Arduino development board comprising of Atmega8 microcontroller of Atmel series. The supplementary MATLAB software is used for image processing of the red coloured object dividing it into frames using a camera mounted on its head. The humanoid is controlled by a computer through wireless module CC2500. The software controls the real time walking of the robot.

**Index Terms:** cheapest bipedal motion, image processing, object detection, path finding, servomechanism, walking pattern, wireless module.

## 1 INTRODUCTION

THE Humanoid term generally refers to the robot which has the resemblance with that of the human being. Since the invention of robots, humanoid robots have always been enthralling and charming the people. In 1495, Leonardo da Vinci designed a mechanical structure like a humanoid which was able to wave its hands and move its head [1, 6]. By the time, ideas keep on triggering among the scientists to modify these structures to make humanoids as an embodiment of artificial intelligence. By the 18<sup>th</sup> century mechanical dolls were able to write short phrases, play drums etc. [2, 6]. One can now easily expect that applications of the robots will expand into our society in the 21<sup>st</sup> century. They work in human environment without a need to adapt themselves with the changing environment. They possess human like motion and have greater potential to survive in the changing environment than wheeled robots. It is just our small initiative step towards the manufacturing of humanoid robot to create the replica of ourselves which could be beneficial for our society. The self guided robot is made up acrylic and plastic material sheets properly designed using CNC machine. It is around 25 cm tall and weighing up to 500 gm. The robot has a simple design and it is assembled using four servo motors. The power supply of +5V from a cell mounted on pallet activates the microcontroller and a rechargeable battery provides +8V which is responsible for running of motors. After this, the robot detects the red coloured object placed at a distance of few metres from it with the help of a wireless camera and through image processing on computer it follows the object. This process involves wireless module. This communication is useful who wish to manufacture their own humanoids in future.

## 2 BLOCK DIAGRAM AND ALGORITHM INVOLVED



**Fig.1** Block diagram of Self Guided Humanoid Robot

From fig.1, the algorithm lying behind the working of self guided humanoid robot is provided step wise:

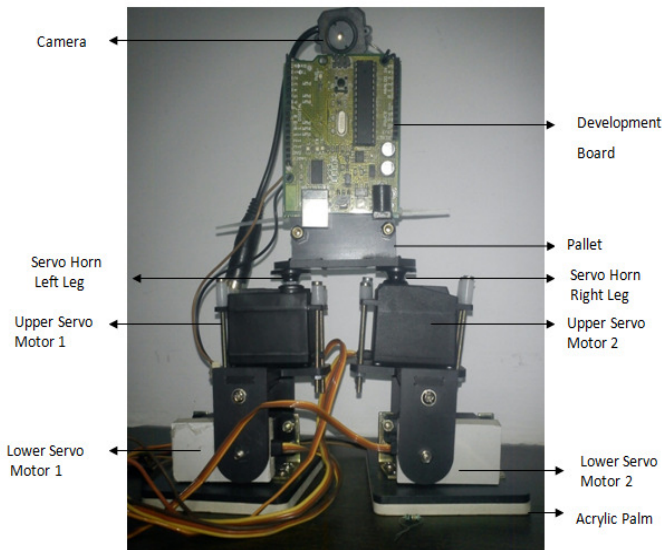
- Initially power supply of +5V is provided to microcontroller.
- Camera is mounted on top of humanoid.
- Detects the object present in the environment.
- Image is send to PC for image processing.
- ASCII value is send to microcontroller. 'f' for forward 'b' for right 'n' for left
- Servo motors acts accordingly.
- Humanoid walks in the object direction

## 3 HARDWARE DESCRIPTIONS

### 3.1 Mechanical Structure

The mechanical structure (fig.2) comprises of four servo motors, two for thigh motion and two for below knee motion. They are operated by the principle of servomechanism which is an error control feedback mechanism where angular movements produced by servo motors are constantly improved and thus they are more reliable than dc geared motors [3]. A pallet is mounted over motors that are fixed by using servo horn manufactured using CAD/CAM tool. Over the pallet the developed board is mounted in which microcontroller is present and a wired camera is also mounted through which image of the object is captured. In the mechanical structure, a total of four degrees of freedom are present.

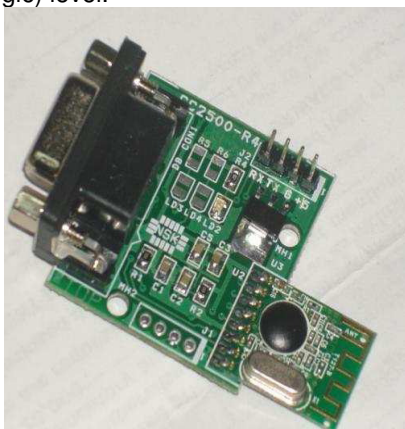
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**Fig.2** Self Guided Humanoid Robot

**3.2 Electronics components and Wireless module**

In this humanoid robot some basic electronic devices like resistors, Light Emitting Diodes, voltage regulator, electrolytic capacitors, etc. are present on development board which are responsible for desired power generation. The Atmega8 microcontroller is backbone of the board. The CC2500 (fig.3) is a low cost 2.4 GHz transceiver designed for very low power wireless applications. The circuit is intended for I.S.M. (Industrial, Scientific and Medical) and S.R.D. (Short Range Device) frequency band i.e. for 2400-2483.3 Mega Hz. The RF transceiver is integrated with a highly configurable base band modem. The modem supports various modulation formats and has a configurable data rate up to 500kBaud. CC2500 provides extensive hardware support for packet handling, data buffering bursts transmissions, clear channel assessment link quality indication [4]. It is responsible for converting RS232 (Recommended Standard 232) level into TTL (Transistor Transistor Logic) level.



**Fig.3** CC RF2500 Module

**4 SOFTWARE DESCRIPTION**

**4.1 MATLAB**

This software is used for processing of image of red object detected. The software is used for data visualisation &

computing and simulation of various physical problem statements.

**4.2 ARDUINO**

Arduino is a tool for making computers that can sense and control more of the physical world than desktop computer. It's an open-source physical computing platform based on a simple microcontroller atemga8 board, and development environment for writing software for the board [5].

**4.3 EAGLE**

Easily applicable Graphical Layout Editor Cad Soft computer software is widely acceptable for PCB designing. The development board is designed by using this software which involves the basic processes like drilling, etching, fabrication, soldering etc.

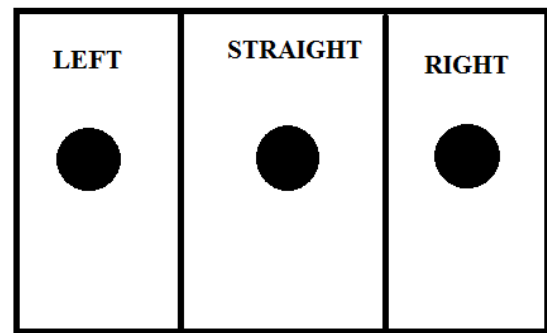
**5 AUGMENTING HUMANOID**

**5.1 Implementing Image processing**

The task is to move the humanoid in three directions: Left, right and Straight according to the position of the ball placed. The image of the ball is captured through camera (fig.4) and is divided into three frames (fig.5) and then humanoid moves accordingly.



**Fig.4** Image Capturing



**Fig.5** Object Detection



Fig.6 Humanoid Motion

### 5.2 Balancing challenge

It became quite tedious task due to the weight of board, camera, etc resulting inappropriate motion of the humanoid. To eradicate this problem, we placed batteries at either side of pallet giving a balanced motion to our robot [7]. One important term arises called as zero moment point theory which is defined as the point about which sum of the moments of all the active forces is zero. The humanoid is stable when zero moment point is within the contact points between the feet and the ground [6, 9].

### 5.3 Walking pattern

Unlike other complex bipedal robots, self guided uses only four servo motors for locomotion. The walking pattern of the robot involves the tilting of servo motors on each specific angle causing the rotary motion to be converted into linear motion. Our servo motor comprises of 16 steps each and each step has the angular motion of 10 degrees. Servo motors are rotated in the clockwise and in the anticlockwise directions to move feet in the appropriate direction. The instant when one foot is placed on ground, the upper and lower motors of other foot tilt (fig.6) allowing other foot to be placed on the ground [7].

### 5.4 Mathematical Equation

The gears present inside the servo motors have their own angular velocities and number of teeth. For two mating gears present in servo motors the angular velocity, number of teeth and the radius of gear are related as follows:

$$(\omega_A / \omega_B) = (r_B / r_A) = (N_B / N_A) \quad (1)$$

Where,  $\omega_A$  = angular velocity of gear A,  $\omega_B$  = angular velocity of gear B,  $r_B$  = radius of gear B,  $r_A$  = radius of gear A,  $N_B$  = Number of teeth of gear B and  $N_A$  = Number of teeth of gear A.



Fig.7 Gears

The gear A moves at higher angular velocity than B due to lesser number of teeth present on the former rather than latter. (fig.7) [3, 8]

TABLE NO. 1 – EXPERIMENTAL RESULTS

Robot Specifications	Result
Weight(gm)	~500
Height(cm)	~25
Degree Of Freedom	4
Camera	Wired 2MP @30fps
Main Board	Arduino Board
Battery	Li ion, 8V
Operating System In PC	Windows 7,8
Servo Motors	Drive shield V3.0
Price	15k

## 6 CONCLUSION

In this paper we described a way to augment a low cost bipedal humanoid robot in order to convert it to a tool for further modifications. For autonomy we attached a wireless module and the efficiency of controller board is sufficient not only for behaviour control but also for image processing. To allow visual feedback from the environment, we attached a colour camera [7]. The friction problems were not significant in project. Many humanoid research projects focus on human robot interaction. The space missions which are quite dangerous, there is a need to complement or replace the human beings by the human like robots to be sent in space for research purposes [6]. In 2013, AUTMan Robots participated in Robocup competitions [10]. Also, one can think of military robots too! The general conclusion here is that our culture of human - human communication allow also for intuitive human – machine communication.

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