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IoT BASED HUMANOID ROBOT

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ABSTRACT

This paperpresents the system configuration, basic control algorithm and functions of IoT basedHumanoid Robot. It works in the semi-autonomous mode. The robot consists of a torso, a head, two arms and two legs. These robotic arms and legs are each capable of independent motion.

This humanoid robot is powered by 13 Servo motors. It can be utilized in applications such as presentation of bouquets to guests, sweeping floors, precisely impersonating human actions, etc. The IoT system help in keeping a track of the battery and maintaining a record of the actions done by the humanoid robot.

Keywords*: Bipedal Robots, Humanoid Robot, Internet of Things.*

1. INTRODUCTION

The advancement of technology and sophistication in the field of automation and robotics has revolutionized every field of life. Machines that offer greater efficiency combined with the precision of the robotic systems are minimizing human involvement in dangerous areas and eliminating the limitations that bind the human body and brain. A humanoid robot is a robot with its body shape built to resemble that of the human body.

The development of bipedal humanoid robots began more than thirty years ago. A stable walking motion in a humanoid robot requires effective gait balancing and robust posture correction algorithms. Despite the several research efforts, it is still an extremely challenging task to develop and implement intelligent motion algorithms to control a bipedal humanoid robot, particularly with regards to adaptability, robustness and stability of the robot.

The task of making a humanoid robot walk is however not trivial one, since the system is a highly complex one, often with a large number of degrees of freedom. This is also what makes the area very interesting, and why many researchers have dedicated themselves to solve these challenging problems.

2. LITERATURE REVIEW

For control and balancing of bipedal robots, many studies and works were done from the 70s. Some of them are mentioned below, Vukobratovic [M. Vukobratovic et al., 1973] was one of the pioneers in studying bipedal locomotion. Miura [H. Miura, I. Shimoyama et al., 1984] developed the inverted pendulum model concept and applied it on bipedal walking [1]. The study of bipedal walking on rugged environment began in the early 90s. Since the late 90s, various control strategies and synthesizing methods to generate bipedal walking trajectories were initiated. They have enriched the bipedal research community and grow by leaps and bounds.

More recent humanoids will exhibit emotions and are able to 'learn while they walk' as they learn through autonomous interaction with the environment. One such robot is the ASIMO built by Honda [2].

3. BLOCK DIAGRAM

The hardware includes the different components that were used in the implementation of the humanoid robot. To move the robot, a number of actuators must be inserted. The system shown in Figure 1, consists of an on-board computer that controls the whole system and to control or command the robot, a controller is required.

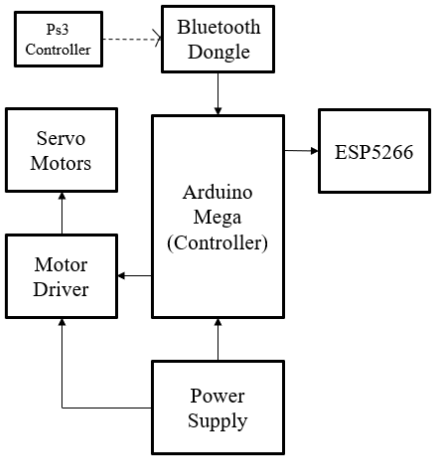

Figure1: Block Diagram of Humanoid Robot

3.1 Components Used

3.1.1 Arduino Mega: The Arduino Mega is a microcontroller board based on theATmega1280. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller.Here the pin numbers 2 to 13 and 44 to 46, provide 8-bit PWM output.

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3.1.2 ESP5266: The ESP5266 is a low-cost Wi-Fi chip with full TCP/IP stack and MCU (Micro Controller Unit) capability produced by Shanghai-based Chinese manufacturer, Espressif Systems. This small module allows microcontrollers to connect to a Wi-Fi network and make simple TCP/IP connections using Hayes-style commands.

3.1.3Actuator Control

An actuator is a type of motor that is responsible for moving or controlling a mechanism or system. It is operated by a source of energy, typically electric current, hydraulic fluid pressure, or pneumatic pressure, and converts that energy into motion. An actuator is the mechanism by which a control system acts upon an environment. The control system can be simple (a fixed mechanical or electronic system), software-based (e.g. a printer driver, robot control system), a human, or any other input. Actuators are of several types: Hydraulic, Pneumatic, Electric and mechanical.

3.1.4Servo mechanism

A servo system mainly consists of three basic components - a controlled device, an output sensor, a feedback system. This is an automatic closed loop control system. Here instead of controlling a device by applying variable input signal, the device is controlled by a feedback signal generated by comparing output signal and reference input signal.

When reference input signal or command signal is applied to the system, it is compared with output reference signal of the system produced by output sensor, and a third signal produced by feedback system. This third signal acts as input signal of controlled device. This input signal to the device presents as long as there is a logical difference between reference input signal and output signal of the system. After the device achieves its desired output, there will be no longer logical difference between reference input signal and reference output signal of the system. Then, third signal produced by comparing theses above said signals will not remain enough to operate the device further and to produce further output of the system until the next reference input signal or command signal is applied to the system. Hence the primary task of a servomechanism is to maintain the output of a system at the desired value in the presence of disturbances.

3.1.5Specifications of motors

The Ultra Torque motors have been used at the feet and at the hips, while the rest of the robot consists of High Torque Motors. Their specifications are as follows:

Table 1: Specifications of High Torque Motor

Required Pulse	3-5 Volt Peak to Peak Square Wave
Operating Voltage	4.8-6.0 Volts
Stall Torque	14kg/cm
Dimensions	41 x 20 x 36mm
Weight	48gm

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Table 2: Specifications of Ultra Torque Motor

Required Pulse	3-5 Volt Peak to Peak Square Wave
Operating Voltage	6V ~ 8.4V
Stall Torque	31kg/cm
Dimensions	40 x 20 x 40.5mm
Weight	64±1g

Table 3: Degrees of Freedom

Head	Neck Movement (Left/Right)	1x1=1
Arms	Shoulder Joints (Forward/Backward Rotation)	1x2=2
	Elbow Joints (Forward/Backward)	1x2=2
	Wrist Joints (Open/Close)	1x2=2
Legs	Crotch Joint (Forward/Backward Rotation)	1x2=2
	Knee Joints (Forward/Backward)	1x2=2
	Ankle Joints (Forward/Backward)	1x2=2
	Total	**13**

4. IMPLEMENTATION OF THE IoT BASED HUMANOID ROBOT

4.1 Hardware Implementation

The hardware schematic or the circuit diagram shown in Figure 2, was designed originally before the initialization of practical work. This schematic diagram was designed on the Fritzing Simulation Studio software. Software such as Proteus could not be utilized due to the lack of required Servo motor in it.

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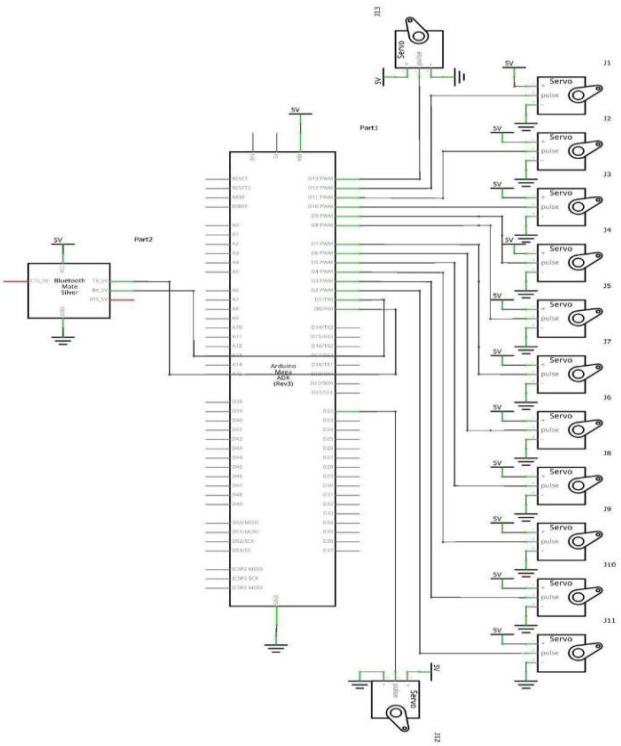


Figure 2: Hardware Schematic of the Humanoid Robot

4.2 Software Implementation

4.2.1 Arduino IDE

The Arduino integrated development environment (IDE) is a cross-platform application written in Java, and is derived from the IDE for the Processing programming language and the Wiring projects. It is designed to introduce programming to artists and other newcomers unfamiliar with software development. It includes a code editor with features such as syntax highlighting, brace matching, and automatic indentation, and is also capable of compiling and uploading programs to the board with a single click. A program or code written for Arduino is called a "sketch".

Arduino programs are written in C or C++. The Arduino IDE comes with a software library called "Wiring" from the original Wiring project, which makes many common input/output operations much easier. Users only need define two functions to make a runnable cyclic executive program:

setup(): a function run once at the start of a program that can initialize settings loop(): a function called repeatedly until the board powers off.

It is a feature of most Arduino boards that they have an LED and load resistor connected between pin 13 and ground; a convenient feature for many simple tests. The previous code would not be seen by a standard C++ compiler as a valid program, so when the user clicks the "Upload to I/O board" button in the IDE, a copy of the code is written to a temporary

file with an extra include header at the top and a very simple main() function at the bottom, to make it a valid C++ program. The Arduino IDE uses the GNU toolchain and AVR Lib to compile programs, and uses avrdude to upload programs to the board.

4.2.2 Servo Control Using potentiometer with Arduino

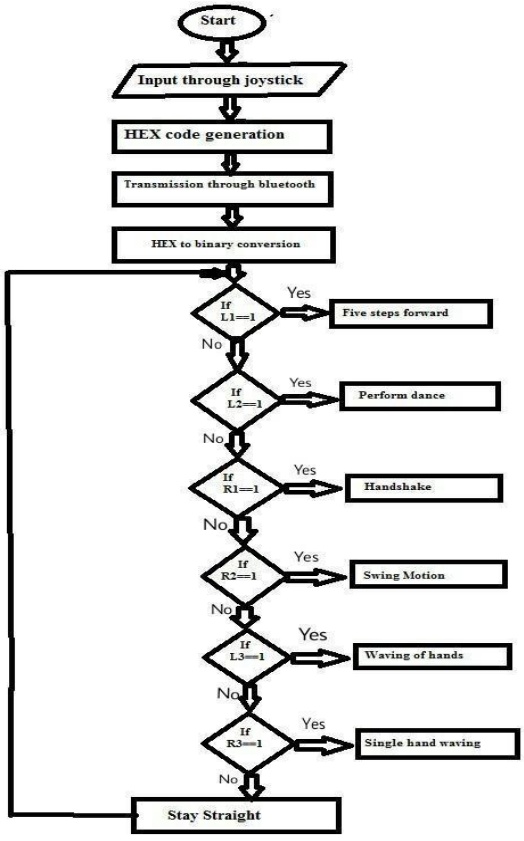
Algorithm

1. Start
2. Read the analog input (from 0 to 5v DC) coming from the potentiometer at pin number 0 of theArduino
3. Convert the analog value from analog to digital value ranging from 0-1024 i.e. 10-bit conversion
4. Map the digital value to the appropriate servo angle using the following table

Sensor Value	Servo Angle
0-255	0-180

Table 4: Prescaler to angle conversion

Flowchart



4.2.3 Robot walking algorithm

Making a Humanoid robot walk is the most difficult part of its design. A lot of testing was done on various algorithms for walking. After many practices runs, the following algorithm was finalized. The walking algorithm is represented in Figure 3.

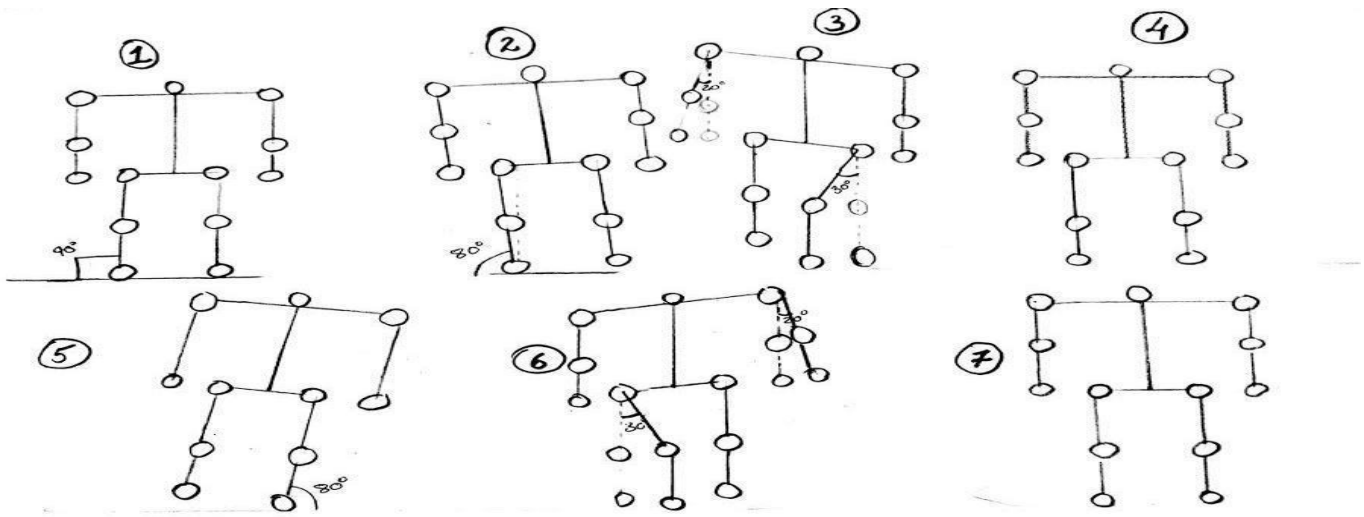


Figure 3: Robot Walking Algorithm

Step 1: Start

Step 2: Initialize the motors (motors 1 to 12)

Step 3: Tilt the robot to left by tilting (changing the angle) the motors of the foot (5&6), so that right leg lifts up (motors 5,6 => 80,80)

Step 4: Take the right leg forward (motors 1,3 => 93,93)

Step 5: Place the motors of the foot in initial position (motors 5,6 => 90,90)

Step 6: Place the motors 1 and 3 in initial position (motors 1,3 => 80,90)

Step 7: Tilt the robot to right by tilting (changing the angle) the motors of the foot (5&6), so that left leg lifts up (motors 5,6 => 102,102)

Step 8: Take the left leg forward (motors 2,4 => 87,87)

Step 9: Place the motors of the foot (5&6) in initial position (motors 5,6 => 90,90)

Step 10: Repeat Steps 3 to 9

Step 11: Stop

4.2.4 Interfacing the Robot using IoT

Connecting ESP5266 to Arduino

In order to upload code to the ESP5266 and use the serial console, you will need a USB to serial converter! Use either an FTDI cable or any console cable; you can use either 3V or 5V logic and power as there is level shifting on the RX pin. Connect USBSerial cable or connect either your console cable or FTDI cable. If using FTDI, make sure the black wire goes to the GND (ground) pin If using a console cable, connect the black wire to ground, red wire to V+, white wire to TX and

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green wire to RX. You will see the red and blue onboard LED flicker when powered up, but they will not stay lit. Install the Arduino IDE 1.6.4 or greater. The Board manager is used to install the ESP5266 package. The CPU frequency is set as 50 MHz.The baud upload speed is 115200. The matching COM/serial port for your FTDI or USB-Serial cable. Figure 4 and Figure 5 show the code and serial monitor output by linking ESP5266 to Arduino.

Figure 4: Arduino Code to connect to WiFi

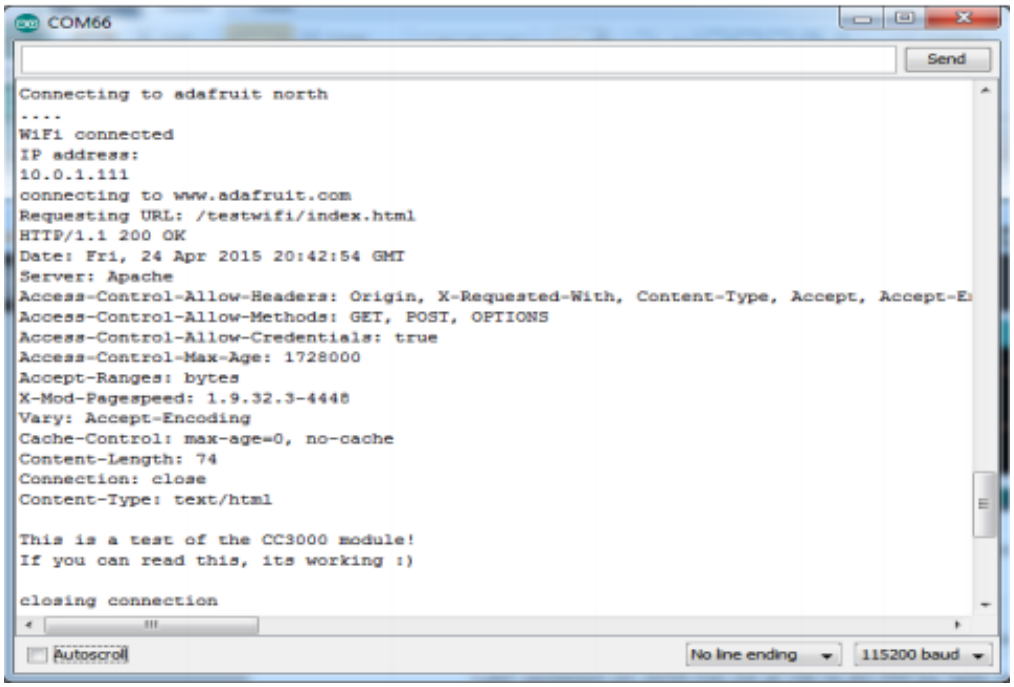

Figure 5: Serial Monitor

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ThingSpeak

ThingSpeak is an Internet of Things (IoT) platform that lets you collect and store sensor data in the cloud and develop IoT applications [5]. The ThingSpeak IoT platform provides apps that let you analyze and visualize your data in MATLAB, and then act on the data. Sensor data can be sent to ThingSpeak from Arduino.

Blynk App

Blynk is a Platform with iOS and Android apps to control Arduinoover the Internet [6]. It is a digital dashboard where we can build a graphic interface for your project by simply dragging and dropping widgetsBlynk is not tied to some specific board or shield. It supports Arduino linked to the Internet over Wi-Fi, Ethernet or new ESP5266 chip. When Blynk is turned on it is ready for the Internet of Your Things. Figure 6 shows the Blynk Architecture using Arduino.

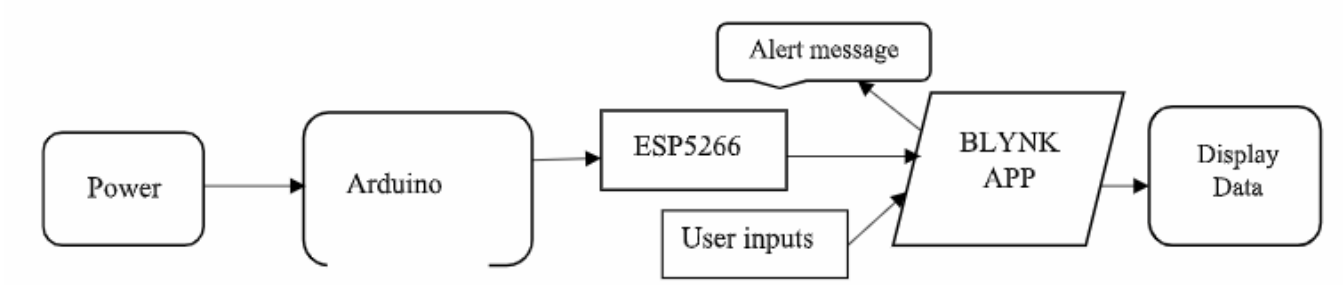

Figure 6: BLYNK APP Architecture

5.CONCLUSION

Stable humanoid bipedal locomotion is still an ongoing and challenging research activity for researchers from the robotics community. The primary objective and milestone of this research was to design, build and develop a framework for a bipedal humanoid robot that can walk in a steady manner. The movements were tracked and battery was monitored using ThingSpeak and Blynk app.

The final robot is shown in the Figure 7, the weight of the robot was roughly 2.5 kg.

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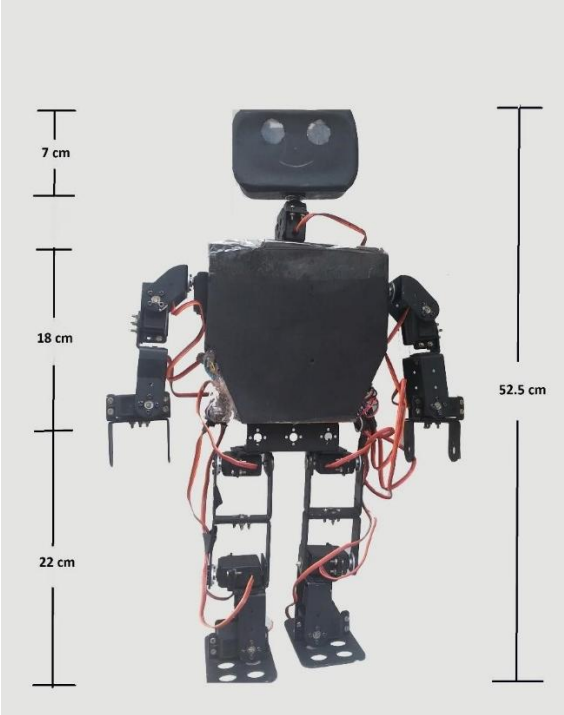

Figure 7: Final Humanoid Robot

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