



Design and Implementation of Speech Controlled Spider Bot

Kazi Mustafizul Gani, Hafezur Rahman Chowdhury, Sakil Khan, Tauhid,
Wayes Arefin and Saniat Rahman Zishan

Department of EEE, American International University Bangladesh, Dhaka, Bangladesh
kazigani03@gmail.com

ABSTRACT

This paper emphasizes in the construction of hardware & software of spider bot and creates a powerful combination between them. Speech controlled spider bot is in the field of robotics, where it has integrated the hardware & software to create a working, walking model. The robot has four operational feet that will move it to the relegated goal. One of the benefits of strolling robots is that they are more qualified to deal with harsh territory than versatile robots. The experiment began with the building of a prototype & integrating its design into the real robot. The spider bot is able to move its body with the circular rotation of servomotor & the rotation of servos are controlled through speech which is conveyed wirelessly via Bluetooth with the help of software called BitVoicer. An additional programming language termed Python is also used in this project as a medium of communication. DroidCam app is used to act android camera as spy camera.

Keywords: Speech controlled, robot, servo motor, spider bot

INTRODUCTION

Despite the fact that naturally more intricate than a solitary robot, automated swarms provide many benefits over their singular counterparts and have thus been the subject of recent research. The usage of numerous operators to achieve errands considers more straightforward, and hence more dependable, singular robots. These have proven to be important factors in completing real-world scenarios. This trustworthiness makes multi-specialist groups appropriate for an extensive variety of undertakings, for example, the exploring of battle zones, looking of hazardous circumstances, and even additional planetary inquisition. This wide range of potential applications has motivated research that has brought together the otherwise disparate fields of wireless communication, control theory and embedded systems. When assembled, these are capable of creating a platform that can facilitate a transition in the field of multi-agent systems from theoretical findings to real life implementations of robot collectives, along with extending the reach of the field from university laboratories to classroom settings. A spider bot is a new design of legged parallel mechanism structure. Parallel instrument structures are those ones having parallel connections (struts) joining between its base and its stage, or the yield piece. Many researches were done regarding spider bot or legged robot. For example, in 1974, a spider bot with legs arranged radially about a central vertical axis was made in the Aviation Instrument Institute in St. Petersburg by (Ignatyev *et al* in 1974) [1]. The arm on the spider bot is actually the end-effector of the main robot on the right-hand side, and not the other way around [2]. Researchers from the University of Cape Town in South Africa built a robot called LEAP (Line-Equipped Autonomous Platform) to see if they could replicate the skills of the jumping spider [3]. Also Genghis robot was designed by MIT (Massachusetts Institute of Technology) [4]. The robot is provided with force sensors at each joint (actually, it is the current used by each motor that is measured), contact/force sensors all along the lower part of the body, two frontal whiskers to detect contacts, one pitch inclinometer, four infrared sensors, and a set of five pyro sensors [5].

The main problem of this spider bot is that in order to move the robot anywhere, the four legs need to be very modified which must be worn by the user. It is also quite expensive compare to other spider bot. Computer controlled robots are one of the most traditional ways to control a robot, using modern technologies software system. Faster data processing take place in the transmitting side as it takes data for movement. The objective of this work was to recognize the command from device and transmit the data via Bluetooth to robot to control the robot. Our first target was to recognize the spider bot through voice command. So the desired data needed to take from the controlling device and the data than needed to be processed to control the robotic spider bot. So first we tried to fix the robot acts according

to the voice command spoken. That is why rather using robot in the receiver side we used several LEDs to check out all the directions. After providing command the main work was to process the data and transmit it wirelessly to spider bot. The wireless part was the key factor in this project. The block diagram of following figure shows the Speech Controlled spider bot. On the left side of the block diagram shows the DC power supply which is used to provide power to the microcontroller through a buck regulator.

On the top of the right side there is a microphone which is used to recognize voice command and take the voice command as an input and pass it to the BITVOICER. It takes the voice command as its input. It recognizes the speech and analyses it. After analysing the speech command it sends command signal to the microcontroller.

From the microcontroller the controlling command signal passes to the servos through the micro serial controller. After getting this controlling command signal, the servos move accordingly to it. An additional language Python is also used in this project as an alternative way to convey speech to the spider bot. It is a general-purpose interpreted, interactive, object-oriented, and high-level programming language [6]. There is also an android camera which is connected to the microcontroller. In this project Arduino ATmega 1280 microcontroller is used. Arduino is an open source platform used for building electronics projects. The ATmega 1280 has 128 KB of flash memory for storing code (of which 4KB is used for the bootloader), 8 KB of SRAM and 4KB of EEPROM (which can be read and written with the EEPROM library). The CHASIS which is used in this project is an affordable kit for the making of walking robots. It also provides all the mechanic parts necessary to build a 4 legged robot and can be used with any controller of driving at least 8 servos. For power supply LiPo battery is used. It is a type of rechargeable battery that has taken the electric RC world and robot world by storm, especially for planes, helicopters & multi-rotor robot. Bluetooth HC-05 module is used as a medium of communication with BITVOICER. HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup [7-12]. The app which helps android camera to act as spy camera is DroidCam. DroidCam comes in two parts, an Android app is free from Google Play, and the desktop client component, which is available for Windows and Linux [13].

WORKING METHOD

In Fig. 1 the block diagram of speech controlled spider bot is shown. After setting up the BITVOICER software, a microphone is connected to a laptop/desktop computer. All the servos of spider bot are connected properly according to the pin configuration of the code which is burned into the Arduino spider controller (ATMEGA 1280). The spider controller is powered through the Lip battery (rating-11.1V/1800mAh) which is used for this project. According to the operation of buck regulator it will convert 11.1 V to 5V & supply 5V to the spider controller. After that a Bluetooth module HC-05 is connected to the controller for communication & at the same time Bluetooth software of laptop should be turned on & paired up with the module. In desktop, Bluetooth software is not built in. In that case; a mini portable Bluetooth device can be the alternative option. Now whenever someone says the encoded speech through the microphone, it will transmit that 'speech' via Bluetooth & the Bluetooth module of spider controller will receive that through its RX pin. After that through Bluetooth module the Controller will get instruction & according to the instruction the servos will operate. The android camera which will be attached with spider bot as spy cam will be also operated through Bluetooth with the help of DroidCam software.

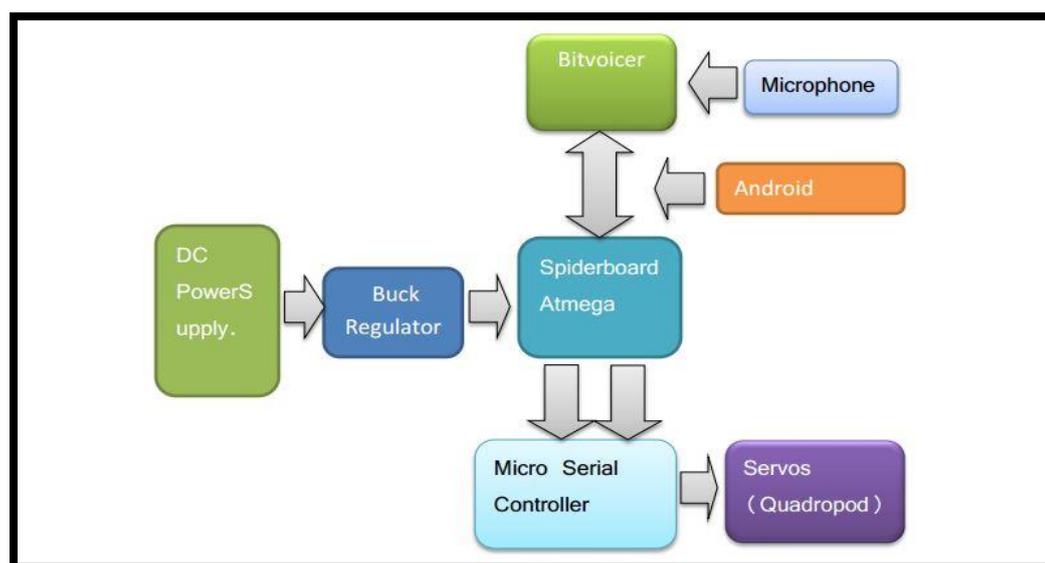


Fig. 1 Block Diagram of Speech Control Spider Bot

SIMULATION ILLUSTRATION

The entire simulation of spider bot is implemented through PROTEUS simulator.

Servo Motor as Quadruped

Eight servos in Fig. 3 are connected with the Arduino board. Each servo consists three pins-positive, negative & signal. Over here, pin 0 & 1 is connected to the TXD (transmit data) & RXD (receive data) of Bluetooth module for communication. On the other side, pin 2 to 9 are connected to the signal pins & the rest other pins of servos are shorted & connected to the source & ground. The green labels beside servos indicate the rotation angle. Fundamentally a servo motor can typically just turn 90-degree point in either bearing for an aggregate 180-degree movement. The motors unbiased position is characterized as the position where the servo has a similar measure of potential revolution in the both the clockwise or counter-clockwise course.

Virtual Terminal

In Fig. 32 among eight servos, four servos are holding positive angle value & on the contrary, rest four servos are holding negative value. Positive sign of angle defines clockwise rotation & negative sign of angle defines counter-clockwise rotation of servo motor. In the virtual terminal six instructions/command are displayed & each command is denoted with an alphabet. The following Table-1 shows the position of knee & leg servo before receiving any command.

Through the virtual terminal of PROTEUS simulator, the command/instruction provided to the spider bot can be displayed. Fig. 3 shows the overview of virtual terminal and the actual scenario of virtual terminal.

But after receiving command, the angular position of servos started to vary. Mainly the walking procedure of spider bot is quite similar to human being. For instance, when a human begins to walk, each foot contacts the ground for an insignificant time amid which a hasty power pushes the body along an allegorical direction until the point that the inverse foot strikes the ground. During this process, one’s angular position of knee & leg varies spontaneously. It should be noted that without friction walking process of human/spider bot is not possible. Friction mainly occurs between two legs when they have two opposite angles. If the all legs (servo) of spider bot start to move in clockwise direction it will not be able to walk.

According to the law of friction, it will get down. The following table 2 shows different angular position of servos depending on various commands.

Table-1 Position of Servos Before Receiving Command

Servo	Knee 1	Leg 1	Knee 2	Leg 2	Knee 3	Leg 3	Knee 4	Leg 4
Angle	0.52	90.5	4.09	-8.51	63.5	166	76.1	74.2
Rotation	clockwise	clockwise	clockwise	Counter clockwise	clockwise	clockwise	clockwise	clockwise

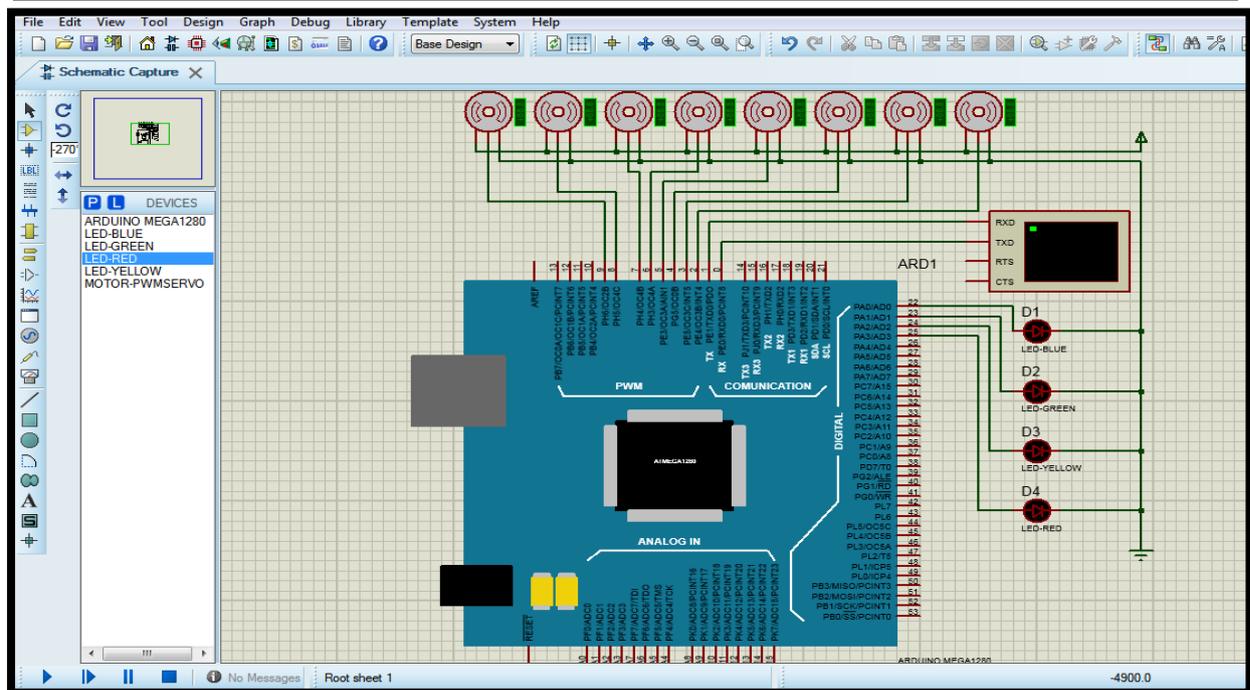


Fig. 2 Simulation of Spider Bot
Table-2 Position of Servos After Receiving Command

Servo	Angle (Initial)	Movement	Sleep	Play Inactive	Sit	Stand	Wake up
Knee 1	+0.52	+54.5	+0.45	+0.45	+74.3	+0.45	+0.45
Leg 1	+90.5	+36.5	+90.5	+90.8	+76.1	+90.5	+90.5
Knee 2	+4.09	-49.9	+4.09	+4.07	+40.1	+4.08	+4.09
Leg 2	-8.51	+45.5	-8.53	-8.53	-62.5	-8.53	-8.51
Knee 3	+63.5	-62.5	+63.5	+64.0	+90.0	-62.5	+63.5
Leg 3	+166.0	+40.0	+166.0	+166.0	-90.0	+40.1	+166.0
Knee 4	+76.1	-49.9	+76.1	+76.4	+90.5	-49.9	+76.1
Leg 4	+74.2	-51.7	+74.3	+74.1	+0.45	-51.7	+74.3

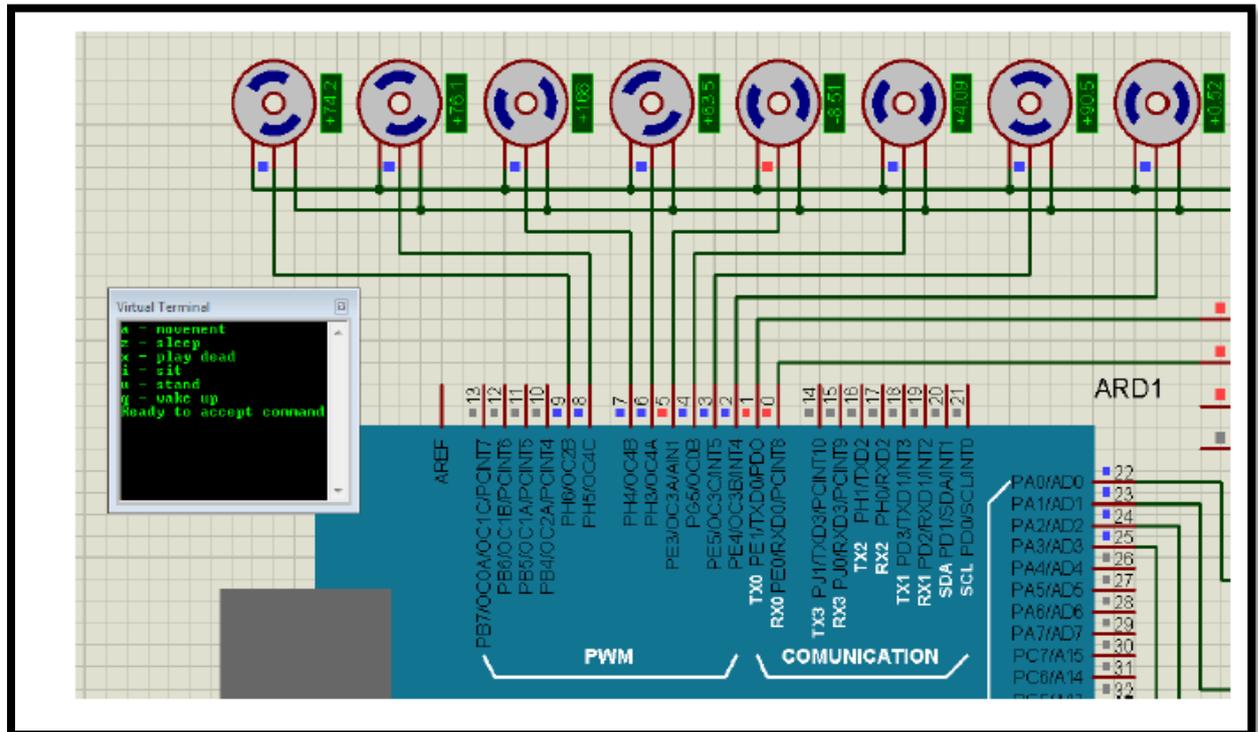


Fig. 3 Overview of Virtual Terminal

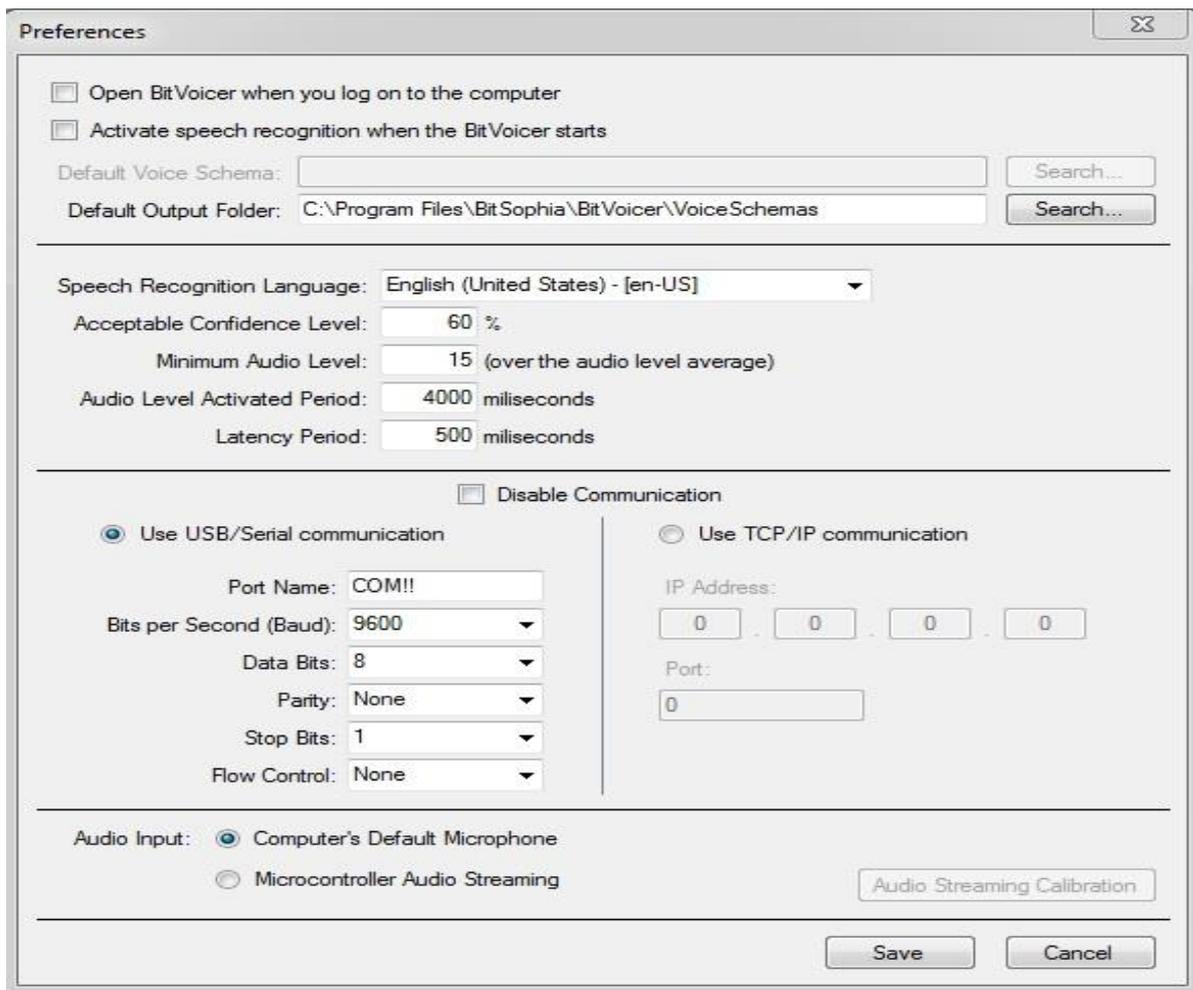


Fig. 4 Voice Scheme of BitVoicer
Fig. 5 Preferences



Fig. 6 COM Port Selecting from Device Manager

BLUETOOTH COMMUNICATION VIA BITVOICER

The most important part after setting up BitVoicer is to establish communication of spider bot via Bluetooth. Without proper connection between BitVoicer & Bluetooth, it is not possible to convey any message to the spider bot. Necessary steps should be followed for pairing

Bluetooth with BitVoicer

[1] A right click was done on Bluetooth Devices icon in the tray bar & 'Add a device' option was clicked from them [Fig. 4].

[2] It will search over again & again until HC-05 pops up.

[3] After getting the device, double click must be done over the device to select it [Fig. 5].

[4] In the next stage, a dialogue box will appear & a code four digit- '1234' must be typed for pairing. It should then install HC-05 to the computer.

[5] Now from the 'Ports' option such ports should be selected which is given in Fig. 6. It should be noted that in selecting COM port always first port will be the first preference.

SIMULATION RESULT

The Table-3 shows the simulation result that was obtained from the PROTEUS Simulator.

Table-3 Simulation Result Scenario

Alphabet	Command	Alphabet	Command
D	Turn right	A	Turn left
Z	Sleeps	W	Run forward
U	Stand up	S	Run back
X	Play dead	H	Swing your leg
I	Sits	Q	Wake up

HARDWARE IMPLEMENTATION

The entire circuit connection of spider bot is as similar as the simulated circuits which is shown in Fig. 7. The precise assembly of hardware equipment is shown through the following steps.

Step 1 - In the first step, the foam rubber feet were mounted to leg segments as shown using 3mm x 12mm pan head self-tapping screws as shown in Fig. 8.

Step 2 - In the second step, a servo was mounted on each of the leg segments fitted with a foot as shown using 2.3mm x 8 mm self-tapping screws as shown in Fig. 9.

Step 3 - After completing second step, a servo horn was mounted to four unused leg segments as shown using 2mm x 6mm self-tapping screws. The servo was centred at first & then the leg segment was fitted to the servo using 2.3mm x 10mm pan head screw as shown. Then the servo was turned gently by hand to check the range of movement & it was adjusted if necessary as shown in Fig. 10.

Step 4 - In step 4, four servos were mounted as shown in the diagram with 2.3 mm x 8mm self-tapping screws as shown in Fig. 11.

Step 5 - In fifth step, servos were centred & legs were mounted onto the mounting plate using 2.3mm x 8mm pan head screws as shown in Fig. 12.

Step 6 - Once all legs are mounted the chassis is finished. A rectangular hole (marked with red as shown in Fig. 13) in the base plate allows to mount the desired spider-controller or any other gadgets over there.

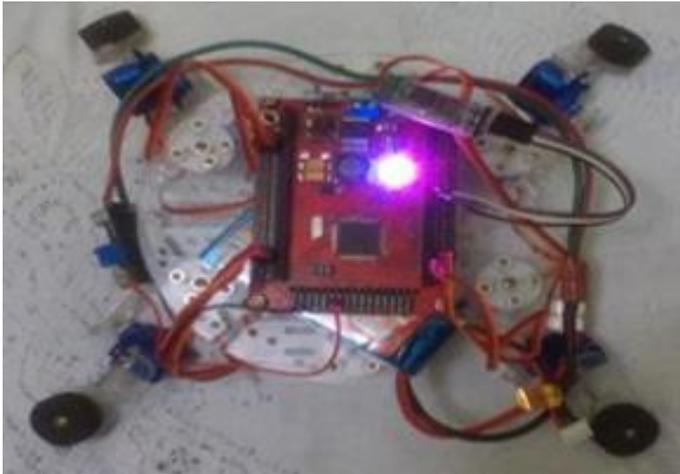


Fig. 7 Entire Connection of Spider Bot

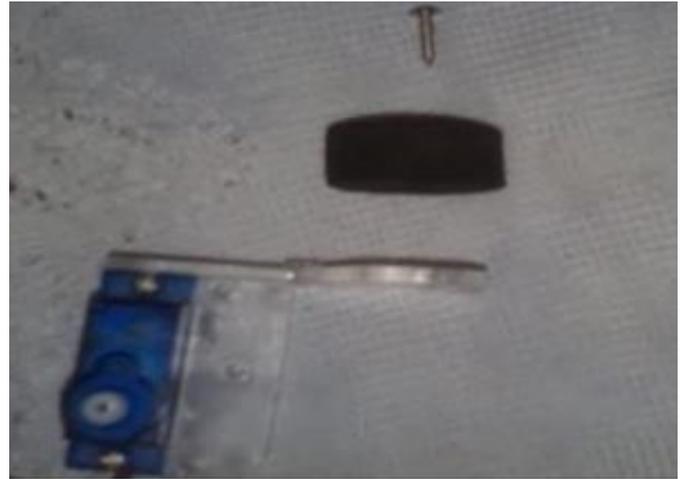


Fig. 8 Mounting Foam Rubber with Leg Segment

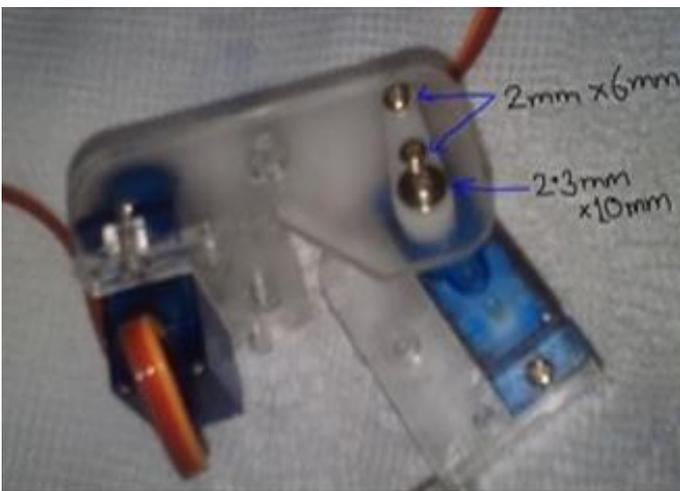


Fig. 9 Mounting Servo with Leg Segment

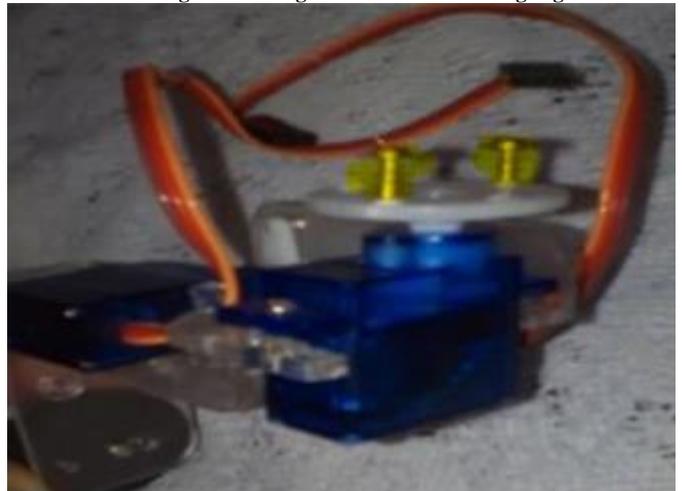


Fig. 10 Mounting & Adjusting Servo with Leg Segment



Fig. 11 Complete Mounting of a Leg Segment

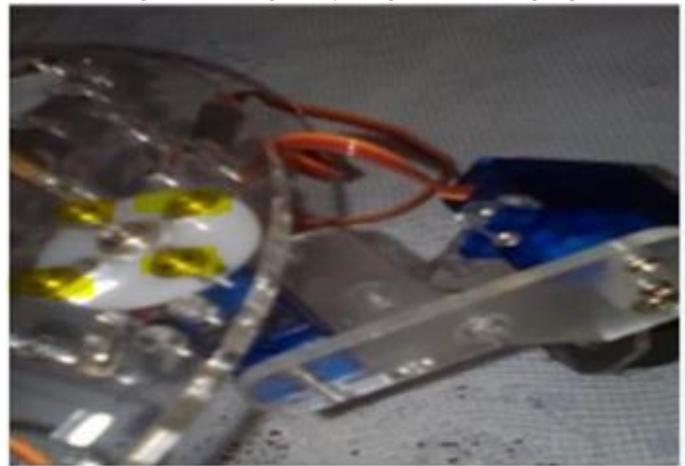


Fig. 12 Mounting A Complete Leg Segment with Base Plate



Fig. 13 Mounting Spider Controller Over Base Plate

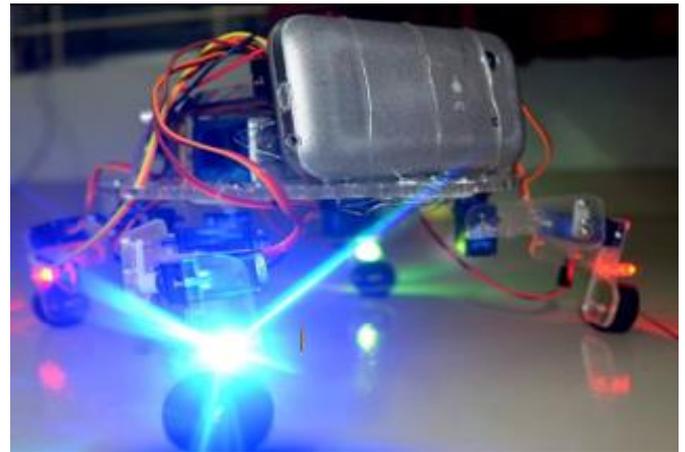


Fig. 14 Final Overview of Spider-Bot

Step 7 - Now it is time to power up the spider controller. The Arduino controller will get power supply from 11.1V LiPo Battery. But as the serial pins can absorb 5V power supply, a buck regulator is used to convert 11.1V to 5V. As indicated by the pin configuration of re-enactment, this module was associated with the serial pin which is shown in Fig. 14.

HARDWARE RESULT ANALYSIS

The hardware result of spider bot is as same as the result of simulation. After completing hardware portion of spider bot, it needs to communicate with software for receiving command. An additional gadget termed spy cam is added with the spider bot which will be operated through an android mobile camera. Here is the final figure of spider robot after attaching android mobile camera.

CONCLUSION

The four legged spider bot has met the goals that were set out toward the start of its development. The spider bot could play out the principle work that was expected of it; it could advance its feet while keeping up its adjust on the staying three feet that remained on the ground. In this task, we have demonstrated the leg system of a robot as it is much adaptable to stroll in plane and harsh land. The discourse acknowledgment innovation cannot exclusively be utilized like creature formed robot (spider bot) yet in addition in humanoid robot. Various energetic researchers are tackling this development nowadays. By utilizing this computerization over robot, human will have the capacity to perform such errands in far off future for which they never at any point envision to do as such.

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