# DIRECTIONAL CONTROLLED SPIDER ROBOT

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*In partial fulfillment of the requirements for the award of the Degree*

*of*

**Bachelor of Engineering in Robotics and Artificial Intelligence** *from*

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MAY 2024

**DEPARTMENT OF ROBOTICS AND ARTIFICIAL INTELLIGENCE**

# CERTIFICATE

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*"Directional Controlled Spider robot"*

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**DEPARTMENT OF ROBOTICS AND ARTIFICIAL INTELLIGENCE**

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# ABSTRACT

The Wheeled robots cannot work properly on the rocky surface or uneven surface. They consume a lot of power and struggle when they go on rocky surface. To tackle the disadvantages of wheeled robot we replaced the wheels like shaped legs with the spider legs or spider arms. Quadruped robot has complicated moving patterns and it can also move on surfaces where wheeled shaped robots would fail. They can easily walk on rocky or uneven surface. The main purpose of the project is to develop a surveillance system utilizing a Cam module, which can be deployed in places that are difficult to reach by humans, such as underground pipelines, mining areas, and collapsed buildings. It can be used for metal detection. We can use this for various surveillance purposes by making needed modifications. We can add many more features to enhance its abilities.

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# CHAPTER 1

# INTRODUCTION

## 1.1 Introduction to Spider Bot

Nowadays robots are being used extensively for different applications. Our idea was to design a robot that can be used by individuals to reach their desired work and control them in a handy way. The design of this type of robot was inspired by a biological spider, which has the ability to navigate through different terrains and uneven surfaces. Spider robot is ideal for this type of application. We have come up with a capable mechanical design for the robot so that it can freely move around and do the movements needed. The environmental effects were minimized by the reusable electronic parts such as servos and microcontrollers. The software part of the robot is offering logic. We designed the robot in such a way that it has a good speed, smooth and controlled movement. To steer and control the robot we have designed an android application that everyone can use. As it should work for a reliable time period we have installed a battery which lasts longer. The robot can be easily manufactured in a short time for further applications.

## 1.2 Why legged robot?

There are a few fundamental robot types: wheeled, tracked and legged robot. Wheeled robots are quick, however not reasonable for unpleasant regions. Tracked robots are more slow, however more reasonable to tough regions. Legged robots are slow, much hard to control however very strong in unpleasant region. Legged robots are equipped for crossing enormous openings and can work even subsequent to losing a leg. Many investigates were acted in this field in the beyond couple of years, due to its huge potential. There are likewise a few tasks in military examination. Legs have obvious focal points over wheels. The greatest benefit is in cross over capacity and capability. Legged robot has a unique ability to isolate their body from territory abnormalities. Legged robots are more energy efficient as compare other robot types.

### 1.3 Walking Theory

The robot manufacturing in this paper has total.12 degrees of freedom, with each leg having 3 degrees of freedom. This means being able to move 12 different joints in different positions. Legs are positioned symmetrically on both sides. Servo motors provide movement of joints. Servo motors that connect the legs to the body allow it to rotate sideways. The other two servo motors provide movement of the joint.

## 1.3. Problem statement

To develop a control system for a quadruped spider robot to enable omnidirectional movement, prioritize stability and manoeuvrability, and ensure adaptability for tasks like exploration and surveillance.

# CHAPTER 2

# LITERATURE REVIEW

**Zareei Amir, et al. 2011** developed a spider-like quadruped mobile robot that used Geometrical approaches to examine the robot's inverse kinematics. The differential kinematics also determines the velocity of the joint variables. The robot's inverse kinematics are then solved for a particular motion. Many scientists have been interested in the research on these walking machines over the last two decades since they have a lot of potential features. These robots can be divided into two groups: biped and multi-legged robots, which have significant mechanical distinctions.

**Tolga Karakurt, et al. 2015** has described the creation of a legged robot with features that are required for search and rescue activities. For this objective, a variety of walking algorithms have been developed and tested. The spider-inspired four-legged robot was created with a control mechanism and can perform a variety of walking behaviours. The robot's efficacy is determined by how well it performs on various terrains. A robot is an electromechanical system that can do tasks on its own or according to a set of instructions. Search and rescue robots, space robots, and discovery robots are all possibilities for the four-legged robot. Quadruped robots offer advantages in these domains due to their compact size and practical mobility. One of the fundamental steps to achieving the primary goal is to build walking algorithms for functional and flexible control without being locked in a given limit. Being able to move more readily is one of the basic steps to achieving the main goal. Walking algorithms are used to acquire the required velocity in this scenario.

**Yam Geva, et al. 2015** shows how he came up with the idea for a new quadruped robot. The proposed design is characterised by its simplicity, modularity, and ease of interface. The robot is primarily made up of off-the-shelf parts. Four 3-DOF legs, the robot body, and its electronics are all part of the design. The proposed robot can navigate tough terrain while carrying extra payloads. Sensors and computing hardware can both be included in such payloads. The robot's design, control system, and forward and inverse kinematics are all presented.

**Akash Maity, et al. 2018** talks about how to design a quadruped robot, how to make it with a 3-D printer, and how to analyse it thoroughly. It emphasises the benefits of additive manufacturing over traditional production techniques while also pointing out its drawbacks. This paper examines the pros and downsides of various materials for 3-D printing.

**Nikunj S Yagnik, et al. 2017** discusses about the history, early literature, and current developments in the field of quadruped robots. The difficulties of developing and operating quadruped robots are highlighted. These robots' gait mechanisms, path movement methods, static and dynamic stability margins, power supply, posture control, fault tolerant control, and reconfiguration are all covered. Finally, the report concludes with a discussion of quadruped robot development in the future.

# CHAPTER-3

# SYSTEM COMPONENTS

## 3.1 Hardware Specifications:

### Servo Motors:


*Figure1.0-servo Motor*

The MG90 Servo Motor is a precision-oriented motor type renowned for its capacity to rotate with remarkable accuracy. Typically, this motor configuration incorporates a control circuit that provides continuous feedback on the current position of the motor shaft. This feedback mechanism empowers servo motors to execute movements with exceptional precision. Servo motors find their ideal application in scenarios requiring precise object rotation at specific angles or distances. Essentially, these motors consist of a basic motor mechanism operating through a servo mechanism, making them versatile tools in various applications.

### HC-05 Bluetooth Module:

*Figure 1.1-HC-05 Bluetooth Module*

The HC-05 Bluetooth Module offers a straightforward solution for establishing a Bluetooth SPP (Serial Port Protocol) connection, tailored for wireless serial communication setups. Its communication protocol is rooted in serial communication, simplifying interfacing with controllers or PCs. Notably, the HC-05 Bluetooth module facilitates seamless switching between master and slave modes, enabling it to receive and transmit data as needed.

## Arduino Nano:

*Figure 1.2-Arduino Nano*

Arduino is the core part the quadruped robot. it is the hardware in which all the commands to be executed by the quadruped robot are stored. Nano Arduino is connected to the servo motors, Bluetooth module, Ultrasonic sensor with the help of Jumper wires.It operates on 5V and consists of ATmega328P Chip. 32KB Flash memory, 2KB SRAM, 16MHz Clock Speed.

## Buck Converter:

*Figure 1.3-Buck Converter*

The buck converter is an extremely straightforward kind of DC-DC converter that delivers an output voltage less than its input. The buck converter is so named because the inductor generally "bucks" or acts against the input voltage. It is a DC-DC step-down converter that can drive a 3A load with excellent line and load regulation. The output voltage can be regulated using an in built potentiometer. For our case, we regulated the output voltage of 5V as Arduino Nano can only work on 5V.

## Arduino Nano Expansion:

*Figure 1 . 4 - Arduino Nano Expansion*

It is used as the extension PCB for Arduino Nano and is very much helpful in connecting all the components. The Nano 328P Expansion Adapter Breakout Board IO Shield acts as a breakout board for the Arduino Nano microcontroller. There are several different options for power input and the footprint of this board is the same as the Arduino Duemilanove. In addition, each pinout includes 5V and GND pins for easy connection to sensors or servos. The unit comes fully assembled.Arduino Nano IO Expansion Shield is specifically designed to facilitate an easy connection between Arduino Nano and many other devices.

## Li-Ion Battery:


*Figure 1.5 -Li-Ion battery*

This battery is an ideal power source for your 4-legged spider robot, providing sufficient capacity and voltage to drive both the Arduino Nano and the 12 mini servo motors. Its compact size and rechargeable nature make it a practical choice for mobile robotics applications, ensuring prolonged operation without compromising performance.

## 3.2 CIRCUIT DIAGRAM OF ARCHANO BOT

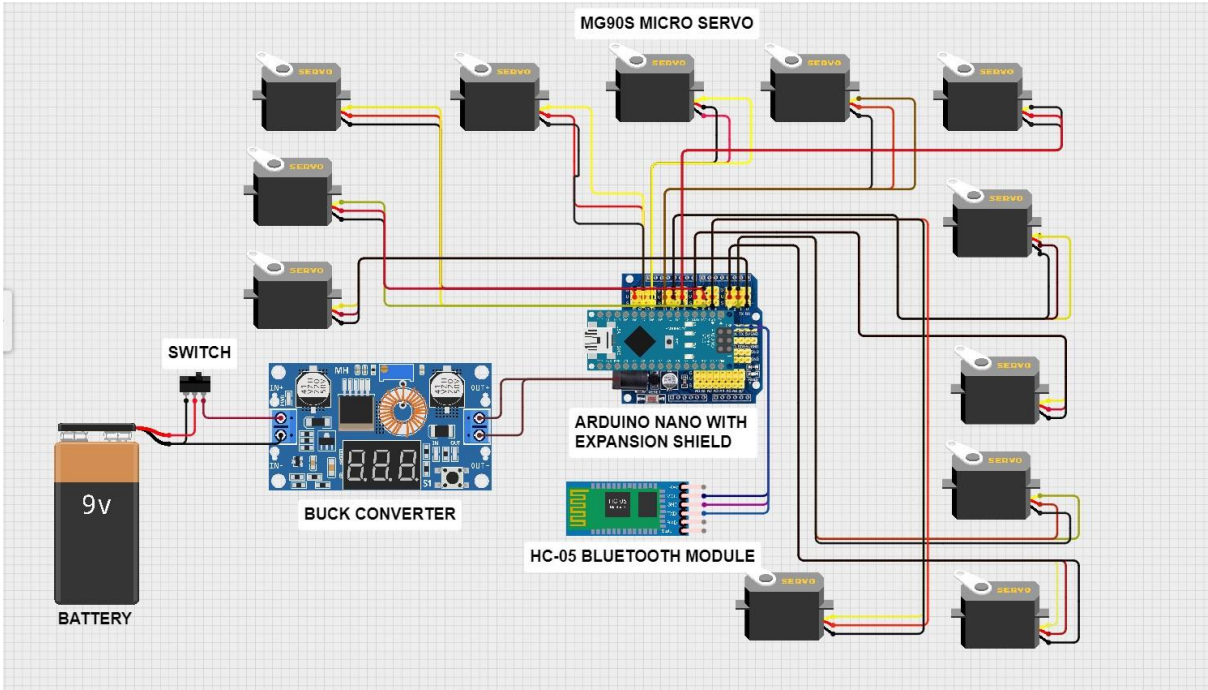


*Figure 1.6 -Circuit Diagram*

## CHAPTER-4

# METHODOLOGY

**Control System Design:** The control system architecture for the mini project is meticulously outlined, detailing how the Arduino Nano, 12 servo motors, Bluetooth HC-05 module, buck converter, and lithium-ion battery will interact. A precise control algorithm is devised to manage servo motor positions and movements based on wireless signals received via Bluetooth.

**Component Integration**: Integration efforts focus on seamlessly connecting the Arduino Nano with any necessary expansion boards for controlling the 12 servo motors. The Bluetooth HC-05 module is intricately linked to the Nano to facilitate wireless communication, while the buck converter ensures stable voltage regulation from the lithium-ion battery to power all components effectively.

**Firmware Development**: The development of firmware for the Arduino Nano is executed with precision, enabling it to interpret commands wirelessly received from the Bluetooth module and translate them into precise servo motor movements.

**Testing and Calibration**: Extensive testing is conducted to validate the functionality and reliability of the control system across various operating conditions. Servo motors undergo meticulous calibration to guarantee accurate and consistent movement in response to control commands. Communication between the Arduino Nano and Bluetooth module is rigorously validated, alongside stability checks for the power supply from the buck converter and lithiumion battery.

**Performance Evaluation**: The performance of the control system is evaluated based on key criteria such as responsiveness, servo motor positioning accuracy, and power efficiency. Usability and user experience are assessed, particularly focusing on the remote-control functionality and overall ease of operation. Any areas for improvement or optimization are identified through performance testing and user feedback, ensuring the mini project meets its objectives effectively.

# CHAPTER-5

# CONTROL SYSTEM

## 5.1 Software Control System

The software part of the robot consists of two major sections

I. Microcontroller logic

II Android application to control


*Figure 1.7-Ardiono IDE Interface*

In Microcontroller logic, servo motor position and direction are controlled using PWM (Pulse with Modulation) received from the Microcontroller. Firstly, we ran a code to initialize the servos i.e., to identify the 0 position of the servos to clamp the legs as we desired. Then we upload the code to control the robot using Bluetooth, after that the robot is ready for the commands from the user to get steered and controlled.

The open-source Arduino Software (IDE) simplifies it to make code and move it to the board. It turns on Windows, Mac OS X and Linux. The environment is written in Java and considering handling and other open-source programming. This is the place where you type the code you need to incorporate and ship off the Arduino as well as other development boards

## 5.2 Android application to control:

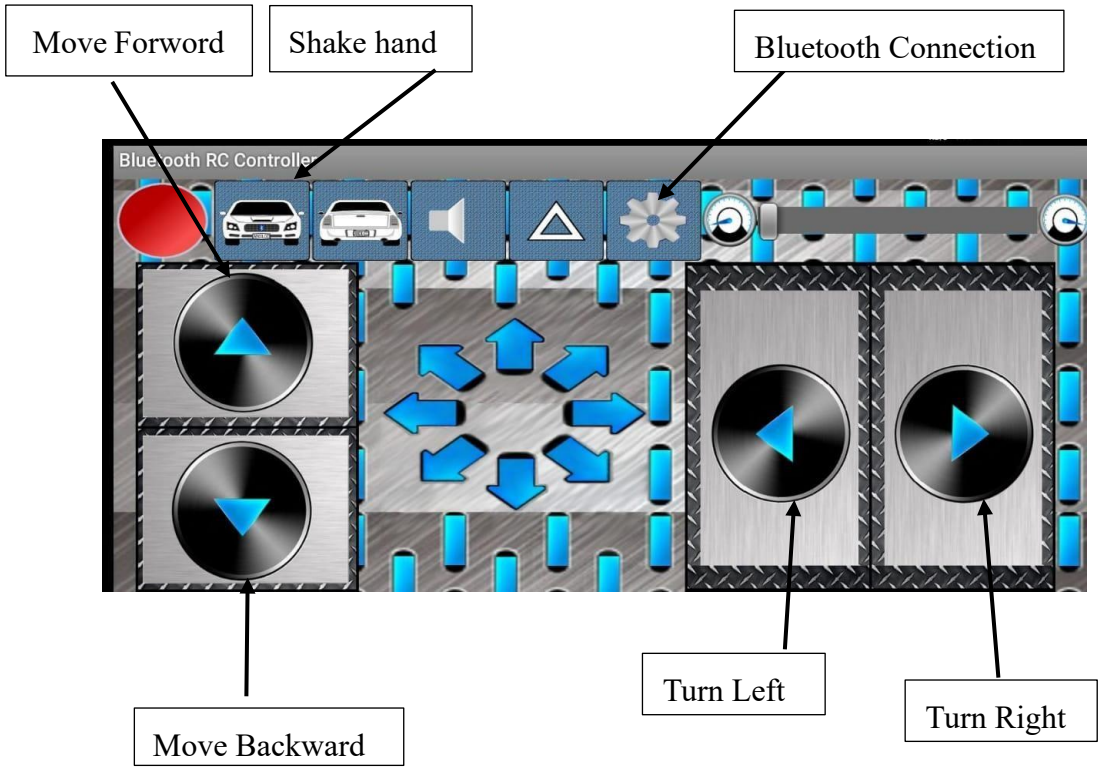


*Figure 1.8-RC controller Interface*

It depicts the application interface of the RC Bluetooth Controller App. The user interacts with the robot by simply clicking buttons corresponding to desired actions. For instance, if the user selects the "forward" button, the robot promptly initiates forward movement. Similarly, pressing the "Left" button triggers a leftward turn, while selecting the "backward" button prompts the robot to move in reverse. Furthermore, the robot exhibits its versatility by executing dynamic dance maneuvers, featuring fluid up-and-down motions and even the capability to lift one of its legs. In this interactive process, the user issues commands via button selections, and the robot responds by executing corresponding movements, ensuring a seamless and engaging user experience.

## 5.3 Assembly Design

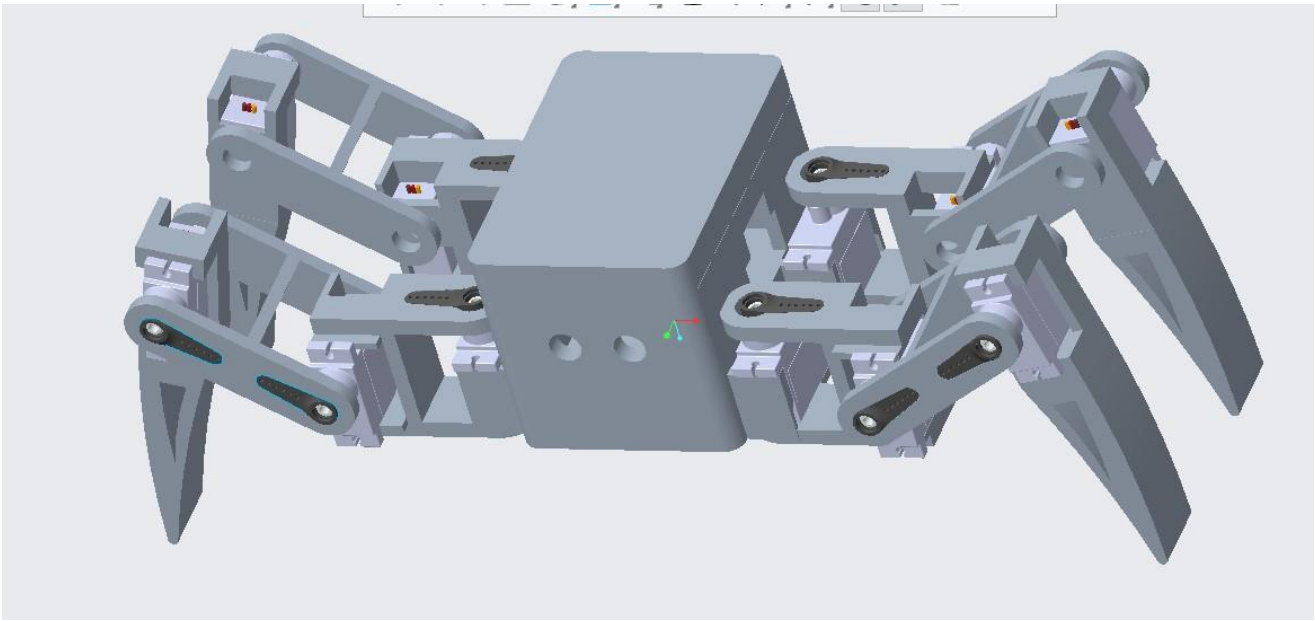

*Figure 1.9-CAD Model of Archano Bot*

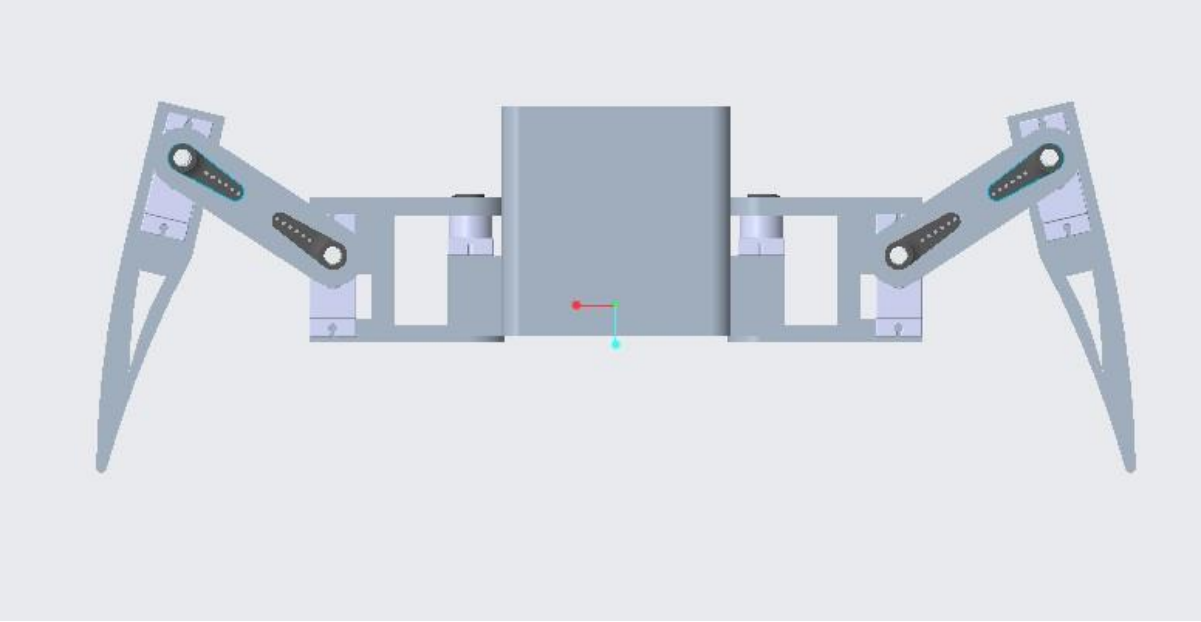

*Figure 1.10-Front View of Archano Bot*

**CHAPTER-6**

# RESULT AND DISCUSSION

## 5.1 Prototype:

We have built a prototype of the robot using 3d printing and standard components as discussed earlier. In this project, the spider robot is assembled along with corresponding electrical circuit. In the electrical circuit  Arduino and Bluetooth module are used, along with micro servomotors which are supplied by separate two lithium ion batteries. Robot is connected through mobile app by Bluetooth moduleThe final look of the Robot is shown in figure 1.11 below.

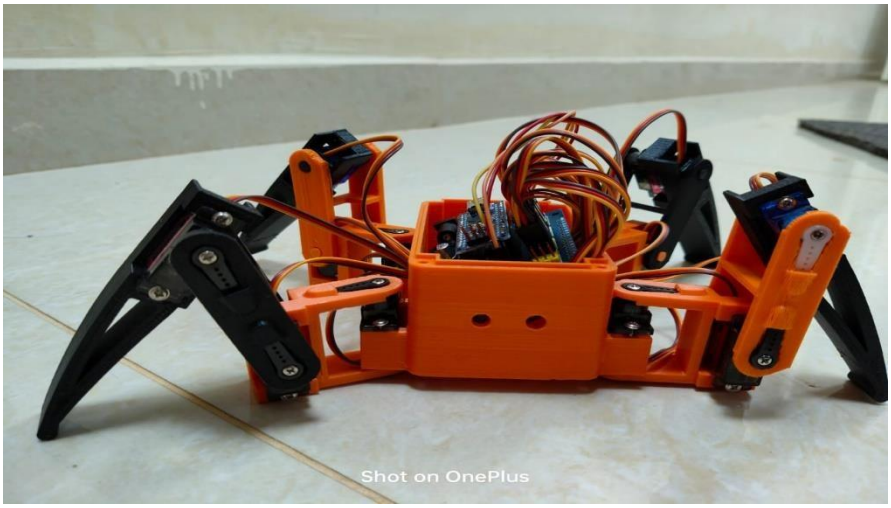


*Figure 1.11-prototype of robot*

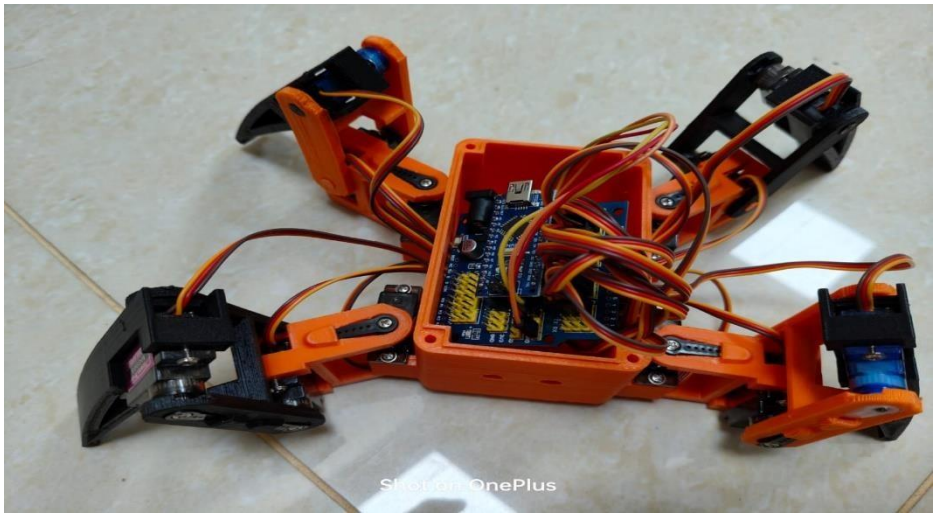

*Figure 1.12-prototype of robot*

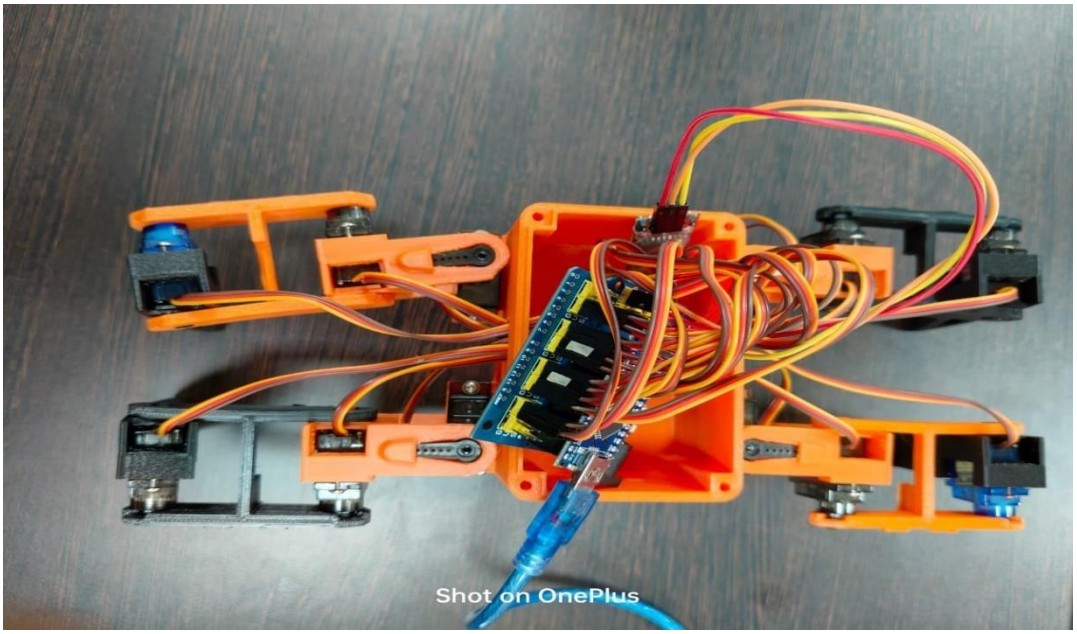


*Figure 1.13-Prototype of robot*

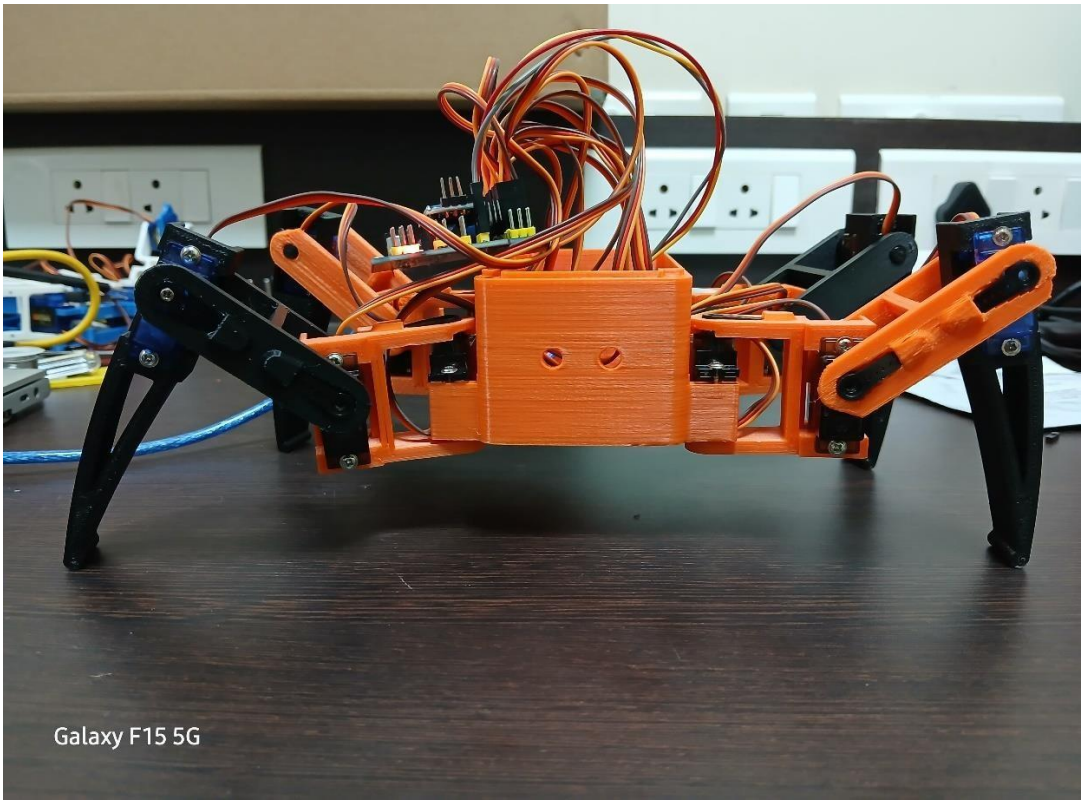


*Figure 1.14- Prototype of robot*

## CHAPTER-7

# FUTURE AND SCOPE

The robot can be made more adaptable by involving different connection lengths for front and back legs. Intelligence can be improved by introducing different types of sensors and vision to improve the effectiveness of this robot in future Scope of movement and minutes accessible at each joint are the best worry as it is significant for accomplishing position and bug strolling. The robot can also be optimized in its movement. This could be done by extensive testing and coding. We can improve the range for long distance communication. To make Spider Robot more compact in size. Improve the battery life.

## CHAPTER-8

# CONCLUSION

In conclusion, the development of the quadrupedal Spider Robot represents a significant step forward in the realm of real-time detection prototypes. By harnessing a carefully designed architecture, this robot demonstrates remarkable adaptability across various terrain types and challenging environments. Its four-legged structure not only enhances locomotion but also ensures stability, providing a distinct advantage in practical applications. Seamless wireless control, facilitated by the integration of a Bluetooth Module, further enhances its operational versatility. Each component's strategic placement underscores a meticulous optimization effort aimed at maximizing performance. Through the integration of cutting-edge hardware and innovative technologies, this project realizes its full potential, marking a significant achievement in the field of robotics..

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