# FOUR LEGGED WALKING ROBOT (QUADRUPED)

*Abstract*— **This project presents the design, development, and implementation of a versatile four-legged walking robot controlled via a smartphone application. The robot employs 12 servo motors, an Arduino UNO microcontroller, and a Bluetooth module for seamless wireless communication. This report outlines the comprehensive process of constructing the robot, programming its movements, and establishing remote control via a smartphone, showcasing the fusion of robotics and mobile technology.**

## I. INTRODUCTION AND MOTIVATION

In the ever-evolving landscape of robotics, the development of intelligent and versatile robotic platforms has gained substantial momentum. One fascinating area of exploration is the creation of four-legged walking robots, known for their agility, adaptability, and potential applications in various domains. In this report, we delve into the design, construction, and programming of a four-legged walking robot, using Arduino uno, twelve servo motors, and integrated with a bluetooth module for remote control via a smartphone.

The integration of twelve servo motors allows for precise control of each leg's movements, facilitating lifelike and dynamic walking patterns. This level of sophistication opens doors to a multitude of applications, from educational tools to exploration in rough terrains and search and rescue missions. Furthermore, we have harnessed the power of modern communication technologies by incorporating a bluetooth module into our robot. This addition allows users to control the robot remotely through a smartphone application.

This report aims to provide a comprehensive overview of our venture into the world of robotics, offering insights into the processes, innovations, and potentials that have arisen from the creation of a four-legged walking robot controlled via a smartphone interface. It is our hope that this project will inspire future advancements in the field of robotics, driving innovation and pushing the boundaries of what robots can achieve in various applications and industries.

## II. LITERATURE SURVEY

*1. "Four-Legged Walking Robot for Surveillance" by Manish Dhakolia, Pranay Chalke, Shubham Baniya, and Atharv Desai.*

There is a need for reliable surveillance technology in response to increasing global crimes and malicious activities. This project introduces the concept of a four-legged walking robot as a solution for monitoring remote and challenging terrains. The project aims to construct an autonomous robot equipped with a robotic arm using open-source components like Arduino Mega and ESP32. The key objective is to reduce human risk in dangerous areas by utilizing this robot, which can navigate rough terrain and avoid obstacles. This technology addresses the limitations of existing surveillance methods, such as UAVs and tracked-wheeled robots.

*2. "Quadruped Robot Used for Search and Rescue Operations" by Omkar Jagdale, Prabhat Kaushal, Tushar Vitole and Ganesh Gaikwad.*

This research paper provides an in-depth examination of quadruped robots, emphasizing their design, control methods, and applications. Quadruped robots are increasingly popular for their ability to navigate challenging terrains and perform tasks inaccessible to wheeled or bipedal robots. The paper explores various types of quadruped robots, actuator considerations, and control strategies. It also highlights their diverse applications, including search and rescue, exploration, agriculture, and military use, outlining their unique advantages and challenges.

*3. "[DIY] Spider Robot (Quad Robot, Quadruped)" by RegisHsu, https://www.instructables.com.*

This article is about building DIY four legged spider robot. The components that are used are Arduino Pro Mini, DC-DC(12-5v/3A output), HC-06 Bluetooth module, twelve SG90 servos(3DOF for 4 legs), 3000mhA Li –ion battery , 12V Jack, 680 Ohm 1/4 watt 5% Resistor, 3mm Blue LED, switch and some male and female pin headers. All the instructions are given step by step in detailed manner with clear diagrams and circuits. Different arduino source codes and files for 3D printing of parts are also given.

*4. "How to make a WALKING SPIDER ROBOT at home | 3D printed crawling robot |" by Indian LifeHacker YouTube channel, www.youtube.com*

This video tutorial provides all the details regarding how to make four legged spider robot. All the components required and source codes for arduino are explained in an easy way. The links of 3D printing files as well as links for buying the components are given.

## III. CIRCUIT DIAGRAMS AND COMPONENTS

TABLE I

COMPONENTS LIST

| S.N | Components | No required | Specifications |
|---|---|---|---|
| 1 | Arduino uno | 1 | ATmega328P 16 MHz microcontroller<br>Digital I/O Pins: 14<br>Analog input pins: 6<br>I/O Voltage: 5V<br>Input voltage (nominal): 7-12V<br>DC Current per I/O Pin: 20mA |
| 2 | Servo Motor | 12 | SG90<br>180º rotation<br>Torque: 1.2 - 1.6 Kg.cm<br>Input Voltage : 4.8 – 6 V |
| 3 | Bluetooth Module | 1 | HC-05<br>Frequency: 2.4 GHz<br>Range: 10 m (in open air)<br>Operating voltage: 3.3 – 5 V<br>Operating current : 50 mA |
| 4 | 7.4V Li ion Battery | 1 | 18650 Li-ion cell<br>3.7 V per cell<br>2500 mAh |

A. *Arduino Uno Board*

Arduino UNO is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, 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; 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 Arduino IDE is used to program the arduino boards.

Arduino uno

B. *Bluetooth Module*

The Bluetooth module, is a board with integrated Bluetooth function, is mainly used for short-distance wireless communication, and has become the backbone of the development of the Internet of Things. A It employs Bluetooth technology to establish connections between the sender and receiver.

Bluetooth module

C. *Servo Motor*

The function of the servo motor is to convert the control signal of the controller into the rotational angular displacement or angular velocity of the motor output shaft. Servo motor is used to drive the joints.


D. *Jumper Wires*

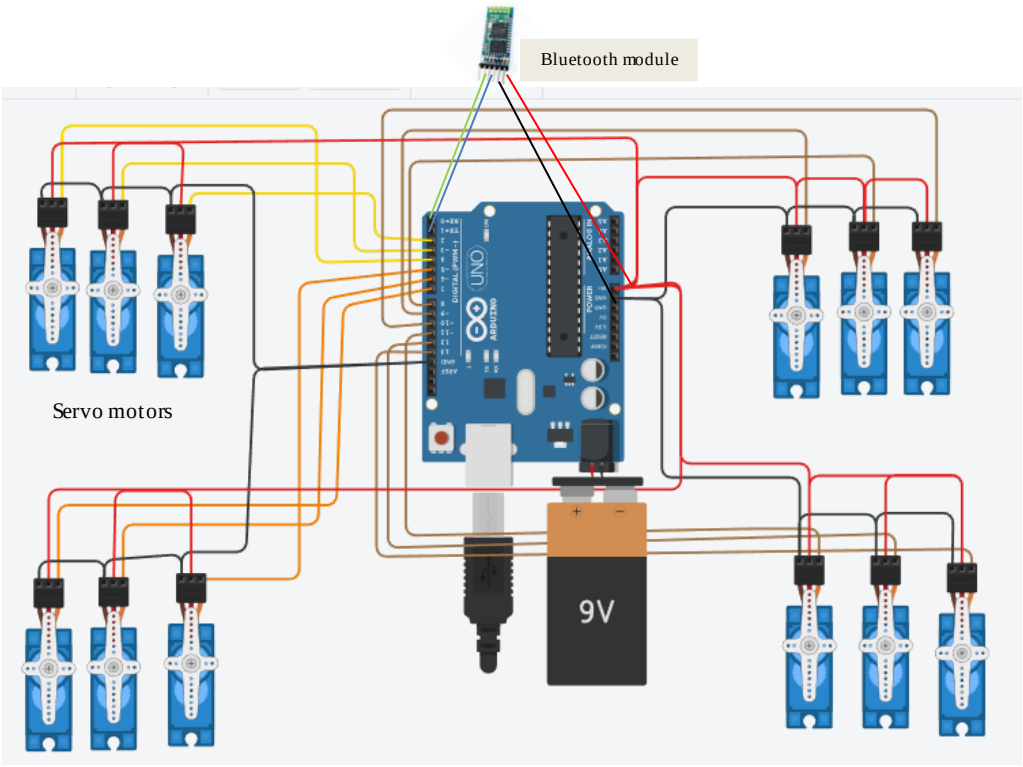
A jump wire is an electrical cable or a group of wires that has a connector or a pin at each end (sometimes without them, just "tinned"). This wire is typically used to connect the components of a breadboard or other prototype or test circuit internally or with other equipment or components, without the need for soldering. It offers a convenient and easy way to interconnect the components of a circuit during testing and experimentation.

E. *Power Source*

7.4 volts two cells lithium-ion battery is used to provide power to the Arduino board and servo motors.

Battery

CIRCUIT DIAGRAMS:



## IV. METHODOLOGY/FLOWCHART/ ALGORITHM

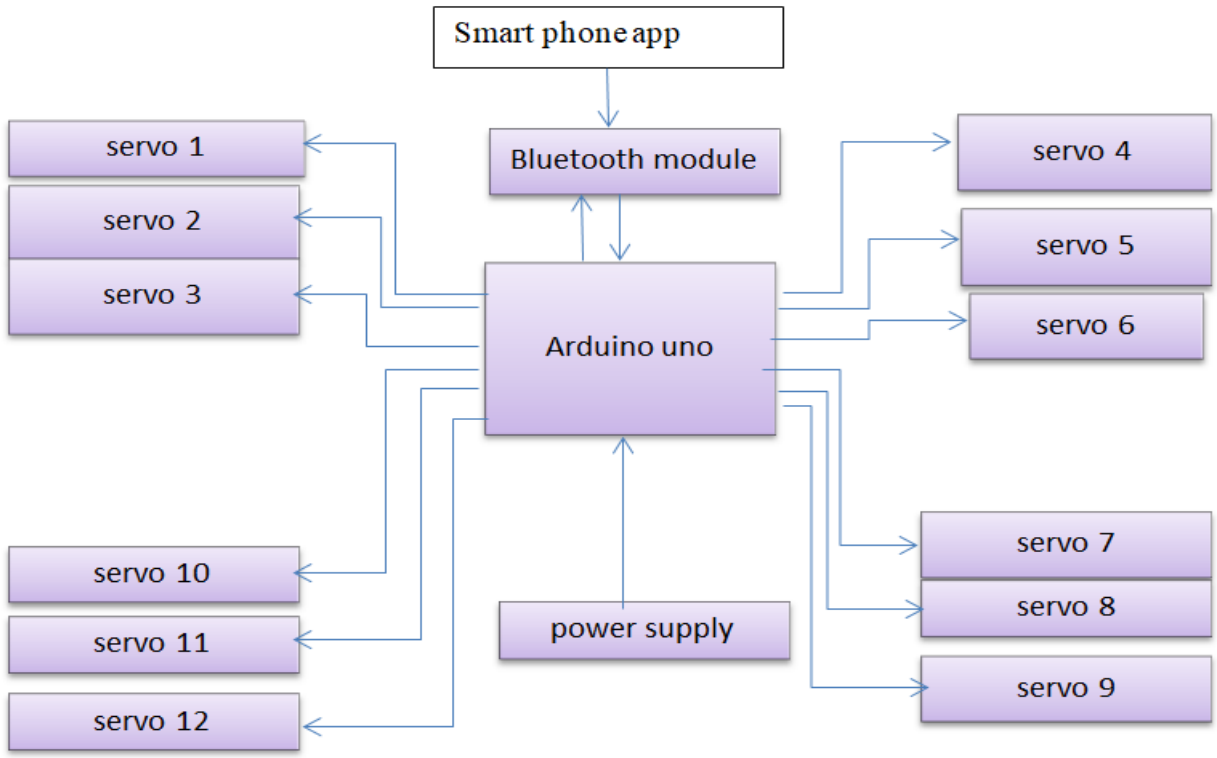



Fig. System Block Diagram

The Methodology of the project included the following steps:

Step 01: Reviewing the existing literature
Step 02: Defining problem statement
Step 03: Selection of micro controller, sensor, motor controller etc.
Step 04: Design of the body
Step 05: Design of robotic legs
Step 06: Design Calculation
Step 07: Design Assembly
Step 08: Writing source code for robot controller
Step 09: Checking for optimality and if YES the moving ahead, if NO then going for redesign from step 4.
Step 10: Fabrication of the robot
Step 11: Solving the issues encountered

## V. TIMELINE OF PROJECT DEVELOPMENT

1) Project Initiation (July 25 - August 4): Objectives were defined and the team was assembled. Set up project documentation.

2) Design and Component Selection (August 5 - September 20): Planned robot design and source components.

3) Prototyping and Assembly (September 21 - September 30): Assemble the robot and calibrate components.

4) Programming and Control (October 1 – October 10): Develop Arduino code for movement and sensors.

5) Testing and Refinement (October 11 - October 25): Test robot's movement, address issues, and refine code.

6) Documentation and Presentation (October 26 - November 9): Create project report and prepare a demonstration.

7) Conclusion and Evaluation (November 10): Final presentation. Complete administrative tasks and archive documentation.

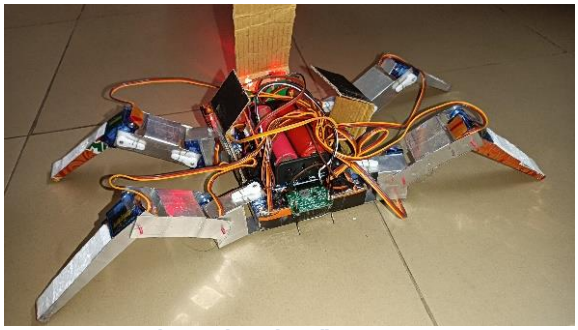


Figure 1: The Quadruped in Idle Position

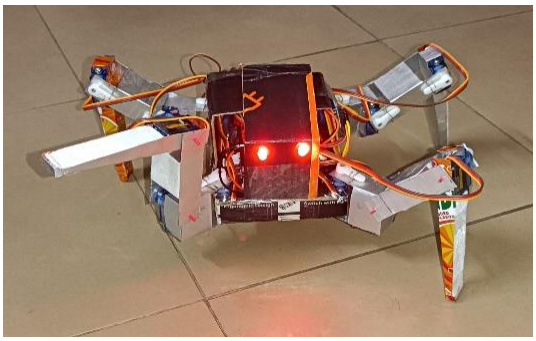


Figure 2: The Quadruped Waving

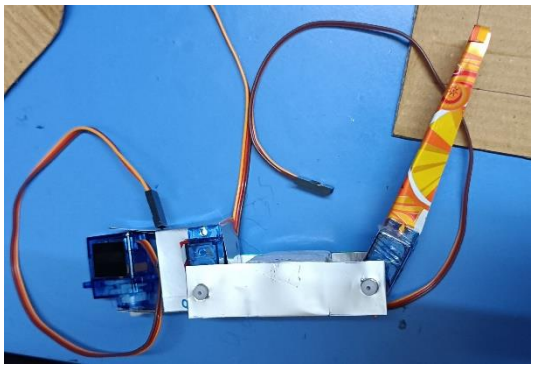


Figure 3: One of the Legs of the Quadruped

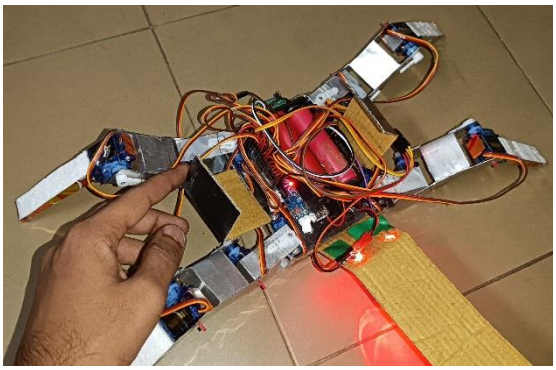


Figure 4: Connections of the Quadruped

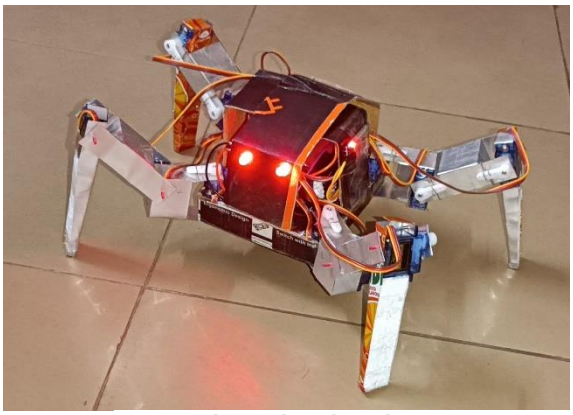


Figure 5: The Quadruped Standing

Figure 6: The Quadruped in off mode

final_robo_code | Arduino IDE 2.1.1

File Edit Sketch Tools Help

Arduino Uno

final_robo_code.ino

```
#include <Servo.h>

Servo servo[4][3];

//define servos' ports
const int servo_pin[4][3] =  { {2, 3, 4}, {5, 6, 7}, {8, 9, 10}, {11, 12, 13} };

void setup()
{
  Serial.begin(9600);
  pinMode(A0,OUTPUT);
  pinMode(A1,OUTPUT);
  //initialize all servos
  for (int i = 0; i < 4; i++)
  {
    for (int j = 0; j < 3; j++)
    {
      servo[i][j].attach(servo_pin[i][j]);
      delay(500);
    }
  }
}

void loop()
{
  Serial.println("1 sit");
  Serial.println("2 stand");
  Serial.println("3 wavehand");
  Serial.println("4 move forward");
  Serial.println("5 turn left");
  Serial.println("6 turn right");
```

Activate Windows
Go to Settings to activate Windows.

IDLE (Python 3.10 64-bit) Ln 3, Col 1 Arduino Uno [not connected] 1

Figure 7: A snippet of the code we wrote for the Quadruped

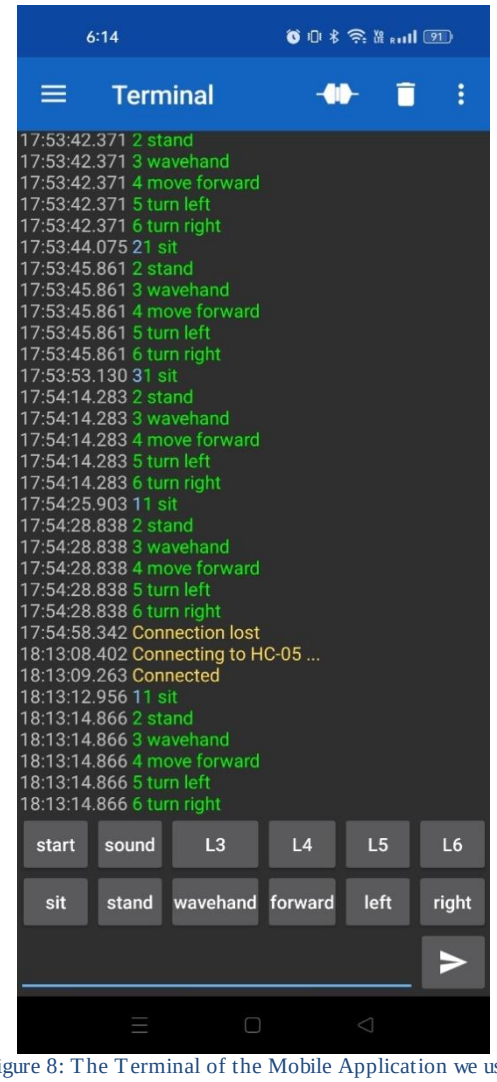


Figure 8: The Terminal of the Mobile Application we used

## VI. APPLICATIONS OF LEGGED ROBOTS

Following are the application areas of this project:

1. **Inspection**: Perhaps the most widespread application of legged robots is remote inspection. Thanks to their ability to traverse rough terrain and unstructured environments, these robots are proving incredibly useful as a means of inspecting or analysing locations either dangerous or repetitive for humans. Some examples include inspecting buildings for gas leaks and surveying nuclear sites for contamination.

2. **Surveying**: Legged robots can traverse a construction site and survey terrain, snap images using high-definition cameras, and build out 3D maps, providing operators a way to assess progress with both ease and precision.

3. **Delivery**: Traditional, wheeled, mobile robots are already experiencing a growing wave of commercial adoption, especially as e-commerce delivery systems. Their ability to transport goods through planned, paved roads, and other such structured environments is proving to be incredibly successful.

4. **Security and monitoring**: Security outfits have already found a number of effective uses for legged robots. One such application is the use of legged robots as "automated security guards". Using lidar, cameras, and other sensors, a legged robot can be used to patrol buildings or outdoor locations and alert authorities if an intruder is detected.

5. **Search and Rescue**: After disasters, the number one priority is often the search and rescue of survivors. In these dire situations, robots are proving to be highly effective supplements to human efforts. Quadrupeds, in combination with other types of robots like drones, are excellent tools for providing situational awareness, mapping debris, and helping provide context to areas where it was previously extremely difficult to do so. Time is critical in all search and rescue efforts, and these robots can accelerate these operations and ultimately save lives.

## VII. FUTURE DEVELOPMENTS

We can make some advancements such as:

1. Using ultrasonic sensor to avoid obstacles.
2. To make it sturdier and more durable we can use metal gear servo motors and for the mechanical parts we can use 3D printer to make these parts.
3. Using a vision sensor or Lidar to make it detect objects or to make it human following.
4. We can make it self-balancing using the gyroscope module.

## VIII. CONCLUSION

The main theme of this project is to build a quadruped Spider Robot. This designed architecture is suitable for all terrains like rigid and smooth surfaces. A quadruped robot can take an advantage of multiple legs to walk easily. The control of robot can be wirelessly done by means Bluetooth module and smart phone application. Using advanced hardware and with the help of innovating technology the project has been successfully implemented.

## REFERENCES


[1] Dhakolia M., Chalke P., Baniya S. & Desai A. (2021) , *Four Legged Walking Robot for Surveillance* , International Research Journal of Engineering and Technology (IRJET) Volume: 08 , May 2021

[2] Jagdale O., Kaushal P., Vitole T. & Gaikwad G.(2023), *Quadruped Robot Used for Search and Rescue Operations,* International Journal of Research Publication and Reviews, Vol 4, no 5, pp 6838-6842 , May 2023

[3] RegisHsu, *[DIY] Spider Robot(Quad Robot, Quadruped)*, https://www.instructables.com/DIY-Spider-RobotQuad-robot-Quadruped/

[4] Indian LifeHacker (2018), *How to make a WALKING SPIDER ROBOT at home | 3D printed crawling robot |*, https://www.youtube.com/watch?v=fiQbOWvqVco