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# **Four-Legged Bluetooth-Controlled Spider Robot**

# **A product development report**

# ***Submitted to***

# **Saveetha Institute of Medical and Technical Sciences**

# **Bachelor of Technology**

***BY***

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# Certified that this product development report “Four Legged Blueetooth controlled Spider Robot ” is the Bonafide of “Chandra Manaswitha”, ”192225050”,”B-Tech AIML 3rd Year” who carried out Product Development work under my supervision.

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# **Declaration by candidate**

The undersigned declares that the “Four Legged Bluetooth controlled Spider Robot” project submitted for the SPIC763 Product Development Course in our original work. We carried out this project under the guidance of Dr. Karthik Raja from January to March 2024 and it has been completed.

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**Four Legged Blueetooth controlled Spider Robot**

**Executive Summary**

The Bluetooth-Controlled Four-Legged Spider Robot is an innovative, low-cost robotics project designed to simulate real-world multi-legged movement using just two BO motors and a mechanical linkage system. Powered by an Arduino Nano, the robot is controlled wirelessly via the HC-05 Bluetooth module, allowing users to send movement commands—forward, backward, left, and right—through a mobile app interface. Built on a 3D-printed lightweight chassis, the spider robot is capable of walking on diverse surfaces, including wood, tile, and cardboard, making it highly versatile for educational demonstrations and experimental environments. The robot offers an engaging hands-on learning platform that combines mechanical design, embedded systems, and wireless communication, making it ideal for students, educators, and DIY robotics enthusiasts. With its modular and upgradeable design, the spider robot also opens possibilities for future enhancements like obstacle detection, gesture control, or camera integration—promoting creativity, problem-solving, and STEM learning.

**Introduction**

**Problem Statement**

There is a lack of affordable and compact robotic platforms that effectively demonstrate legged locomotion with wireless control, especially for educational and prototyping purposes. Most available solutions are either too simplistic in movement or too expensive for widespread adoption in schools and personal learning environments. Additionally, current robotic kits often rely on wheels, which do not accurately represent real-world multi-legged motion.

This project aims to bridge that gap by developing a cost-effective, Bluetooth-controlled spider robot capable of walking on various surfaces using just two motors to control eight legs. It provides an interactive, hands-on learning experience that combines mechanical design, embedded systems, and mobile-based wireless communication, making it ideal for learners exploring robotics, motion control, and Arduino programming.

**Purpose**

The purpose of this project is to design and develop a low-cost, Bluetooth-controlled four-legged spider robot that can demonstrate realistic walking motion using a minimal motor setup and Arduino-based control. By integrating mechanical movement, wireless communication, and surface adaptability, the robot serves as an educational and functional prototype to help students, hobbyists, and educators understand the fundamentals of robotics, embedded systems, and control mechanisms in a practical, hands-on manner.

**Scope**

This project focuses on the design, development, and testing of a Bluetooth-controlled four-legged spider robot that uses a minimal hardware setup—specifically, two BO motors and an Arduino Nano—to control eight legs through a mechanical linkage system. The robot will be capable of performing basic movements such as forward, backward, left, and right rotations, controlled via a smartphone app (Serial Bluetooth Terminal) using the HC-05 Bluetooth module.

The robot is built to walk on various flat surfaces such as wood, tile, and cardboard, making it suitable for indoor educational environments. The scope includes circuit design, motor driver integration (L298N), power management using 18650 batteries, and software development using Arduino IDE. Future enhancements like obstacle detection, gesture control, or sensor modules fall outside the current build but remain part of the robot’s expansion potential.

**GPCU**

**Market Gap**

The robotics education sector is rapidly growing, but there remains a significant gap in the availability of cost-effective, functional legged robot kits that can realistically simulate animal-like locomotion. Most commercial products either rely on simple wheel-based designs that don’t teach the complexity of mechanical leg coordination, or are advanced quadrupeds that cost thousands of rupees—making them inaccessible to the average student, hobbyist, or school lab.

Additionally, while Bluetooth-controlled toys and robots exist, they rarely offer open-source flexibility for students to modify or learn from. Very few products demonstrate how complex leg movement can be achieved using minimal hardware, such as only two motors for eight legs, making this robot a unique solution in both learning and prototyping environments.

There is also a growing demand for portable, mobile-app-controlled robots that are affordable, adaptable, and surface-compatible, especially for educational institutions in developing regions. The lack of such mid-level, hands-on robots that combine mechanical design, embedded programming, and wireless communication creates a strong market opportunity for this innovative spider robot.

### **Gap Analysis**

| **Identified Problem** | **Proposed Solution** |
| --- | --- |
| Most educational robots use wheels, offering limited learning on real-life locomotion | Introduce a legged spider robot with 8 legs driven by just 2 motors to demonstrate mechanical linkage and walking dynamics |
| Existing robotics kits are expensive and inaccessible for many students and schools | Offer a low-cost, buildable spider robot using affordable components like Arduino Nano, BO motors, and Bluetooth modules |
| Traditional robots lack flexibility in surface adaptability | Design spider legs to handle movement on tiles, cardboard, and uneven surfaces, ensuring multi-surface compatibility |
| Lack of hands-on wireless control in basic DIY robots | Enable control via HC-05 Bluetooth module and mobile apps like Serial Bluetooth Terminal for real-time interaction |
| Current educational robots don't encourage deep learning in both hardware and programming | Provide a complete embedded system experience involving motor drivers, Bluetooth communication, and Arduino |

**Competitive Analysis**

| **Competitor Name** | **Price (INR)** | **Target Audience** | **Unique Value Proposition** |
| --- | --- | --- | --- |
| **Bluetooth-Controlled Spider Robot** | ₹10,000 | Students, hobbyists | Walks using 2 BO motors, Bluetooth app-controlled, Arduino-based, surface-friendly |
| **Quadruped Servo Robot Kit** | ₹18,000 – ₹22,000 | Engineering students | Complex servo-based walking, 12 DOF, requires calibration, advanced coding |
| **Robobloq Q-Elephant Robot** | ₹19,500 | Ages 10–16 | Elephant-style walking robot, app & PC control, obstacle avoidance |
| **Lego Mindstorms EV3** | ₹35,000 – ₹50,000 | High school students | Premium coding and motion platform, sensors, multiple motors, modular |
| **Makeblock mBot Ranger** | ₹21,000 | Ages 10+ | 3-in-1 robot (tank, 2-wheeler, upright), graphical coding, Bluetooth control |
| **Tinkering Labs Electric Motors Catalyst** | ₹14,500 | Ages 10–15 | DIY robotics with motors, wheels, mounts; no walking or Bluetooth feature |

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### **Application Description**

#### **Overview**

The Bluetooth-Controlled Four-Legged Spider Robot is an innovative educational and functional prototype designed to simulate realistic walking movement using minimal hardware. Built on an Arduino Nano microcontroller and powered by just two BO motors, the robot uses a mechanical linkage system to move all eight legs. Controlled wirelessly via a smartphone using the HC-05 Bluetooth module, it offers an engaging and hands-on introduction to embedded systems, robotics, and real-time control.

This compact spider robot is not only a fun and interactive toy but also a valuable tool for students, hobbyists, and developers. It demonstrates mechanical motion concepts, embedded programming, and motor control principles in a cost-effective and modular design. Its sturdy, lightweight build allows smooth operation across different surfaces like wood, tiles, or cardboard, making it ideal for educational environments, robotics exhibitions, personal assistant prototypes, and basic lab testing scenarios.

**Key Features**

**Legged Walking Mechanism**  
Uses only 2 BO motors to drive all 8 legs through a smart mechanical linkage system, mimicking spider-like movement.

**Bluetooth-Controlled via Smartphone**  
Operates wirelessly using the HC-05 Bluetooth module and a mobile app (e.g., Serial Bluetooth Terminal).

**Arduino Nano-Based**  
Powered by an Arduino Nano microcontroller, programmed using Arduino IDE (C/C++), making it ideal for learning embedded systems.

**L298N Motor Driver**

Controls motor direction and speed with reliable H-Bridge functionality.

**Multi-Surface Movement**  
Designed to walk effectively on surfaces like tiles, cardboard, and wood, enhancing its real-world adaptability.

**Lightweight & Modular Design**  
Easy to carry and maintain; suitable for upgrades like adding sensors, cameras, or voice control.

**Battery Powered**  
Operates using 3 × 18650 Li-ion batteries with separation for logic and motor power lines, increasing stability.

**Use Cases**

**STEM Education Tool**  
Ideal for students and educators to demonstrate real-world robotics, motion mechanics, and embedded programming.

**DIY Toy for Hobbyists**  
A fun and engaging project for tech enthusiasts to explore wireless control, robotics, and Arduino development.

**Personal Assistant Prototype**  
Can be extended with sensors for basic assistant functionality such as object avoidance or gesture response.

**Exhibition Model**  
Showcases motion-based design in tech fairs, school science exhibitions, and college innovation events.

**Lab Testing Bot**  
Useful in labs for testing surface friction, load balancing, and prototype locomotion studies.

## **User Pain Points and Solutions**

**High Cost of Educational Robot -** Many programmable walking robots on the market are priced too high for students or educational institutions. This makes it difficult for schools and learners to access practical robotics tools within a limited budget.

**Complexity of Assembly and Programming -** Robots with multiple servos or advanced components often require complex coding and calibration, which can be overwhelming for beginners. Users struggle with lengthy setup times and steep learning curves, reducing hands-on engagement.

**Limited Mobility and Surface Compatibility -** Wheeled or static robots typically cannot operate well on uneven surfaces like cardboard or tiles. Users often find such robots unreliable in dynamic classroom environments where smooth operation across surfaces is necessary.

**Lack of Wireless, App-Based Control -** Some educational robots still rely on IR remotes or physical switches, limiting flexibility. Users expect Bluetooth or smartphone control for convenience, especially in modern classrooms or interactive demos.

**Low Customizability for Future Use -** Many low-cost robots are not designed for upgrades or sensor integration. Once built, they offer little scope for learning beyond basic movement, making them less valuable over time.

## **Product Uniqueness – Bluetooth-Controlled Four-Legged Spider Robot**

### **Lightweight and Modular Construction**

Compact body frame built to support walking on various surfaces (cardboard, tile, wood).

Modular leg system driven by just **2 BO motors (60 RPM)** controlling **8 legs** using a mechanical linkage design.

Lightweight structure ensures **safe handling** by kids and easy transport during demonstrations or workshops.

### **Bluetooth-Based Wireless Control**

### Controlled via **HC-05 Bluetooth module**, paired with a smartphone app (e.g., Serial Bluetooth Terminal).

Eliminates the need for dedicated remotes or wired setups, providing freedom and flexibility.

Simple command interface supports forward, backward, left, and right motion with real-time responsiveness.

### **Customizable & Educational**

### Powered by **Arduino Nano**, coded in **C/C++ via Arduino IDE**, enabling hands-on learning in embedded systems.

Easily upgradeable to include **sensors (ultrasonic, IR)**, **gesture control**, or **voice interaction**.

Ideal for those interested in **mechanical design + programming integration**.

## **Design & Engineering Standards**

**Mechanical**

Uses 2 × BO Motors (60 RPM) to actuate all 8 legs through efficient linkage.

3D-printed or laser-cut chassis provides a balanced and durable housing for motors and electronics.

Power toggle switch and 3 × 18650 battery cells offer dedicated lines for logic and motor power.

Walks reliably on flat to mildly uneven indoor surfaces like wood, paperboard, or tile.

**Software & Electronics**

**Arduino Nano** handles movement logic and Bluetooth serial communication.

Codebase designed for modular updates — future additions like obstacle detection can be integrated smoothly.

Real-time data transmission through mobile app enhances interactivity during use.

**Target Audience**

**Students (Ages 10+) & STEM Enthusiasts** – Ideal for beginners in Arduino, mechanics, and Bluetooth projects.

**Educators & Workshops** – Used as a teaching aid for motion mechanics, coding basics, and wireless control systems.

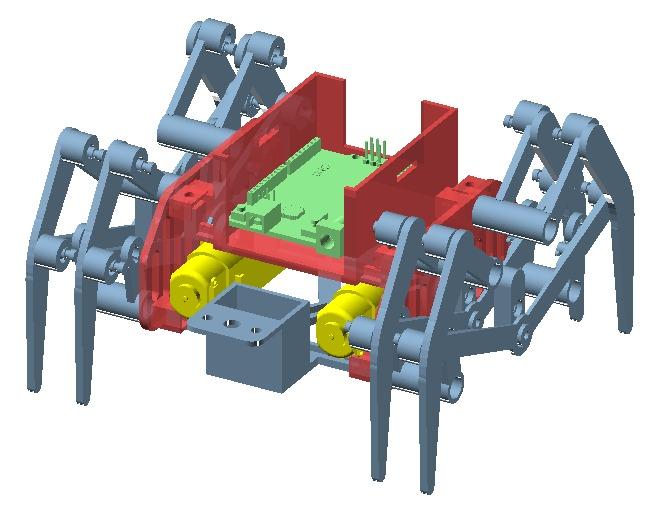
**DIY Hobbyists** – Encourages creativity and hands-on building, with scope for add-on modules.

**Makers & Roboticists** – A great platform for prototyping walking robots with low-cost components.

**Tech Exhibitions** – Perfect for showcasing robotics innovation and cost-effective engineering in college fairs or expos.

**Schools & Institutions** – Fits into academic robotics kits with a focus on budget-friendly, engaging solutions.

**3D Design**



**3D Design of the product**

**Robot Chassis**

Custom-built lightweight body housing the electronics and motor system.

Designed to support a four-legged mechanism, converting motor rotation into spider-like walking.

Durable and compact, suitable for classroom demonstrations and hobbyist use.

**BO Motors (2 × 60 RPM)**

Two BO motors drive all 8 legs using a synchronized linkage mechanism.

Motors provide enough torque to support walking over smooth and semi-rough surfaces.

Energy-efficient and safe speed range for indoor, educational use.

**Arduino Nano**

The microcontroller that acts as the brain of the robot.

Processes Bluetooth commands and controls motor direction through the motor driver.

Allows easy programming using the Arduino IDE for future customization.

**HC-05 Bluetooth Module**

Enables wireless control via smartphone (e.g., using Serial Bluetooth Terminal app).

Receives directional commands (forward, backward, left, right) and relays them to Arduino.

Facilitates user-friendly operation without additional remotes or screens.

**L298N Motor Driver**

Controls motor direction and speed based on commands from the Arduino.

Dual H-bridge configuration allows smooth forward and reverse walking motion.

Handles current load from motors while protecting the Arduino from back EMF

**Power Supply – 3 × 18650 Batteries**

Two batteries power the motors, while one powers the control circuit.

Dual-line setup prevents voltage drops and ensures stable performance.

Rechargeable and easily replaceable, ideal for prototyping and repeated use.

**Movement Mechanism**

Eight legs are driven by only two motors using a mechanical linkage system.

Converts rotary motion into a walking gait that mimics a spider's movement.

Supports movement on tile, wood, and flat cardboard surfaces.

**Control Interface**

Bluetooth app interface (e.g., Serial Bluetooth Terminal) used for navigation.

Commands like "F" (forward), "B" (backward), "L" (left), "R" (right) are sent from the phone to the robot.

Real-time movement makes it interactive and engaging for learning.

**Future Expansion Possibilities**

Can be upgraded with sensors (IR, ultrasonic) for obstacle avoidance.

Compatible with gesture, voice control, or camera modules for advanced development.

Modular design enables easy hardware and code modifications.

**Future Enhancements**

**Obstacle Detection System**

Add ultrasonic or IR sensors to detect and avoid obstacles during movement.

Improve autonomy and navigation on uneven or cluttered surfaces.

**Custom Bluetooth App Interface**

Replace Serial Bluetooth Terminal with a user-friendly mobile app.

Integrate buttons, joystick controls, and visual feedback for better user experience.

**Voice Command Support**

Incorporate voice control using a Bluetooth voice recognition module.

Enable simple commands like “move forward” or “stop” to make it more interactive for children.

**Camera Attachment (Optional)**

Add a lightweight camera module to stream or record robot navigation.

Useful for STEM demonstrations or surveillance-based learning activities.

**Battery Monitoring System**

Integrate a voltage sensor and OLED display to show live battery percentage.

Helps users charge timely and avoid unexpected shutdowns.

**Gesture Control Module**

Use IR/ultrasonic hand gesture modules for contactless movement control.

Enhances accessibility for younger or special-needs users.

**RGB LED Feedback System**

Add LED indicators that change based on direction, commands, or battery level.

Makes the robot visually engaging and responsive.

**Modular Sensor Expansion**

Design the chassis to easily plug in additional sensors (e.g., light, gas, temperature).

Expands learning possibilities and use in smart-lab environments.

**Conclusion**

The Bluetooth-Controlled Four-Legged Spider Robot is a compact, innovative, and educational prototype designed to make robotics accessible, interactive, and fun. Built with an Arduino Nano, HC-05 Bluetooth module, and BO motors, the robot combines basic mechanics and wireless control in a simple yet powerful way. Its smooth, spider-like walking motion driven by only two motors and an easy-to-use mobile interface demonstrates the potential of minimal components used efficiently.

The robot serves as a versatile platform for hands-on learning, DIY experimentation, and interactive teaching. Whether used as a toy, classroom demonstrator, or personal project, it introduces users to fundamental robotics concepts like movement coordination, Bluetooth communication, and modular design. With its scalable architecture, this spider robot lays a solid foundation for future enhancements, such as obstacle detection, gesture control, or app-based customization.

By blending creativity with technical learning, the project not only addresses the growing demand for affordable, programmable robots but also inspires curiosity and innovation in students, hobbyists, and educators alike.