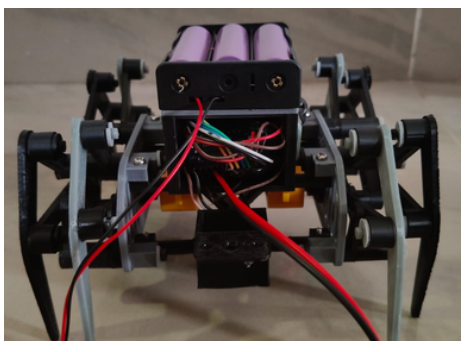
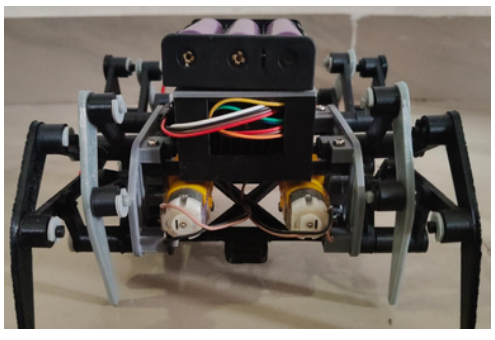
Four-Legged Bluetooth - Controlled Spider Robot

Concept

This Bluetooth-controlled spider robot promotes hands-on learning through motion and control. Using just two motors to drive eight legs, it mimics spider-like movement on different surfaces. Built with an Arduino Nano and HC-05 module, it responds to commands from a smartphone. Compact, modular, and educational, it helps students explore robotics, wireless control, and mechanical design in a fun and interactive way.

Competitive Analysis





Traditional wired or multi-motor spider robots can be bulky, complex, or power-intensive, making them harder to use in learning environments. They often rely on multiple motors for leg movement, increasing cost, weight, and assembly difficulty. On the other hand, advanced quadruped robots with AI and sensors offer great features but are expensive, require high-level coding, and aren't easily accessible to beginners or students.

The Four-Legged Bluetooth-Controlled Spider Robot bridges this gap by offering smooth, spider-like movement using only two motors and a clever linkage design. Controlled via a simple smartphone app, it combines mechanical learning with wireless interaction. Lightweight, cost-effective, and easy to assemble, it's ideal for students and educators looking to explore robotics, motion control, and embedded systems in a fun and accessible way.

Problem Statement

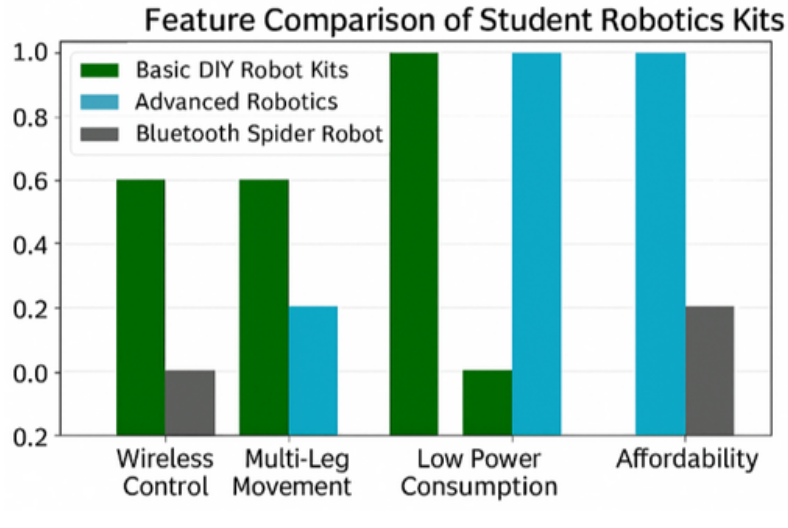
- **Limited access to affordable and functional robotics kits that demonstrate real-world movement and control.**
- **Lack of interactive learning tools that combine mechanical design with wireless communication**

User Persona

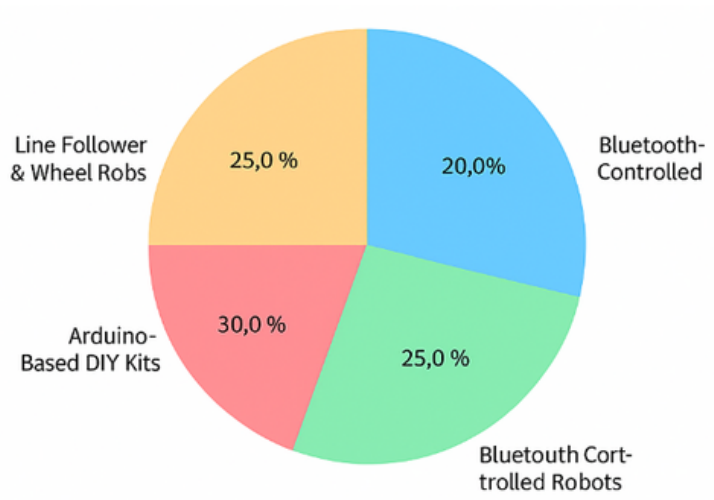
Name: Vignan
Age: 25
Occupation: B.Tech Student (Electronics & Robotics)
Location: Hyderabad, India
Background:
Vigan is a curious and hands-on learner pursuing engineering. He enjoys building small robotic systems, experimenting with Arduino-based projects, and exploring how mechanical movement can be optimized with minimal hardware.

Solution

The Four-Legged Bluetooth-Controlled Spider Robot blends mechanical innovation with wireless technology to create an engaging, hands-on learning experience. It uses a smart linkage system to control eight legs with just two BO motors, enabling smooth, spider-like movement. Controlled via a smartphone using Bluetooth, it introduces learners to embedded systems, motion control, and mechanical design in a simple, affordable, and interactive way.

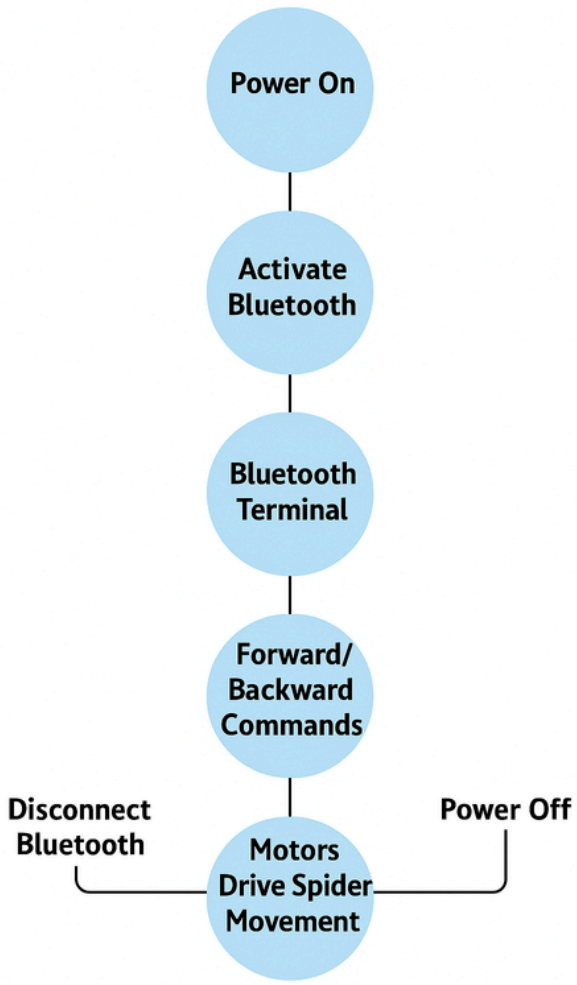


Market Analysis: Interactive Learning Tools for Children



Comparison of Robotics Tools in Indian Market

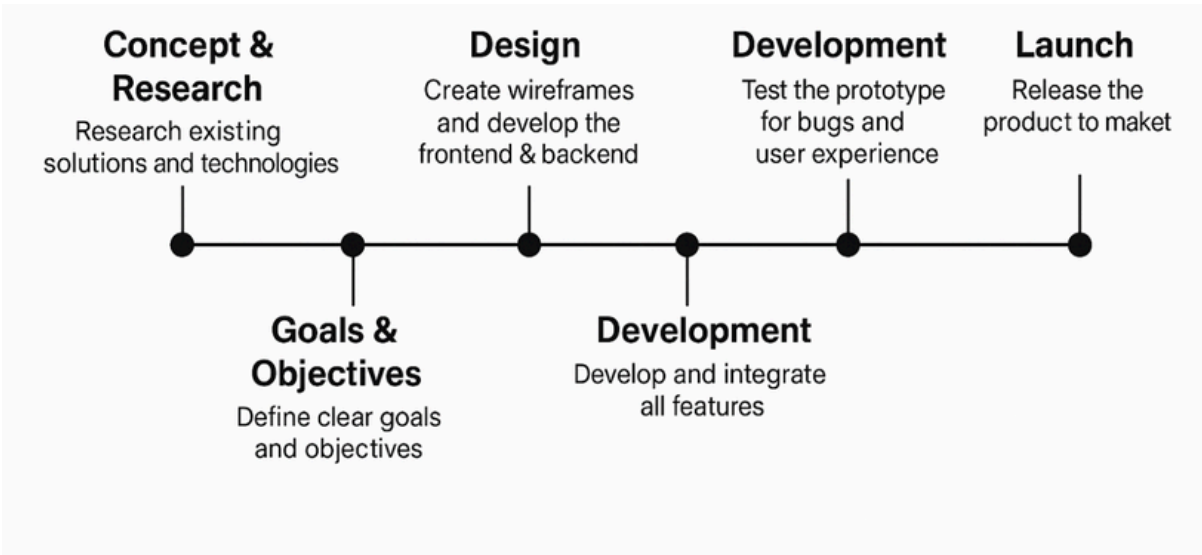
User Flow Diagram



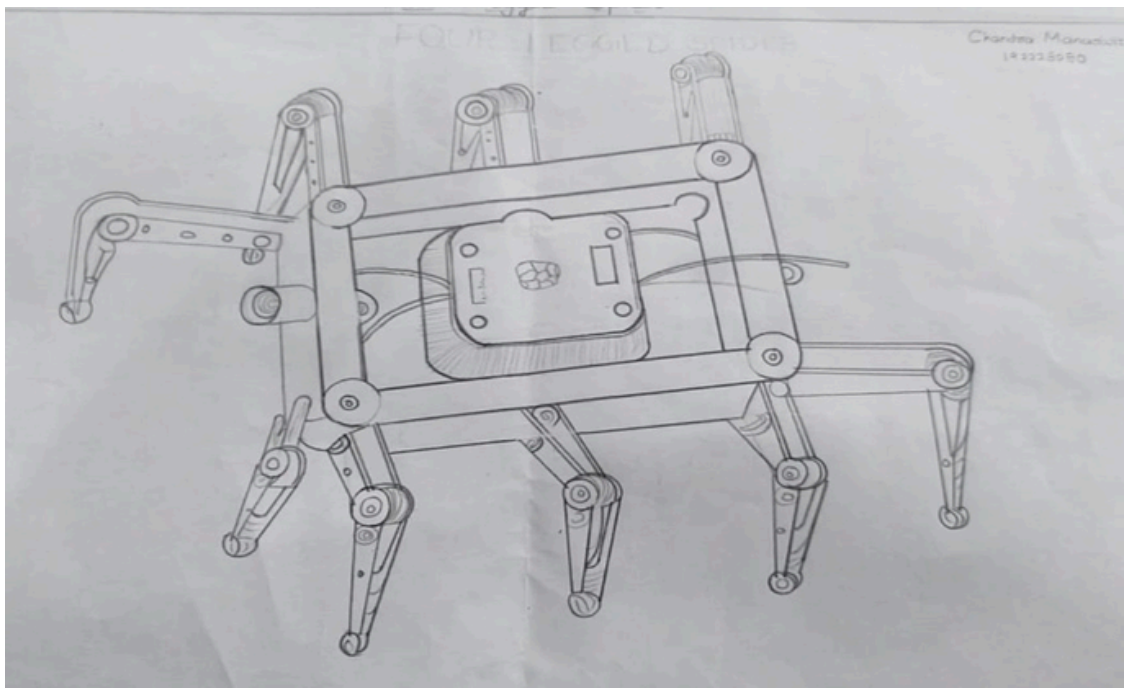
Specifications

Parameter	Specification
Product Type	Wireless, compact, Bluetooth-controlled four-legged spider robot
Motion Mechanism	2 BO motors (60 RPM) driving 8 legs via mechanical linkage system
Control System	Arduino Nano microcontroller programmed for movement and Bluetooth communication
Connectivity	HC-05 Bluetooth module, communicates with mobile app (Serial Bluetooth Terminal)
Motor Driver	L298N dual H-bridge motor driver for directional motor control
Power Supply	3 × 18650 Li-ion batteries (with holder), separate lines for motor and logic
Movement Capabilities	Forward, backward, left, right rotation – via app commands
Control Interface	Smartphone Bluetooth app interface (buttons/commands)
Chassis Design	3D-printed lightweight modular frame, supports smooth walking on rough surfaces
Battery Backup	1–2 hours depending on surface type and usage load
Programming Language	Arduino C/C++ using Arduino IDE
Use Cases	Educational robot, DIY toy, personal assistant, lab/testing prototype
Weight	~500–700g (lightweight for portability)
Future Expansion	Add sensors (IR, Ultrasonic), voice/gesture control, or camera vision modules

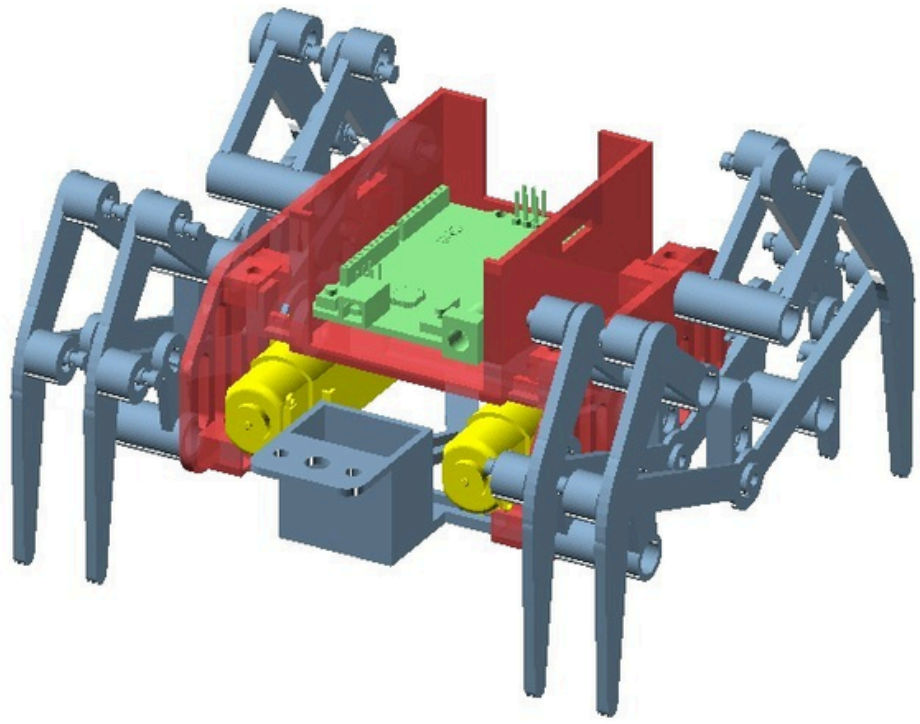
Project Timeline

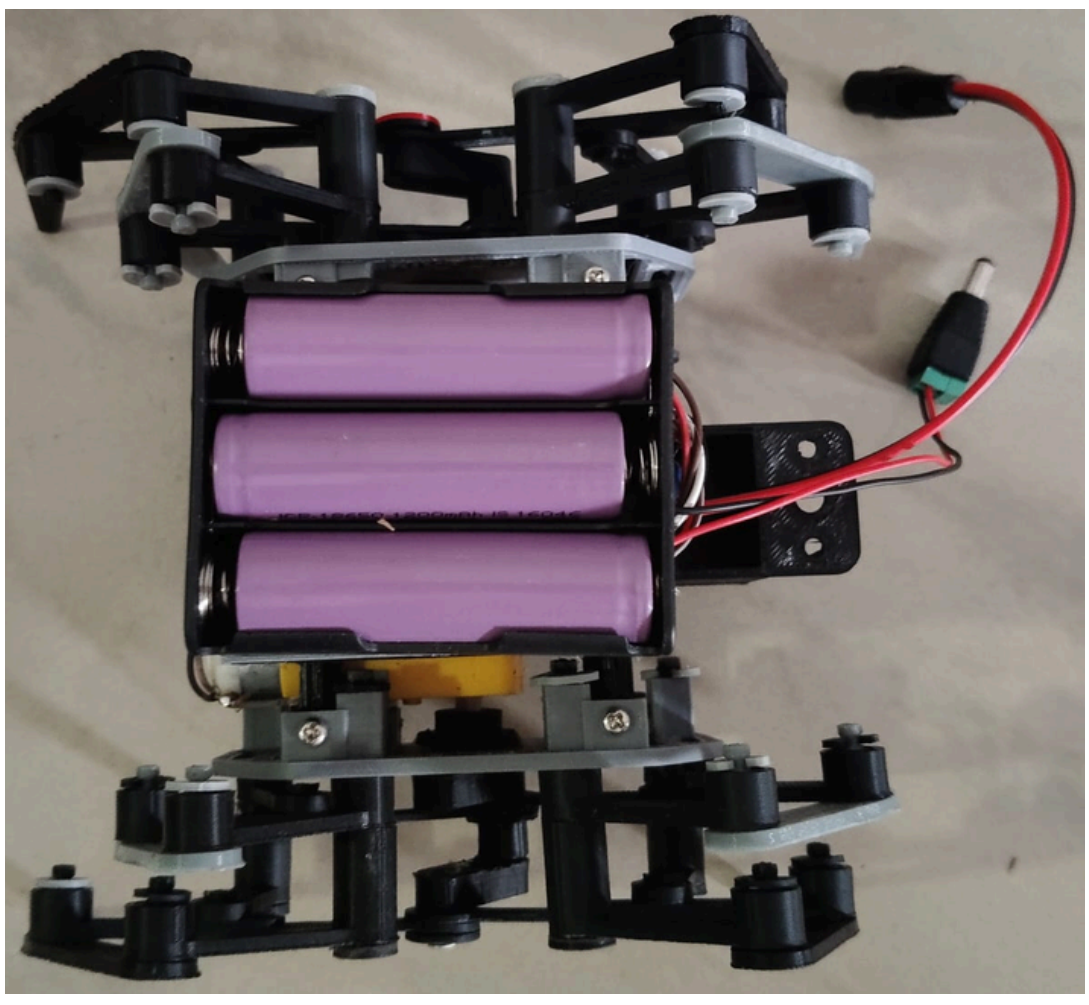


2D Diagram



3D Design





Unique Selling Features

- Interactive & Educational - Introduces children and students to robotics, Bluetooth technology, and movement logic in a fun, hands-on way.
- Mechanically Efficient - Operates 8 legs using just 2 BO motors via a smart linkage system, simplifying complexity without sacrificing mobility.
- Wireless Bluetooth Control - Controlled using a mobile app via the HC-05 module—easy to operate with directional commands like forward, back, turn.
- Compact & Lightweight - Small footprint with a 3D-printed body, designed for classroom desks, labs, and at-home learning environments.
- Child-Friendly Design - Rounded edges, battery-powered operation, and simple app interface make it safe and easy for young users.
- Surface-Ready Mobility - Walks effectively on tile, wood, and cardboard surfaces—ideal for dynamic demonstrations across floor types.
- Modular & Expandable - Built to grow—can be enhanced with sensors, obstacle detection, or gesture/voice controls for advanced functionality.
- Budget-Conscious Build - Delivers advanced features under ₹10,000, making it accessible for schools, STEM clubs, and DIY learners.

Case study - An Overview

Challenge
With increasing interest in DIY robotics but limited access to affordable, programmable walking robots, engineering student Sruthi sought a hands-on project to explore mechanical movement and Bluetooth control.
Available kits were either too expensive, complex for beginners, or lacked flexibility in terms of surface adaptability.
She needed something educational, budget-friendly, and suitable for rough surfaces like wood, tile, and cardboard.

💡 **Solution**
Developed a Bluetooth-Controlled Four-Legged Spider Robot featuring:

- A smart linkage system driven by 2 BO motors to control all 8 legs
- Arduino Nano as the brain for programming movements
- HC-05 Bluetooth module paired with a mobile app for wireless control
- A lightweight, modular chassis for walking across varied surfaces
- Power-efficient design using 18650 Li-ion batteries

📈 **Results**
🦿 Functional Mobility: Smooth walking on multiple indoor surfaces with real-time control
📱 Wireless Control: User-friendly app made the robot fun and engaging for demonstrations
🛠️ STEM Learning: Strengthened understanding of mechanics, programming, and circuit design
💡 Expandability: Designed with future upgrades in mind (sensors, gestures, obstacle detection)

Conclusion
The Four-Legged Spider Robot proved to be an excellent combination of engineering, education, and creativity. It enabled Sruthi to:
✔️ Build a working prototype on a student budget
✔️ Learn Arduino programming and mechanical design
✔️ Inspire others through demos and project showcases

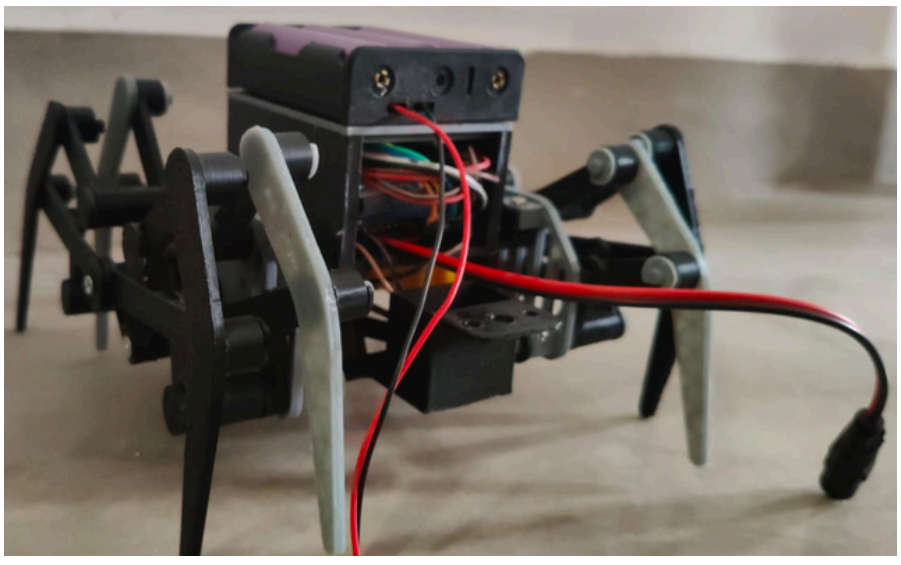
⚙️ Gap Analysis

- Most low-cost robotics kits lack walking motion; instead, they rely on wheels, reducing real-world learning about legged locomotion.
- Current educational robots are either too expensive or too complex for beginners, making them inaccessible to students and hobbyists.
- Limited integration of wireless control and programmable movement in compact spider-style robots.
- Many kits are not optimized for multi-surface mobility, restricting their use in practical environments like classrooms or homes.

✅ Identified User Needs

- An affordable, Bluetooth-controlled walking robot that introduces students to mechanical motion and embedded systems.
- Simple mobile app-based control via HC-05 Bluetooth module for wireless direction commands.
- A mechanical linkage system that simulates realistic walking using only 2 motors for cost efficiency.
- Lightweight, portable spider robot that functions well on surfaces like tile, wood, and cardboard—ideal for labs, classrooms, and tech expos.

Four-Legged Bluetooth-Controlled Spider Robot



Limitations

Surface Dependency
Basic Control System
One-Way Communication

Application

- **STEM Education:** Ideal for teaching students about robotics, Arduino programming, motor control, and mechanical linkages in a hands-on manner.
- **DIY & Hobby Projects:** Great for robotics enthusiasts and makers who want to experiment with multi-legged movement and mobile control systems.
- **Technical Demonstrations:** Suitable for showcasing basic embedded systems and motion control at science fairs, project expos, and academic workshops.
- **Personal Assistant Prototype:** With further development, can be expanded into a basic task assistant for object tracking or gesture-based control.

Advantages

- **Cost-Effective:** Uses minimal components (only 2 motors to drive 8 legs), making it budget-friendly for students and hobbyists.
- **Bluetooth Control:** Wireless operation through a mobile app provides ease of use and flexibility.
- **Educational Value:** Enhances learning in embedded systems, mechanics, and Arduino programming.
- **Portable & Lightweight:** Easy to carry, demo, and use across different locations like classrooms, labs, or homes.
- **Multi-Surface Mobility:** Can walk on tile, wood, and cardboard surfaces with stability.
- **Expandable:** Can be upgraded with sensors (e.g., ultrasonic, IR) for advanced features like obstacle detection or automation.

Disadvantages

- **Limited Movement Precision:** No steering or advanced gait control; only basic forward, backward, and rotation movements.
- **No Autonomy:** Requires manual control via Bluetooth; no obstacle sensing or decision-making.
- **Surface Sensitivity:** May not perform well on soft or uneven surfaces like thick carpet or gravel.
- **Limited Power Backup:** Battery life is around 1–2 hours, depending on usage and surface.
- **Basic Interface:** No display or feedback system to monitor battery status, connectivity, or performance.
- **Not Load-Bearing:** Cannot carry objects or support additional heavy modules without affecting balance.

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