VISVESVARAYA TECHNOLOGICAL UNIVERSITY

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Mini Project Report

on

"WEED REMOVAL ROBOT: DEVELOP A ROBOT THAT CAN IDENTIFY AND REMOVE WEEDS FROM FIELDS, REDUCING THE NEED FOR HERBICIDES."

Submitted in partial fulfillment of the requirements for the **First Semester of the Bachelor of Engineering Degree**, towards the completion of the **Mini Project** under the **Innovation & Design Thinking Laboratory**, Department of Basic Sciences.

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CERTIFICATE

This is to certify that the File Structures mini project entitled "Weed Removal Robot: Develop a robot that can identify and remove weeds from fields, reducing the need for herbicides." has been successfully carried out by Syed Fateh Ali (P-28), Syed Sameena (P-29), and Tanish M (P-30), bonafide students of **CMR Institute of Technology.**

The project is submitted in partial fulfillment of the requirements for the First Semester of the Bachelor of Engineering Degree, towards the completion of the Mini Project under the **Innovation & Design Thinking Laboratory, Department of Basic Sciences.**

It is further certified that all corrections and suggestions indicated during the Internal Assessment have been duly incorporated in the project report submitted to the departmental library. This File Structures mini project report has been reviewed and approved as it satisfies the academic requirements prescribed for the said degree.

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Abstract

The Weed Removal Robot project aims to develop a simple and eco-friendly automated system to assist in weed removal for agricultural applications. The primary objective is to reduce manual labor and minimize the use of chemical herbicides by employing a mechanical weed removal approach. The system operates through controlled movement and a motor-driven cutting mechanism that removes weeds from the soil surface. Wireless control enables flexible operation of the robot during field use, allowing precise movement and activation of the cutting mechanism. The robot is designed to navigate across flat agricultural surfaces and perform weed removal through user-controlled operation. Emphasis is placed on low cost, simplicity, and ease of implementation, making the system suitable for small-scale farming applications. Experimental testing conducted under controlled conditions demonstrates effective weed removal with reduced human effort. The results indicate that the system can perform basic weed removal tasks efficiently while promoting environmentally sustainable farming practices. Overall, the project successfully demonstrates a practical and economical solution for mechanical weed removal, contributing to improved productivity and reduced environmental impact in agricultural operations.

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Chapter 1

INTRODUCTION

Agriculture is one of the most important sectors contributing to the economic growth and food security of a nation. In countries like India, agriculture not only provides food for the population but also offers employment opportunities to a large section of society. Despite technological progress in many sectors, agricultural practices still face numerous challenges that directly affect crop productivity and farmer income. One such major challenge is **weed infestation**.

Weeds are unwanted plants that grow along with cultivated crops. These plants grow aggressively and compete with crops for essential growth resources such as soil nutrients, water, sunlight, and physical space. Due to this competition, crops fail to reach their full growth potential, leading to reduced yield and poor crop quality. Research studies indicate that if weeds are not controlled effectively, crop yield losses can range from 20% to 40%, depending on the type of crop, weed density, and environmental conditions. In severe cases, uncontrolled weed growth can even lead to complete crop failure.

Traditionally, weed control has been carried out using **manual labor**. This method involves farm workers physically removing weeds using hand tools such as hoes and sickles. While manual weeding is effective, it is extremely labor-intensive and time-consuming. Workers are required to bend for long hours under harsh climatic conditions, which causes physical strain, fatigue, and long-term health problems. Additionally, due to increasing labor shortages and rising wages, manual weed removal has become economically unviable for many farmers.

To overcome labor-related challenges, chemical herbicides were introduced and widely adopted. Chemical weed control methods are fast and effective for large agricultural fields. However, excessive use of herbicides has resulted in serious environmental and health-related issues. Chemical residues contaminate soil and water resources, reduce soil fertility, harm beneficial microorganisms, and pose health risks to farmers and consumers. Over time, weeds develop resistance to herbicides, making chemical weed control less effective and more expensive.

With advancements in science and technology, **automation and robotics** have entered the agricultural domain. Simple robotic systems can perform repetitive agricultural tasks

efficiently, reduce human effort, and increase productivity. Mechanical weed removal using robotic systems is gaining attention as an eco-friendly alternative to chemical-based weed control.

This project focuses on the development of a **Bluetooth-controlled Weed Removal Robot that identifies and removes weeds in an efficient and eco-friendly way**. The robot uses a motor-driven cutting mechanism to remove weeds mechanically and is controlled wirelessly using a mobile device. The system is designed to be simple, cost-effective, and suitable for small-scale farming and educational applications.

1.1 Brief History of Weed Control Methods

In ancient agricultural practices, weed control was completely dependent on human labor. Farmers used basic hand tools to remove weeds manually. Although effective for small fields, this method required a large workforce and significant time investment. As agricultural land areas increased, manual weed removal became inefficient and physically exhausting.

The introduction of chemical herbicides during the mid-20th century revolutionized weed control practices. Farmers could manage large areas quickly with minimal labor. However, long-term dependence on chemicals resulted in soil degradation, water pollution, health risks, and herbicide-resistant weeds. These challenges highlighted the need for safer and more sustainable weed control methods.

Mechanical weed control methods such as cultivators and rotary weeders were reintroduced as alternatives. In recent years, robotic weed removal systems have been developed to combine efficiency with environmental safety. Simple robots using mechanical cutting mechanisms represent an important step toward sustainable and technology-driven agriculture.

1.2 Need for Automated Weed Removal System

In ancient agricultural practices, weed control was completely dependent on human labor. Farmers used basic hand tools to remove weeds manually. Although effective for small

fields, this method required a large workforce and significant time investment. As agricultural land areas increased, manual weed removal became inefficient and physically exhausting.

The introduction of chemical herbicides during the mid-20th century revolutionized weed control practices. Farmers could manage large areas quickly with minimal labor. However, long-term dependence on chemicals resulted in soil degradation, water pollution, health risks, and herbicide-resistant weeds. These challenges highlighted the need for safer and more sustainable weed control methods.

Mechanical weed control methods such as cultivators and rotary weeders were reintroduced as alternatives. In recent years, robotic weed removal systems have been developed to combine efficiency with environmental safety. Simple robots using mechanical cutting mechanisms represent an important step toward sustainable and technology-driven agriculture.

Chapter 2

2.1 Problem Statement

Weed growth is one of the most critical challenges faced by farmers across different types of agricultural practices. Weeds grow faster than crops and consume vital resources such as water, nutrients, sunlight, and soil space. This competition directly impacts crop health, leading to reduced growth rate, poor yield quality, and significant economic losses for farmers. Studies show that weed infestation can reduce agricultural productivity by up to 40% if not controlled at the right time.

Traditional weed control methods have several limitations. Manual weed removal, although effective, is highly labor-intensive and physically exhausting. Farm workers are required to work in bent positions for long durations, often under extreme weather conditions. This leads to physical fatigue, musculoskeletal problems, and decreased efficiency. Additionally, the availability of agricultural labor is declining due to urban migration and changing employment patterns. As a result, labor costs are increasing, making manual weed removal economically unsustainable for many farmers.

Chemical herbicides were introduced to address labor shortages and speed up weed control. While herbicides are effective, their excessive use has led to environmental degradation. Chemical residues contaminate soil and water bodies, harm beneficial organisms, and pose health risks to farmers and consumers. Long-term herbicide use has also resulted in herbicide-resistant weed species, which require higher chemical doses and increase production costs.

Mechanical weed removal offers an environmentally friendly alternative, but conventional mechanical tools still require human operation and are not efficient for continuous operation. Therefore, there is a strong need for an **automated or semi-automated weed removal system** that can reduce human effort, eliminate chemical usage, and provide consistent weed control. The system should be affordable, easy to operate, and suitable for small and medium-scale farming environments.

2.2 Objective of the Project

The primary goal of this project is to design and develop a **Bluetooth-controlled Weed Removal Robot** that can mechanically remove weeds while minimizing human effort and environmental impact. The detailed objectives are:

1. To design a mobile robotic platform capable of stable movement in agricultural fields
2. To implement Arduino-based control logic for robot movement and weed removal
3. To integrate Bluetooth communication for wireless control using a mobile device
4. To design a mechanical cutting mechanism for physical weed removal
5. To protect electronic components using relay-based switching
6. To reduce dependency on manual labor and chemical herbicides
7. To develop a low-cost and portable system suitable for educational and small-scale agricultural use
8. To demonstrate the practical application of embedded systems and robotics in agriculture

---

2.3 Proposed Solution

The proposed solution is the development of a **Bluetooth-controlled Weed Removal Robot** designed to reduce manual labor and eliminate the use of chemical herbicides in agricultural weed management. The system is based on a simple yet effective embedded control approach using an **Arduino UNO microcontroller** as the central control unit.

The robot is mounted on a **four-wheel chassis** driven by **four DC motors**, which provide stable movement across the field. The motion of these motors is controlled using an **L298N motor driver module**, which allows the robot to move forward, backward, left, and right based on control commands. The motor driver acts as an interface between the Arduino and the motors, ensuring safe and efficient power delivery.

A **mechanical weed cutting mechanism** is used to physically remove weeds. This mechanism consists of a **DC motor attached to a plastic fan blade**, which rotates at high

speed to cut weeds near the soil surface. To protect the Arduino from high current drawn by the cutting motor, a **relay module** is used. The relay functions as an electrically controlled switch, enabling safe activation and deactivation of the cutting motor without damaging the microcontroller.

The robot is controlled wirelessly using an **HC-05 Bluetooth module**, which allows the user to send movement and cutting commands from a mobile device. This provides flexibility and ease of operation, enabling the user to manually guide the robot toward weed-affected areas.

The entire system is powered by **rechargeable Li-ion batteries**, making the robot portable and suitable for outdoor field operations. The design emphasizes **simplicity, low cost, modularity, and ease of maintenance**, making the system suitable for small and medium-scale farmers as well as educational and demonstration purposes.

2.4 Advantages of Proposed Solution

The proposed Weed Removal Robot offers several advantages over traditional weed control methods such as manual weeding and chemical herbicide application.

Environmental Advantages

- Eliminates the use of chemical herbicides, reducing soil and water pollution
- Prevents contamination of groundwater and nearby water bodies
- Protects beneficial insects and soil microorganisms
- Supports eco-friendly and sustainable agricultural practices

Economic Advantages

- Reduces dependency on manual labor, lowering labor costs
- Eliminates recurring expenses related to herbicide purchase
- Uses low-cost and easily available components
- Provides long-term cost savings through reusable hardware

Operational Advantages

- Can operate continuously without physical fatigue
- Wireless Bluetooth control allows easy handling and flexibility
- Provides consistent weed removal performance
- Portable battery-powered operation enables use in different locations

Technical Advantages

- Simple Arduino-based design ensures easy programming and modification
- L298N motor driver enables smooth control of multiple DC motors
- Relay protection increases system reliability and safety
- Modular structure allows easy repair, replacement, and future upgrades

Social and Practical Advantages

- Reduces physical strain and health issues associated with manual weeding
- Encourages adoption of automation in agriculture
- Improves farmer safety by avoiding chemical exposure
- Suitable for educational projects and small-scale agricultural applications

Overall, the proposed solution provides a **practical, low-cost, and environmentally safe approach** to weed control. It bridges the gap between traditional farming practices and modern agricultural automation while remaining simple and accessible.

Chapter 3

3.1 Design Thinking Process

The Weed Removal Robot was developed using a structured **design thinking approach** to ensure that the solution addresses real agricultural problems in a practical and affordable manner. This approach focuses on understanding user needs, defining the problem clearly, exploring solutions, building a prototype, and testing its performance.

The design thinking process followed five main stages: **Empathize, Define, Ideate, Prototype, and Test**.

---

a) Empathize

The empathize stage focused on understanding the challenges faced by farmers and agricultural workers during weed removal operations. Through basic observations, discussions, and analysis of farming practices, several common problems were identified.

Farmers reported that manual weed removal requires long working hours and involves bending continuously, which leads to physical strain, back pain, and fatigue. Labor shortages during peak agricultural seasons further increase the difficulty of timely weed management. Many farmers also expressed concern over the rising cost of labor and the harmful effects of chemical herbicides on soil quality and human health.

These observations highlighted the need for a **simple, safe, and affordable solution** that can reduce physical effort and eliminate chemical dependency.

---

b) Define

Based on the empathize stage, the problem was clearly defined as:

The need for a low-cost, easy-to-operate weed removal system that reduces manual labor, avoids chemical herbicides, and improves efficiency in small and medium-scale farming.

The system should:

- Reduce physical strain on farmers

- Be simple to operate without technical expertise
- Use mechanical weed removal instead of chemicals
- Be portable and battery powered
- Be affordable and easy to maintain

---

c) Ideate

During the ideation stage, multiple solutions were considered to address the defined problem. These included traditional manual tools, tractor-mounted weeders, sensor-based systems, and robotic platforms.

After evaluating cost, simplicity, availability of components, and feasibility within an academic project timeline, a **Bluetooth-controlled Arduino-based robot** was selected as the most suitable solution.

This approach was chosen because:

- Arduino is easy to program and widely available
- Bluetooth control allows flexible manual operation
- Mechanical weed cutting is effective and eco-friendly
- Components are affordable and easy to assemble

---

d) Prototype

A working prototype of the Weed Removal Robot was developed using readily available electronic and mechanical components. The robot was built on a **four-wheel chassis** to ensure stability and smooth movement.

The prototype includes:

- **Arduino UNO** as the control unit
- **L298N motor driver** to control four DC motors
- **HC-05 Bluetooth module** for wireless control

- **DC motor with plastic fan blade** for weed cutting
- **Relay module** to protect Arduino pins
- **Rechargeable Li-ion battery** for power supply

All components were assembled and wired carefully to ensure proper functioning and safety.

---

e) Test

The prototype was tested under basic field-like conditions. The robot successfully moved in all directions and activated the weed cutting mechanism when commanded through Bluetooth.

The system operated continuously for approximately **2–3 hours** on a single battery charge. Minor issues such as reduced performance on uneven terrain were observed, but overall functionality was satisfactory. The testing phase confirmed that the design meets basic weed removal requirements.

3.2 Methodology

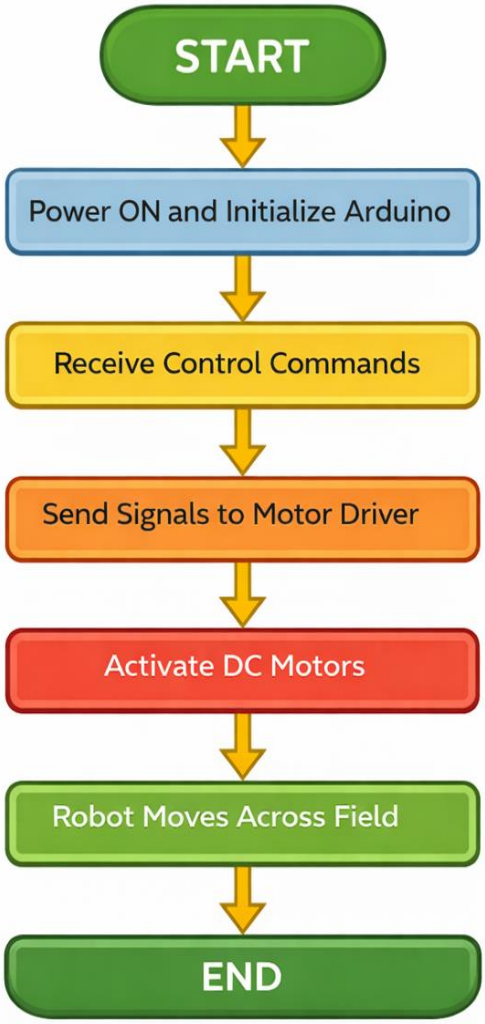
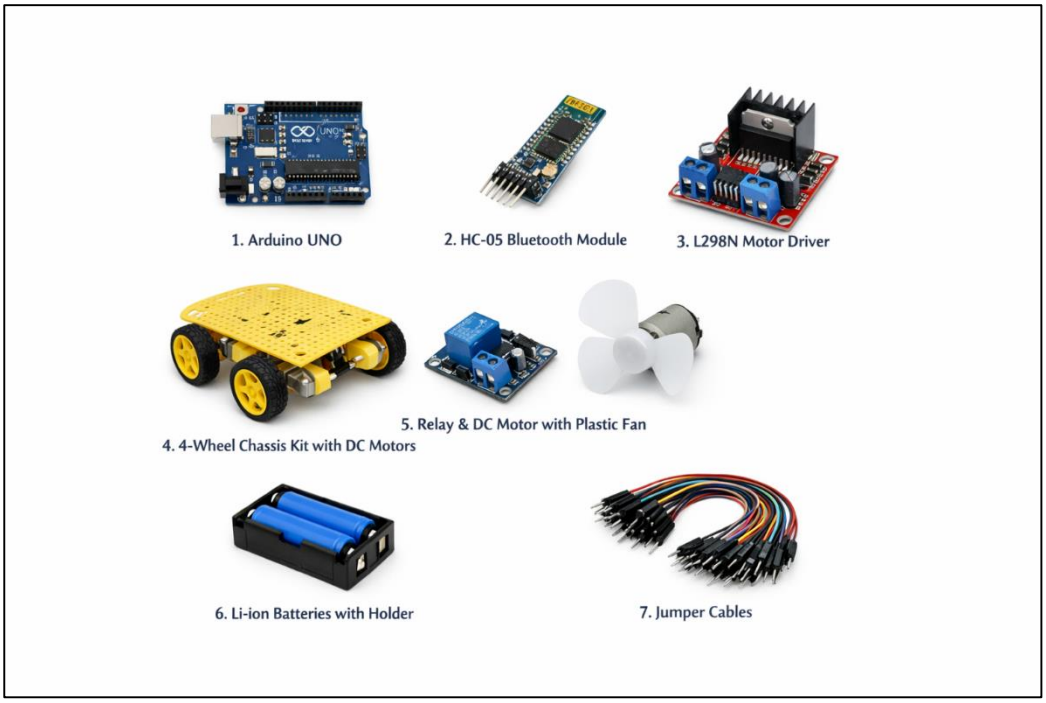


Fig 3.3 Working Procedure Flow Chart of Weed Removal Robot

The flow chart above illustrates the working procedure of the Weed Removal Robot from power ON. The robot starts by initializing the A-rduino and then waits for control commands sent via Bluetooth. Upon receiving commands, it sends signals to activate DC motors, enabling the robot to move forward, backward, left, or right across the field. This cycle repeats until the operation is manually stopped.

3.3 Prototype Description

3.3.1 Materials Used



The following hardware components were used in the development of the Weed Removal Robot. All components were selected based on low cost, easy availability, and suitability for basic agricultural automation.

Arduino UNO

Arduino UNO is used as the main microcontroller of the robot. It was selected due to its simplicity, reliability, low cost, and ease of programming.

HC-05 Bluetooth Module

The HC-05 Bluetooth module is used to enable wireless communication between the robot and a mobile device. It allows remote control of the robot during operation.

L298N Motor Driver Module

The L298N motor driver module is used to drive the DC motors of the robot. It is capable of controlling motor speed and direction and protects the Arduino from high current loads.

Four-Wheel Chassis with DC Motors

A four-wheel chassis fitted with DC motors is used to provide mobility to the robot. This configuration offers stability and smooth movement on flat agricultural surfaces.

Relay Module and DC Motor with Plastic Fan

A relay module is used to control the weed cutting motor safely. The DC motor attached to a plastic fan acts as the weed cutting mechanism, enabling mechanical and chemical-free weed removal.

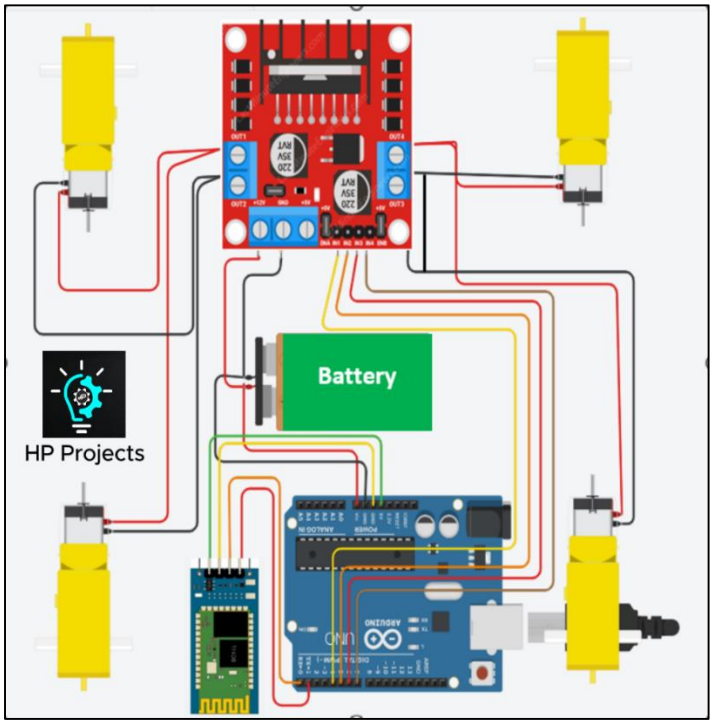
Li-ion Batteries with Holder

Rechargeable Li-ion batteries are used to supply power to the entire system. Battery operation makes the robot portable and suitable for outdoor applications.

Jumper Wires

Jumper wires are used to establish electrical connections between various electronic components. They allow easy assembly, testing, and maintenance of the system.

3.3.2 Circuit Diagram of Weed Removal Robot



The circuit diagram represents the hardware design of the Weed Removal Robot. The system mainly consists of an Arduino Uno microcontroller, L298N motor driver module, DC motors, relay module, Bluetooth module, and a battery power supply.

Circuit Description

The Arduino Uno acts as the main controller and is connected to the L298N motor driver through digital input/output pins to control the wheel motors. The DC motors are connected to the output terminals of the motor driver. A relay module is interfaced with the Arduino to switch the weed cutting motor safely. The Bluetooth module is connected to the Arduino for receiving wireless control commands from a mobile device. A rechargeable battery supplies power to all components, enabling portable operation of the robot.

Working of the System

1. Control commands are sent from a mobile device to the robot through the Bluetooth module.
2. The Arduino Uno receives these commands and processes them according to the programmed logic.
3. Based on the received commands, the Arduino sends appropriate control signals to the L298N motor driver.
4. The motor driver drives the DC motors, allowing the robot to move forward, backward, left, or right.
5. When weed cutting is required, the Arduino activates the relay module, which switches ON the cutting motor.
6. The rotating plastic fan attached to the DC motor cuts the weeds mechanically without the use of chemicals.
7. This working mechanism enables simple, low-cost, and effective weed removal suitable for small-scale agricultural applications.

Chapter 4

Implementation

Program Code:

```
char data;
int LM1 = 4, LM2 = 5;
int RM1 = 6, RM2 = 7;
int CUTTING_MOTOR = 13;  // Cutting motor pin
void setup()
{
Serial.begin(9600);
pinMode(LM1, OUTPUT);
pinMode(LM2, OUTPUT);
pinMode(RM1, OUTPUT);
pinMode(RM2, OUTPUT);
pinMode(CUTTING_MOTOR, OUTPUT);
stopMotors(); // Start with motors off
digitalWrite(CUTTING_MOTOR, LOW); // Cutting motor off initially
}
void loop()
{
if (Serial.available() > 0) {
data = Serial.read();
switch (data) {
case 'F': moveForward(); break;
case 'B': moveBackward(); break;
case 'L': turnLeft(); break;
case 'R': turnRight(); break;
case 'S': stopMotors(); break;
case 'C': toggleCuttingMotor(); break;  // Toggle cutting motor
case 'W': toggleCuttingMotor(); break;  // Triangle button (alternate command)
}
}
}
void moveForward()
{
digitalWrite(LM1, HIGH); digitalWrite(LM2, LOW);
digitalWrite(RM1, HIGH); digitalWrite(RM2, LOW);
}
void moveBackward()
{
digitalWrite(LM1, LOW); digitalWrite(LM2, HIGH);
digitalWrite(RM1, LOW); digitalWrite(RM2, HIGH);
}
void turnLeft()
```

```
{
digitalWrite(LM1, LOW); digitalWrite(LM2, HIGH);  // Left motor backward
digitalWrite(RM1, HIGH); digitalWrite(RM2, LOW);  // Right motor forward
}
void turnRight()
{
digitalWrite(LM1, HIGH); digitalWrite(LM2, LOW);  // Left motor forward
digitalWrite(RM1, LOW); digitalWrite(RM2, HIGH);  // Right motor backward
}
void stopMotors()
{
digitalWrite(LM1, LOW); digitalWrite(LM2, LOW);
digitalWrite(RM1, LOW); digitalWrite(RM2, LOW);
}
void toggleCuttingMotor() {
static bool motorState = false;  // Track motor state
motorState = !motorState;  // Toggle state
digitalWrite(CUTTING_MOTOR, motorState ? HIGH : LOW);
}
```

Explanation of Program Code:

The Arduino program controls the movement of the Weed Removal Robot and the operation of the weed cutting motor using Bluetooth commands. The HC-05 Bluetooth module sends control characters from a mobile device to the Arduino UNO through serial communication.

Based on the received command, the Arduino activates the L298N motor driver to control the four DC motors for forward, backward, left, and right movement. A relay module is used to safely control the cutting motor, protecting the Arduino from high current.

The program continuously monitors incoming Bluetooth data and executes the corresponding motor control functions, ensuring smooth movement and efficient weed cutting operation.

Chapter 5

Results and Analysis

5.1 Result

The Weed Removal Robot was successfully designed, assembled, and tested under basic field-like and laboratory conditions. Multiple trial runs were conducted to evaluate the performance of the robot in terms of movement control, weed cutting operation, and overall system stability. The robot responded accurately to Bluetooth commands sent from a mobile device and performed the intended operations effectively.

The robot demonstrated smooth movement in all directions, including forward, backward, left, and right, using the four DC motors controlled through the L298N motor driver. The chassis remained stable during motion, and the motor driver provided sufficient torque for movement on flat surfaces. Directional control through Bluetooth communication was responsive and reliable during testing.

The cutting mechanism, consisting of a DC motor connected to a plastic fan acting as a blade, successfully removed small weeds placed in the test area. The relay module effectively protected the Arduino from high current drawn by the cutting motor, ensuring safe operation. The cutting motor could be switched ON and OFF using Bluetooth commands without affecting the movement of the robot.

The robot operated continuously for approximately **2–3 hours** on a fully charged Li-ion battery pack. The battery-powered design made the system portable and suitable for outdoor agricultural environments. All electronic components functioned as expected, and no major mechanical or electrical failures were observed during the testing phase.

The use of a mechanical weed removal method eliminated the need for chemical herbicides. During testing, crop plants placed near the weeds were not damaged, demonstrating that the system is safe, eco-friendly, and suitable for sustainable agricultural practices.

5.2 Screenshots

Image 1 – Side View

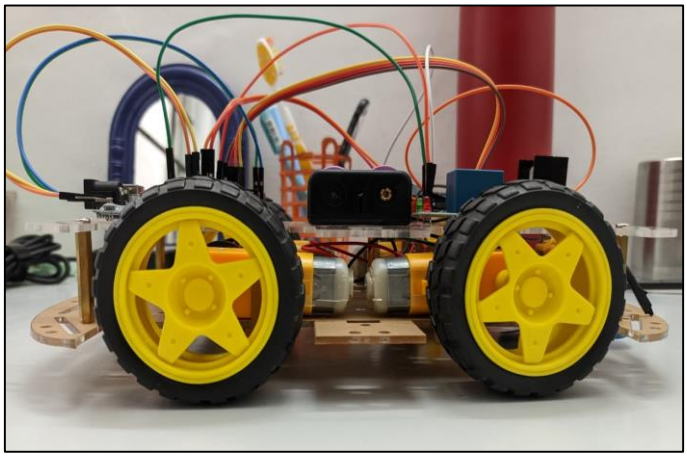


Fig. 5.1 Side view of the Weed Removal Robot showing wheel arrangement and chassis structure

This image shows the side view of the Weed Removal Robot highlighting the four-wheel chassis, DC motors, and mechanical structure used for stable movement.

Image 2 – Top View (Complete Wiring)

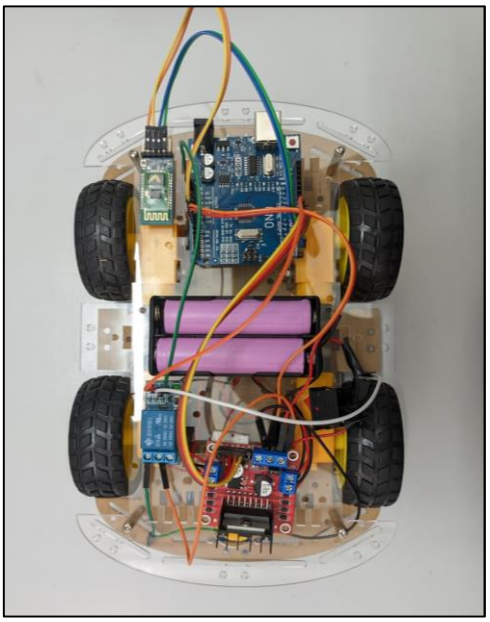


Fig. 5.2 Top view of the Weed Removal Robot showing Arduino UNO, battery pack, and wiring connections

The figure illustrates the placement of the Arduino UNO, Li-ion battery holder, relay module, motor driver, and interconnecting jumper wires.

Image 3 – Motor Driver & Relay Section

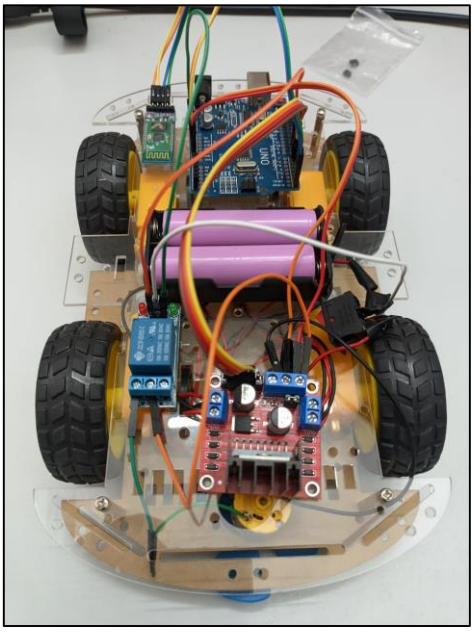


Fig. 5.3 L298N motor driver and relay module used for motor and cutting mechanism control

This image highlights the L298N motor driver used to control wheel motors and the relay module used to safely operate the weed cutting motor.

Image 4 – Front / Control Module View

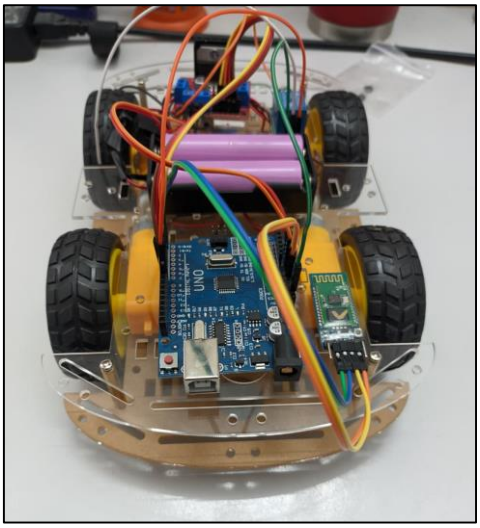


Fig. 5.4 Arduino UNO and HC-05 Bluetooth module used for wireless robot control

The figure shows the Arduino UNO microcontroller connected with the HC-05 Bluetooth module, enabling wireless control of the robot using a mobile device.

The above screenshots and photographs demonstrate the successful implementation and testing of the Weed Removal Robot. The images show the mechanical structure, electronic components, wiring layout, and control modules used in the project. These visuals confirm the practical realization of the proposed system and validate the proper integration of hardware components such as the Arduino UNO, L298N motor driver, relay module, Bluetooth module, and battery supply.

Chapter 6

Conclusion & Future Work

The Weed Removal Robot project successfully demonstrates a practical and eco-friendly approach to basic agricultural weed management. The project focused on reducing manual labor and eliminating chemical herbicides by implementing a Bluetooth-controlled robotic system using simple and affordable components.

The robot integrates an Arduino UNO, DC motors, motor driver, relay module, and Bluetooth communication to perform controlled movement and mechanical weed cutting. The system performed reliably during testing, proving that embedded systems and basic robotics can be effectively applied to agricultural automation.

All project objectives were achieved, including smooth robot navigation, effective weed cutting, wireless control through Bluetooth, and safe operation using a relay-protected cutting motor. The project highlights the feasibility of developing low-cost agricultural robots suitable for small and medium-scale farmers.

Although the prototype has limitations related to terrain handling and manual control dependency, it successfully validates the concept of automated weed removal using mechanical methods. The Weed Removal Robot represents an important step toward sustainable and technology-assisted farming practices.

Future Work

The following improvements can be considered for future development of the Weed Removal Robot:

- Enhancement of the cutting mechanism for removing tougher and deeper weeds
- Use of higher torque motors for better performance on uneven terrain
- Implementation of obstacle detection using ultrasonic sensors
- Addition of speed control using PWM techniques
- Integration of rechargeable solar panels for extended operation

- Development of a dedicated mobile application for improved control
- Fully autonomous navigation using sensor-based guidance
- Improved battery management and power efficiency
- Expansion of chassis size for large-scale field coverage
- Modular design upgrades for different crop types

These enhancements would increase the efficiency, autonomy, and practical usability of the system in real agricultural environments.

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2. Siegwart, R., Nourbakhsh, I. R., *Introduction to Autonomous Mobile Robots*, MIT Press.
3. Murphy, R. R., *Introduction to AI Robotics*, MIT Press.

Web Resources

Arduino Official Website – https://www.arduino.cc

Arduino Reference Documentation – https://www.arduino.cc/reference/en/

HC-05 Bluetooth Module Datasheet – https://components101.com

L298N Motor Driver Module – https://lastminuteengineers.com

DC Motor Working Principle – https://www.electronics-tutorials.ws

Basic Robotics Concepts – https://www.tutorialspoint.com

Project & Learning Resources

Arduino Motor Control Tutorials – Arduino Project Hub

Bluetooth Controlled Robot Projects – Instructables

Basic Agricultural Robotics Concepts – Engineering student project blogs

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Annexures

Annexure A – User Feedback Forms

This annexure contains feedback collected from users who observed or tested the Weed Removal Robot during demonstration and testing. Feedback was obtained from students, faculty members, and individuals familiar with basic agricultural practices.

The feedback focused on:

- Ease of operating the robot using Bluetooth
- Effectiveness of weed cutting mechanism
- Safety of surrounding plants
- Practical usefulness of the system

Most users found the robot easy to control and appreciated the reduction in manual effort. Suggestions included improving battery life and enhancing cutting strength, which were noted for future development.

Annexure B – Iteration Notes

This annexure documents the improvements made during different stages of development of the Weed Removal Robot.

Key iterations include:

- Adjustment of motor wiring for smoother movement
- Addition of a relay module to protect Arduino pins
- Improvement in cutting motor stability
- Optimization of Bluetooth command control logic

- Strengthening battery connections for reliable power supply

These iterations helped improve system safety, performance, and reliability.

Annexure C – Team Roles

This annexure describes the responsibilities assigned to each team member during the project.

Team Member 1: Developed and tested the software for robot movement and weed cutting control.

Team Member 2: Handled chassis assembly, mechanical setup, and project documentation.

Team Member 3: Connected the circuit, integrated hardware components, and performed testing.
