A project report on

Design and Development of an Agriculture Robot

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by

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AGRICULTURE ROBOT PROJECT REPORT

Abstract

This project presents the design and development of an **Arduino-based Agriculture Robot** aimed at automating small-scale farming operations through a combination of mechatronic systems, environmental sensing, and wireless control. The prototype robot integrates sensors for soil moisture, temperature, and humidity monitoring, coupled with a mobile robotic base for seeding, irrigation, and soil mixing. The system is controlled using an **Arduino Nano**, supported by a **Bluetooth communication module** for remote control and real-time monitoring. A water pump, soil sensor, DC motors, and servo-based mechanisms enable the robot to perform multiple agricultural tasks autonomously.

The system was tested under simulated conditions, demonstrating reliable operation across soil moisture measurement, obstacle avoidance, and irrigation tasks. The robot contributes to sustainable agricultural practices by reducing manual labor, optimizing water use, and enabling real-time soil monitoring. This work lays the groundwork for low-cost automation solutions adaptable for farmers in developing regions.

Keywords: Arduino, Soil Sensor, IoT, Bluetooth, Smart Farming, Robotics, Automation.

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1. Introduction

Agriculture remains a critical sector globally, yet it faces growing challenges related to labor shortages, inefficient resource use, and increasing food demand. Automation technologies, particularly **agriculture robots**, have emerged as powerful solutions to enhance precision and reduce human effort in farming operations. This project focuses on developing an agriculture robot that can autonomously perform soil monitoring, irrigation, and seeding activities using an **Arduino-based control system**.

The robot combines multiple modules: a soil sensor for monitoring soil moisture, a Bluetooth module for wireless communication, and a motor driver circuit to control wheel and plough movements. By leveraging low-cost microcontrollers, the system ensures affordability and replicability for small and medium-scale farmers.

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2. Literature Review

The integration of **automation, IoT, and robotics in agriculture** has gained significant attention in recent years. Studies by Khosravani and Reinartz (2019) highlight the role of robotic systems in achieving precision agriculture, minimizing waste, and increasing productivity. Arduino-based prototypes have been developed for irrigation automation (Singh, 2020), demonstrating the viability of microcontrollers for small-scale farming.

Recent advancements in low-cost sensors and open-source platforms have enabled scalable automation solutions. Adhikari and Dey (2021) showed how IoT-enabled robots can perform environmental monitoring and automated spraying tasks. However, most systems remain application-specific and expensive, which limits accessibility in rural areas. The presented project aims to overcome these limitations by developing a modular, low-cost, and flexible robotic framework.

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3. System Overview

The **Agriculture Robot** system is designed to perform multiple farming operations such as soil sensing, irrigation, and movement across terrain. The system comprises:

- **Microcontroller:** Arduino Nano – central control unit.
- **Sensors:** DHT11 (temperature/humidity), soil moisture sensor, ultrasonic obstacle sensor.
- **Actuators:** 4 DC motors for wheel and plough movement, water pump for irrigation, and servo motor for soil sampling.
- **Communication Module:** HC-05 Bluetooth module for wireless data exchange.
- **Power System:** 12V solar-charged battery supply.

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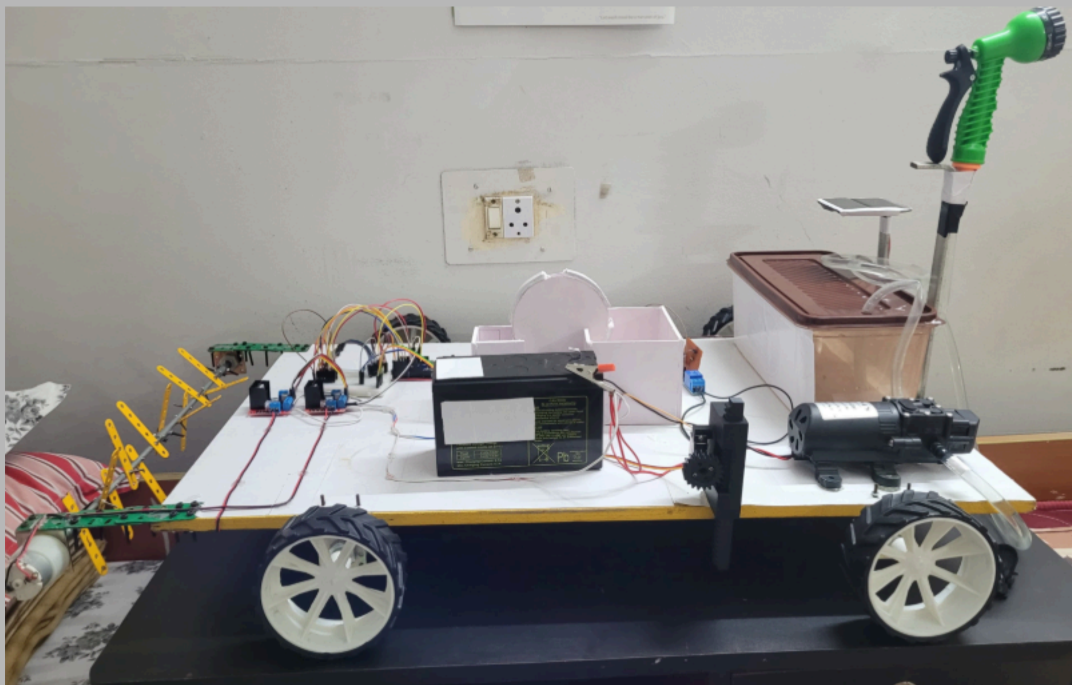
4. Working Principle

The robot operates on the principle of closed-loop control where sensors continuously provide environmental feedback to the microcontroller. The soil moisture sensor detects the water content in the soil. When the value drops below a predefined threshold, the Arduino activates the water pump through the motor driver to irrigate the soil. Simultaneously, the DHT11 sensor monitors temperature and humidity levels for environmental assessment.

The robot's locomotion is controlled via Bluetooth commands received from a smartphone. The user can move the robot forward, backward, left, or right using a mobile interface. The ultrasonic sensor ensures obstacle detection, halting motion when necessary to prevent collisions. This approach allows the robot to perform irrigation and soil analysis autonomously or through semi-manual control.

Figure 1: Image of Agriculture Robot Prototype



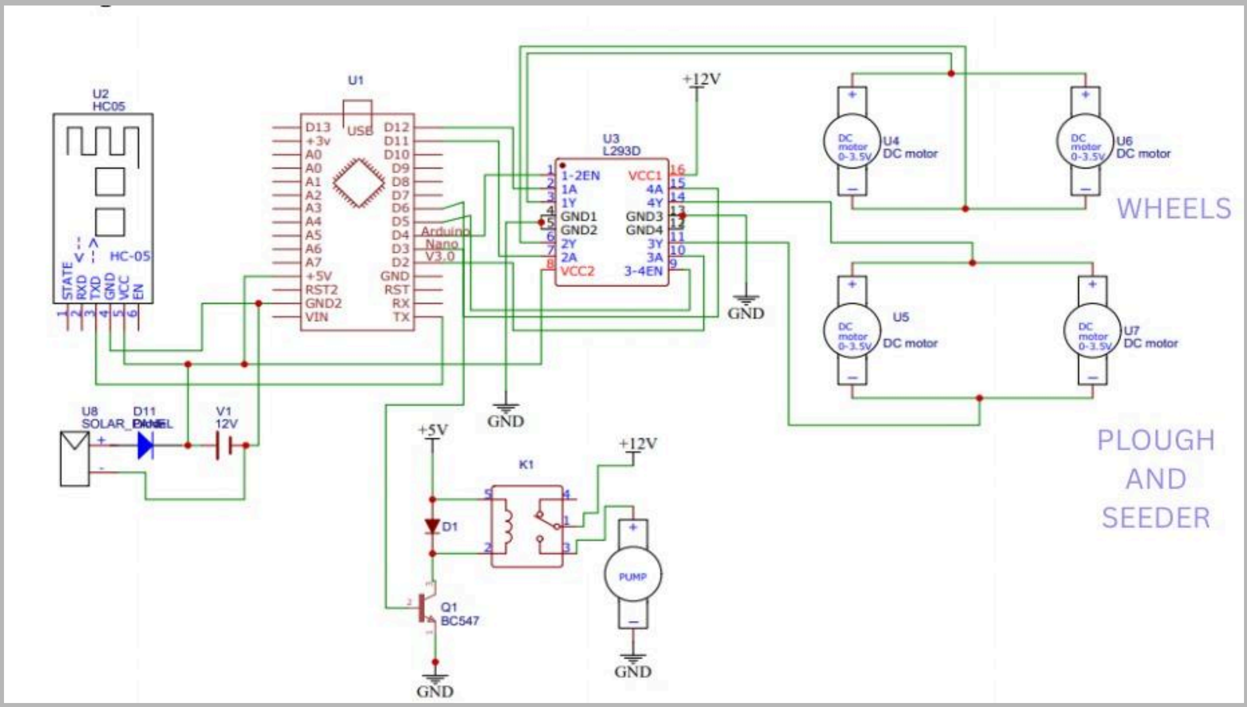
5. Hardware Design and Components

1. **Arduino Nano:** Provides control logic for reading sensor data and driving actuators.
2. **HC-05 Bluetooth Module:** Enables communication between the robot and smartphone controller.
3. **L293D Motor Driver IC:** Controls DC motors responsible for locomotion and seeding mechanisms.
4. **DHT11 Sensor:** Monitors ambient temperature and humidity.
5. **Soil Moisture Sensor:** Determines soil water content to trigger irrigation.
6. **Water Pump:** Distributes water through an attached irrigation unit.
7. **DC Motors (x4):** Provide motion for wheels and plough unit.
8. **Servo Motor:** Used for soil sampling arm control.

6. Circuit Diagram

The circuit schematic integrates all the modules into a centralized control system, enabling real-time coordination between sensors and actuators.

Figure 1: Circuit Diagram of the Agriculture Robot



7. Software Implementation and Control Logic

The Arduino software controls four motors for robot movement and implements soil monitoring and irrigation logic. The robot responds to commands received over Bluetooth while continuously reading environmental parameters.

Code Snippet (Arduino):

```
#include <Servo.h>
#include <DHT.h>

#define DHTPIN 2
#define DHTTYPE DHT11

// Motor driver pins (4 DC motors)
#define LEFT_MOTOR1 3
#define LEFT_MOTOR2 4
#define RIGHT_MOTOR1 5
#define RIGHT_MOTOR2 6
```

```
// Pump and Sensors
#define PUMP_IN1 7
#define PUMP_IN2 8
#define SOIL_SENSOR A0
#define TRIG_PIN 9
#define ECHO_PIN 10
#define SERVO_PIN 11

Servo servo;
DHT dht(DHTPIN, DHTTYPE);

void setup() {
  Serial.begin(9600);
  pinMode(LEFT_MOTOR1, OUTPUT);
  pinMode(LEFT_MOTOR2, OUTPUT);
  pinMode(RIGHT_MOTOR1, OUTPUT);
  pinMode(RIGHT_MOTOR2, OUTPUT);
  pinMode(PUMP_IN1, OUTPUT);
  pinMode(PUMP_IN2, OUTPUT);
  pinMode(TRIG_PIN, OUTPUT);
  pinMode(ECHO_PIN, INPUT);
  dht.begin();
  servo.attach(SERVO_PIN);
  servo.write(0);
  stopAllMotors();
}

void loop() {
  int moisture = analogRead(SOIL_SENSOR);
  float temp = dht.readTemperature();
  float hum = dht.readHumidity();

  Serial.print("Soil Moisture: "); Serial.println(moisture);
  Serial.print("Temperature: "); Serial.println(temp);
  Serial.print("Humidity: "); Serial.println(hum);

  if (moisture < 400) {
    activatePump();
  } else {
    stopPump();
  }
  delay(2000);
}
```

```
void motorForward(int in1, int in2) {
  digitalWrite(in1, HIGH);
  digitalWrite(in2, LOW);
}

void motorBackward(int in1, int in2) {
  digitalWrite(in1, LOW);
  digitalWrite(in2, HIGH);
}

void stopAllMotors() {
  digitalWrite(LEFT_MOTOR1, LOW);
  digitalWrite(LEFT_MOTOR2, LOW);
  digitalWrite(RIGHT_MOTOR1, LOW);
  digitalWrite(RIGHT_MOTOR2, LOW);
}

void activatePump() {
  digitalWrite(PUMP_IN1, HIGH);
  digitalWrite(PUMP_IN2, LOW);
}

void stopPump() {
  digitalWrite(PUMP_IN1, LOW);
  digitalWrite(PUMP_IN2, LOW);
}
```

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8. Testing and Discussion

The robot was tested in controlled field conditions with varying soil moisture levels. Results showed accurate moisture sensing with prompt pump activation when soil moisture dropped below 400 (on a 0–1023 scale). The DHT11 sensor provided stable temperature and humidity readings. Locomotion tests demonstrated smooth control through Bluetooth, with the ultrasonic sensor effectively detecting obstacles within 15 cm.

The system proved responsive and consistent in behavior. Minor latency in Bluetooth communication was observed but did not affect performance. Power consumption was optimized by cycling sensor reads and motor activity.

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9. Limitations and Practical Considerations

- **Limited Communication Range:** Bluetooth restricts control distance to around 10 meters.
- **Terrain Constraints:** The robot performs best on flat or moderately uneven surfaces.
- **Power Supply:** Dependence on battery power limits operational time; future designs could include solar charging.
- **Sensor Calibration:** Soil moisture readings vary across soil types, requiring recalibration for each environment.

Despite these limitations, the system demonstrates a strong foundation for autonomous, low-cost farming robots.

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10. Conclusion and Future Work

The Arduino-based agriculture robot effectively automates irrigation and soil sensing, providing a cost-effective tool for small-scale farmers. Future improvements can include IoT connectivity for cloud data logging, solar-powered operation, GPS navigation, and machine vision for crop detection.

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11. References

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