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# Design And Development of Plant Irrigation Water Sprinkler

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***Abstract-*** ***Efficient water management is a critical challenge in agriculture due to increasing water scarcity and the need for sustainable farming practices. A Plant Irrigation Water Sprinkler Robot is an automated system designed to provide controlled and efficient watering to plants using robotic movement and sprinkler mechanisms. This system reduces human effort, minimizes water wastage, and ensures uniform irrigation across agricultural fields. The robot operates using electric motors, water pumps, and control systems, which allow it to move across the field and spray water in a regulated manner. It can be programmed or controlled manually depending on the requirement. The system is particularly useful for small-scale farmers, gardens, and greenhouse applications. With advancements in automation and robotics, irrigation robots are expected to become smarter, more energy-efficient, and capable of integrating sensors for soil moisture detection and weather-based irrigation. This project demonstrates a cost-effective and practical solution for modern irrigation challenges.***

***Key Words: Irrigation, Sprinkler System, Automation, Agriculture Robot, Water Management***

## I. INTRODUCTION

Agriculture plays a vital role in the economy, and irrigation is one of its most important aspects. Traditional irrigation methods involve manual watering, which is time-consuming, inefficient, and often leads to uneven distribution of water.

With increasing water scarcity and labor shortages, there is a need for smart irrigation systems that can reduce water wastage and improve efficiency. Automation in agriculture has gained importance, and robotic irrigation systems are emerging as a modern solution.

The Plant Irrigation Water Sprinkler Robot is designed to automate the irrigation process. It uses a mobile robotic platform equipped with a sprinkler system to distribute water evenly across plants. This system ensures proper water usage, reduces labor dependency, and improves crop health.

The project focuses on designing, developing, and testing an irrigation robot suitable for small-scale agricultural applications.


## II. LITERATURE REVIEW

Early irrigation relied on simple manual techniques or river diversion, which were unsuitable for large-scale

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farming. Modern techniques like drip and sprinkler irrigation improved efficiency but often face challenges such as high installation costs and a lack of automation. Recent research has focused on IoT-based and sensor-driven stationary systems; however, these are often limited in their ability to cover large areas. The proposed robotic platform addresses these gaps by combining mobility with automated sensing and distribution.

## III. SUMMARY

The project titled "Design and Development of Plant Irrigation Water Sprinkler Robot" focuses on developing an automated and efficient irrigation system to address the challenges faced in traditional agricultural watering methods. In conventional irrigation practices, water distribution is often uneven, labour-intensive, and inefficient, leading to excessive water consumption and reduced crop productivity. This project aims to overcome these limitations by introducing a robotic system that automates the irrigation process and ensures uniform water distribution.

The developed system integrates mechanical, electrical, and fluid components into a single compact unit. The robot is designed with a strong and durable frame that supports all essential components, including a water storage tank, DC motors, wheels, a water pump, and a sprinkler mechanism. The mobility of the robot allows it to travel across agricultural fields or garden areas, making it more flexible compared to fixed irrigation systems.

The working principle of the system is based on the conversion of electrical energy into mechanical and fluid energy. When the system is powered on, the DC motors drive the wheels, enabling the robot to move in the desired direction. Simultaneously, the water pump draws water from the storage tank and supplies it to the sprinkler system. The sprinkler nozzle then distributes water in the form of fine droplets, ensuring even coverage of plants. This controlled spraying mechanism significantly reduces water wastage and improves irrigation efficiency.

The design process involved careful selection of components based on factors such as cost, availability, durability, and performance. Mild steel was chosen for the frame due to its strength and ease of fabrication.[2]

Lightweight materials were used where possible to reduce overall load and improve mobility. The pump and motors were selected based on required flow rate, pressure, and torque to ensure smooth operation.

During testing, the robot was evaluated under different working conditions, including no-load, partial irrigation, and full irrigation scenarios. The results showed that the system performed efficiently, providing uniform water distribution and stable movement. The robot demonstrated reliable operation with minimal human intervention, making it suitable for small-scale agricultural applications, gardens, nurseries, and greenhouses.

One of the major advantages of this system is its ability to save water and reduce labor requirements. By automating the irrigation process, the robot minimizes human effort and ensures timely watering of crops. Additionally, the system is cost-effective and easy to maintain, making it accessible to small and medium-scale farmers.

However, the system also has certain limitations, such as limited battery life and reduced efficiency in large-scale farming applications. Despite these limitations, the project successfully demonstrates the potential of robotics in agriculture and highlights the importance of automation in improving farming practices.

In conclusion, the Plant Irrigation Water Sprinkler Robot is an innovative and practical solution for modern irrigation challenges. It combines simplicity, efficiency, and affordability, making it a valuable contribution to the field of agricultural engineering. The project also opens opportunities for future enhancements, such as integration with sensors, solar power systems, and smart control technologies, which can further improve its performance and usability.

## IV. METHODOLOGY

Overview

The project follows a design and experimental approach to develop a working irrigation robot. The

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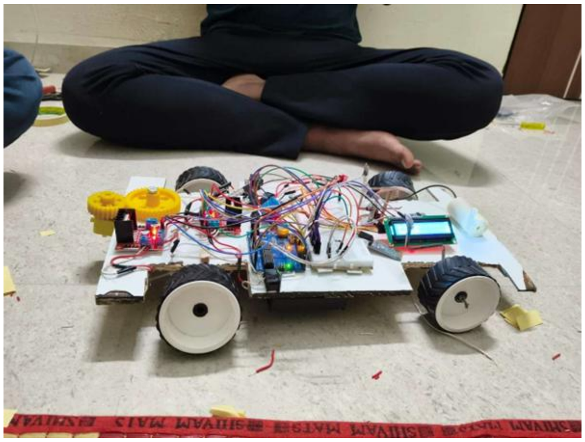
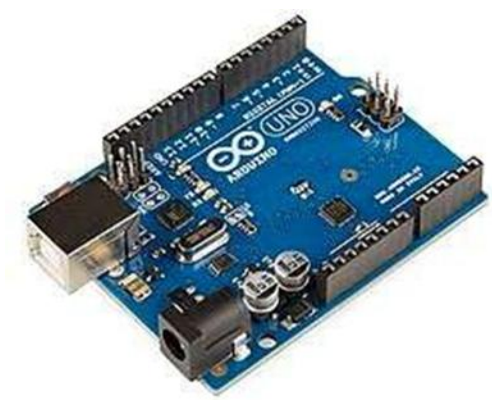
system integrates mechanical components, electrical systems, and water distribution mechanisms.



System Design
Arduino uno is the main component




The robot consists of:
Mobile chassis
Water tank
Pump system
Sprinkler mechanism
Control unit (manual or automated)

Working Principle
The robot moves across the field using motor-driven wheels. A water pump draws water from the tank and supplies it to the sprinkler, which distributes water evenly.

Code

```
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
#include <SoftwareSerial.h>
#include <Servo.h>

// ---------------------- LCD ----------------------
LiquidCrystal_I2C lcd(0x27, 16, 2);

// -------------------- Bluetooth ------------------
SoftwareSerial BT(A3, A2); // RX, TX

// -------------------- Drive Motor 1 --------------
#define IN3 7
#define IN4 11
#define ENB 5

// -------------------- Drive Motor 2 (old steering motor)
----------
#define IN1 2
#define IN2 4
#define ENA 3

// -------------------- Pump Motor -----------------
#define MD2_IN1 12
#define MD2_IN2 A1
#define MD2_ENA 6

// -------------------- Pump Relay -----------------
#define RELAY 13   // Active LOW

// -------------------- Ultrasonic -----------------
#define TRIG 8
#define ECHO 9

// -------------------- Soil Sensor ---------------
#define SOIL A0

// ---------------------- Servo ----------------------
#define SERVO_PIN 10
#define SERVO_CENTER 75
#define SERVO_LEFT 0
#define SERVO_RIGHT 180
#define STEERING_TIMEOUT 300

Servo steeringServo;

// ---------------------- States ----------------------
bool forward = false;
bool backward = false;
bool steeringLeft = false;
bool steeringRight = false;
```

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```
bool pumpState = false;
bool pumpMotorLeft = false;
bool pumpMotorRight = false;

// ---------------------- Timers ----------------------
unsigned long lastLCDUpdate = 0;
unsigned long lastSteeringTime = 0;

//
========================================
=============
void setup() {
  Serial.begin(9600);
  BT.begin(9600);

  lcd.init();
  lcd.backlight();
  lcd.clear();
  lcd.print("System Ready");

  // Drive motors
  pinMode(IN1, OUTPUT);
  pinMode(IN2, OUTPUT);
  pinMode(ENA, OUTPUT);

  pinMode(IN3, OUTPUT);
  pinMode(IN4, OUTPUT);
  pinMode(ENB, OUTPUT);

  // Pump motor
  pinMode(MD2_IN1, OUTPUT);
  pinMode(MD2_IN2, OUTPUT);
}

// Pump motor enable
pinMode(MD2_ENA, OUTPUT);

// ---------------------- Relay ----------------------
pinMode(RELAY, OUTPUT);
digitalWrite(RELAY, HIGH);

// ---------------------- Ultrasonic -----------------
pinMode(TRIG, OUTPUT);
pinMode(ECHO, INPUT);

// ---------------------- Servo ----------------------
steeringServo.attach(SERVO_PIN);
steeringServo.write(SERVO_CENTER);

lastSteeringTime = millis();

//
========================================
=============

// ---------------------- Get Distance ----------------
long getDistance() {
  digitalWrite(TRIG, LOW);
  delayMicroseconds(2);

  digitalWrite(TRIG, HIGH);
  delayMicroseconds(10);

  digitalWrite(TRIG, LOW);

  long duration = pulseIn(ECHO, HIGH, 30000);
  if (duration == 0) return 300;

  return duration * 0.034 / 2;
}

// ---------------------- Soil Moisture --------------
int getSoilMoisture() {
  int raw = analogRead(SOIL);
  return map(raw, 0, 1023, 100, 0);
}

// ---------------------- Update Drive ---------------
void updateDrive() {
  // Motor 1
  if (forward) {
    digitalWrite(IN3, HIGH);
    digitalWrite(IN4, LOW);
  } else if (backward) {
    digitalWrite(IN3, LOW);
    digitalWrite(IN4, HIGH);
  }
}
  else {
    digitalWrite(IN3, LOW);
    digitalWrite(IN4, LOW);
  }

  analogWrite(ENB, (forward || backward) ? 255 : 0);

  // ---------------- Motor 2 ----------------
  if (forward) {
    digitalWrite(IN1, HIGH);
```

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```
    digitalWrite(IN2, LOW);
  }
  else if (backward) {
    digitalWrite(IN1, LOW);
    digitalWrite(IN2, HIGH);
  }
  else {
    digitalWrite(IN1, LOW);
    digitalWrite(IN2, LOW);
  }

  analogWrite(ENA, (forward || backward) ? 255 : 0);
}

//
=========================================
=============
// ---------------- Update Steering -------------------
void updateSteering() {
  if (steeringLeft) {
    steeringServo.write(SERVO_LEFT);
  }
  else if (steeringRight) {
    steeringServo.write(SERVO_RIGHT);
  }
  else {
    steeringServo.write(SERVO_CENTER);
  }
}

//
=========================================
=============
// ---------------- Update Pump -----------------------
void updatePump() {
  digitalWrite(RELAY, pumpState ? LOW : HIGH);

  if (pumpMotorLeft) {
    digitalWrite(MD2_IN1, LOW);
    digitalWrite(MD2_IN2, HIGH);
    analogWrite(MD2_ENA, 255);
  }
  else if (pumpMotorRight) {
    digitalWrite(MD2_IN1, HIGH);
    digitalWrite(MD2_IN2, LOW);
    analogWrite(MD2_ENA, 255);
  }
  else {
    digitalWrite(MD2_IN1, LOW);
    digitalWrite(MD2_IN2, LOW);
    analogWrite(MD2_ENA, 0);
  }
}

void loop() {

  // ----------- Bluetooth -----------
  if (BT.available()) {
    char cmd = BT.read();

    // Movement control
    if (cmd == 'F') {
      forward = true;
      backward = false;
    }

    if (cmd == 'B') {
      backward = true;
      forward = false;
    }

    if (cmd == 'S') {
      forward = false;
      backward = false;
    }

    // Steering control
    if (cmd == 'L') {
      steeringLeft = true;
      steeringRight = false;
      lastSteeringTime = millis();
    }

    if (cmd == 'R') {
      steeringRight = true;
      steeringLeft = false;
      lastSteeringTime = millis();
    }

    // Pump control
    if (cmd == 'P') {
      pumpState = !pumpState;
    }

    if (cmd == 'X') {
      pumpMotorLeft = true;
      pumpMotorRight = false;
    }
```

```
    if (cmd == 'Y') {
      pumpMotorRight = true;
      pumpMotorLeft = false;
    }
  }

  // ----------- Auto Center Steering -----------
  if (millis() - lastSteeringTime > STEERING_TIMEOUT) {
    steeringLeft = false;
    steeringRight = false;
  }

  // ----------- Obstacle Detection -----------
  long dist = getDistance();
  if (dist <= 20) {
    forward = false;   // Stop if obstacle detected
  }

  // ----------- Update Systems -----------
  updateDrive();
  updateSteering();
  updatePump();
}

// Stop both directions if needed
forward = false;
backward = false;
}

// ----------- Update Hardware -----------
updateDrive();
updateSteering();
updatePump();

// ----------- LCD Display -----------
if (millis() - lastLCDUpdate > 200) {
  lastLCDUpdate = millis();

  lcd.clear();

  lcd.setCursor(0, 0);
  lcd.print("D:");
  lcd.print(dist);
  lcd.print(" cm");

  lcd.setCursor(0, 1);
  lcd.print("Soil:");
  lcd.print(getSoilMoisture());
  lcd.print("%");
}
}
```

Research Design
Design and fabrication of robot Installation of sprinkler system Testing under different conditions Performance evaluation

Testing Conditions
No-load condition
Partial irrigation
Full irrigation

Performance Analysis
Water distribution efficiency
Coverage area
Power consumption

Movement efficiency

## V. DESIGN PROCEDURE

Description of the Project
The Plant Irrigation Water Sprinkler Robot is designed to automate watering in agricultural fields. The robot moves on wheels and sprays water using a sprinkler system powered by a pump.

Main Components
Water tank
DC motor and wheels
Water pump
Sprinkler nozzle
Frame structure
Control system

Material Selection
Wooden Board for frame
Plastic tank for water storage
Rubber wheels for mobility
Copper wiring for electrical connections

Design Requirements
Adequate water capacity
Smooth movement
Uniform water distribution
Low power consumption

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Cost-effectiveness

Load Analysis
The system considers:
Weight of robot
Water load
Motor load
Frictional forces

## VI. WORKING

The robot operates by converting electrical energy into mechanical motion. When powered on:

1. Motors rotate the wheels, enabling movement
2. Water pump starts drawing water from the tank
3. Water is pushed through pipes to the sprinkler
4. Sprinkler distributes water over plants

The robot can be controlled manually or programmed for automatic operation.

## VII. RESULT

The irrigation robot was successfully designed and tested. It demonstrated:

Efficient water distribution
Reduced water wastage
Smooth movement across the field
Reliable operation

The system proved to be suitable for small agricultural applications and gardens.

## VIII. ADVANTAGES

Reduces manual labor
Saves water
Ensures uniform irrigation
Cost-effective

## IX. DISADVANTAGES

Limited battery life
Not suitable for large-scale farms
Requires maintenance
Initial setup cost

## X. APPLICATIONS

Agricultural fields
Gardens and lawns
Greenhouses
Nurseries
Small farms

## XI. CONCLUSION

The Plant Irrigation Water Sprinkler Robot provides an effective solution for modern irrigation challenges. It reduces labor, saves water, and improves efficiency. The project demonstrates the practical application of robotics in agriculture.

The system is simple, economical, and suitable for small-scale use. It highlights the importance of automation in improving agricultural productivity.

## XII. FUTURE SCOPE

Integration with soil moisture sensors
Fully automatic operation
Solar-powered system
Mobile app control
AI-based irrigation system
Larger field coverage

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