NSS COLLEGE OF ENGINEERING
PALAKKAD-678008
(Affiliated to APJ Abdul Kalam Technological University)

INTERMEDIATE PROJECT REPORT

on

SMART SOLAR LAWN SKIVER AND PESTICIDE SPRAYING ROBOT

Submitted in partial fulfillment of the requirements for the award of the degree of

BACHELOR OF TECHNOLOGY

in

ELECTRICAL AND ELECTRONICS ENGINEERING

Submitted by

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DECLARATION

We hereby declare that the project report entitled " **SMART SOLAR LAWN SKIVER AND PESTICIDE SPRAYING ROBOT**" submitted by us, for the award of the degree of Bachelor of Technology of APJ Abdul Kalam Technological University, is a bonafide record of the works carried out by me/our batch under the supervision of **Dr. Saju N**, Professor, NSS College of Engineering, Palakkad.

We further declare that the work reported in this thesis has not been submitted and will not be submitted, either in part or in full, for the award of any other degree or diploma in this institute or any other institute or university.

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CERTIFICATE

This is to certify that this is a bonafide report of the Project titled **'SMART SOLAR LAWN SKIVER AND PESTICIDE SPRAYING ROBOT'** which is done by **AGNES LAWRENCE (NSS21EE012), AJAY SARANG (NSS21EE013), AKSHAYA B (NSS21EE015),** and **ARTHA MOHAN (NSS21EE034)** during the academic year **2024-25** under the guidance of **Dr. SAJU N**, Professor, Department of Electrical and Electronics Engineering, as a part of the partial fulfillment for the award of **Bachelor of Technology in ELECTRICAL AND ELECTRONICS ENGINEERING** from **APJ Abdul Kalam Technological University**. No part of this work has been submitted earlier for the award of any degree.

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ABSTRACT

Grass cutting devices are becoming increasingly popular. Pollution is often a result of human activity, evident in our daily lives. Older lawn shaper models used internal combustion (IC) engines, which contributed significantly to environmental pollution. These IC engine-powered machines were not only more expensive to run, but also necessitated substantial maintenance. To address these challenges, we are developing a new form of grass cutter that runs on solar energy. This solar-powered device is more efficient than previous generations, with the goal of conserving electricity and reducing manpower.

In India, various types of pesticide sprayers are used, with the most common being the backpack sprayer. It is preferred by farmers due to its affordability, ease of use, and time efficiency. However, there are certain limitations to the traditional methods. To address these limitations, we propose the design of a solar-powered lawn cutter with an integrated pesticide sprayer. This system operates at different times based on color recognition, allowing for efficient and controlled application of pesticides. The goal of our project is to create a solar-powered lawn cutter that conserves electricity and reduces manual labor. The design incorporates a microcontroller to manage multiple functions, including an obstacle sensor that detects and navigates around obstacles. This grass cutter is designed to be self-contained, requiring no special skills to operate and it requires less to no human interference with automatic lawn pesticide sprayal.

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CHAPTER 1

INTRODUCION

The background of this project is rooted in the growing demand for sustainable and automated solutions in both agriculture and lawn maintenance. Traditional grass-cutting methods and pesticide application rely heavily on gas-powered engines, which contribute to greenhouse gas emissions, environmental pollution, and high maintenance costs. These conventional tools require human labor, exposing operators to potential health risks and consuming significant time and effort. As awareness of environmental issues grows, there is an increasing need for eco-friendly, autonomous systems that reduce operational costs, enhance efficiency, and align with sustainable practices. Addressing these challenges, the development of a solar-powered, smart lawn mower with integrated pesticide spraying capabilities offers a promising solution.

This project focuses on creating a solar-powered robotic system capable of performing grass cutting and pesticide spraying autonomously, with minimal human intervention. By harnessing solar energy, this system eliminates the need for fossil fuels, thereby reducing emissions and minimizing its ecological footprint. The use of solar power also decreases the overall operational cost, as it bypasses the need for gasoline or diesel fuel. Automation further supports environmental and economic benefits by reducing labor costs and lowering the risk of chemical exposure during pesticide application. With its automated and energy-efficient design, this project offers a solution to many pressing issues in modern agriculture and lawn care.

Recent advancements in agricultural robotics have paved the way for innovative solutions in areas such as precision farming, automated pest control, and autonomous lawn maintenance. Robotics is transforming agriculture, offering tools to address labor shortages, increase productivity, and promote sustainable practices. Emerging technologies in sensor integration, microcontrollers, and navigation algorithms have significantly enhanced the capabilities of autonomous robots, enabling them to operate safely and efficiently in outdoor environments. Sensors, for instance, allow these robots to detect and avoid obstacles, ensuring smooth and reliable operation across varied terrains. The solar-powered grass cutter and pesticide sprayer leverages these technological advancements to deliver an efficient, versatile solution for both residential and agricultural applications. The robot's automated functionality allows it to perform grass cutting and targeted pesticide application.

1.1 OBJECTIVES

The primary objective of this project is to design and develop a solar-powered, autonomous robot that can perform grass cutting and pesticide spraying tasks. This eco-friendly system is intended to offer a sustainable alternative to conventional gas-powered lawn mowers, which typically have a higher environmental impact and incur significant operational costs.

By harnessing solar energy, this robot reduces the reliance on fossil fuels, minimizes emissions, and operates at a lower cost, aligning with environmental sustainability goals. The robot is designed to function autonomously, integrating sensors to detect obstacles in its path and a microcontroller to manage its operations, thus minimizing the need for human intervention. The combination of grass-cutting and pesticide-spraying capabilities allows the robot to efficiently handle lawn maintenance and basic agricultural tasks, enhancing productivity and reducing the labor-intensive aspects of these operations. Additionally, this solution aims to provide a safer and more effective approach for pesticide application, ensuring that pesticides are dispensed accurately and only when required. The system's design supports ease of use and accessibility, making it practical for both urban lawn care and agriculture.

1.2 PROBLEM STATEMENT

Traditional lawn cutters, which are typically powered by internal combustion (IC) engines, pose significant environmental challenges due to the pollutants they emit, contributing to air and noise pollution. These gas-powered machines release harmful gases such as carbon monoxide, nitrogen oxides, and particulate matter, which not only degrade air quality but also contribute to climate change. Additionally, they incur high operational and maintenance costs. IC engine-powered devices require frequent servicing, parts replacement, and fuel, making them expensive to operate over time. This can be especially burdensome for homeowners or businesses with large lawns. Moreover, many traditional lawn cutters are labor-intensive, requiring manual operation, which is time-consuming and physically demanding. This makes them less practical for larger areas or for individuals seeking convenience in lawn maintenance. These traditional devices also tend to lack integrated functionalities, with most models focusing solely on the basic task of grass cutting. In the modern landscape, there is a growing need for multi-functional lawn care tools that can go beyond simple grass trimming.

Features such as automated pesticide spraying and obstacle detection, which enhance both the safety and efficiency of the operation, are notably absent in many existing machines. Furthermore, the lack of automation and smart features in traditional models makes them less user-friendly, often requiring constant attention and intervention during use. To address these significant limitations, the proposed project seeks to develop an automated, eco-friendly, and cost-effective lawn skiver that not only integrates grass cutting and pesticide spraying but also includes obstacle detection for safer and more efficient operation. This solution promises to reduce environmental impact, lower operational costs, and provide a more convenient and multifunctional approach to modern lawn care.

1.3 SOCIAL RELEVANCE

A solar-powered lawn skiver robot is socially relevant due to its benefits in environmental sustainability, labor efficiency, and public health. By using solar energy, the robot reduces reliance on fossil fuels, decreasing greenhouse gas emissions and promoting renewable energy use. This approach helps conserve energy resources and supports sustainable development. The automation of lawn maintenance tasks also saves time and labor, making it cost-effective, especially in areas facing workforce shortages or high labor costs. Additionally, the robot's precision in removing thatch enhances lawn health, reducing the need for chemical treatments and benefiting soil quality. Unlike traditional gas-powered equipment, solar-powered robots operate quietly, minimizing noise pollution and contributing to a more peaceful environment. Lower emissions from solar power also reduce air pollution, benefiting respiratory health, while automated operation decreases the risk of injuries from heavy equipment. Overall, the adoption of such green technology encourages wider acceptance of sustainable practices in daily life, furthering societal goals for environmental protection and urban livability.

CHAPTER 2

LITERATURE SURVEY

This project involved a comprehensive review of current research and advancements in the field of solar-powered, autonomous robotic systems for agricultural and lawn maintenance purposes. This section critically examined various studies on smart agricultural robots, solar energy applications, sensor integration for obstacle detection, and control mechanisms for robotic functions. Findings from scholarly articles, case studies, and technical reports provided insights into the latest technologies and best practices in developing efficient, eco-friendly, and automated solutions for lawn care and pesticide application.

1. Agricultural robots for field operations: Concepts and components" by Avital Bechar, Clement Vigneault

This journal discusses the developments and innovations in agricultural robots for field operations, highlighting their complexity and the need for integration of various subsystems to perform tasks effectively. Extensive research has demonstrated the technical feasibility of using robots and automation in agriculture, but these systems must operate in unstructured environments while maintaining the same quality of work as traditional methods. To succeed, agricultural robots must adapt to continuously changing conditions and variability in both produce and environments, necessitating the development of intelligent systems. Furthermore, the robotic systems must be cost-effective and prioritize human safety, environmental preservation, and the protection of crops and machinery.

2. Agricultural Robot" by Kavita Zole, Sanghasevak Gedam, Aditya Dawale, Kiran Nikose, Jayant Hande

This article presents a design for an agricultural robot based on an electronic and mechanical (mechatronics) platform that performs advanced agricultural processes, specifically focusing on operations such as automatic ploughing and seed dispensing. We have developed an electromechanical vehicle steered by a DC motor to drive the wheels, enabling automated cultivation of the farm according to specific crop rows and columns. The system is controlled remotely, and a solar panel is utilized to charge the DC battery. This journal discusses related work in agricultural robotics, highlighting how this robot can reduce labor compared to manual and tractor-based sowing methods, requiring less energy and minimizing environmental pollution through the use of solar energy. Additionally, the development and automation of a robot with a spraying mechanism for agricultural applications have been explored, achieved through the design and construction of an autonomous mobile robot for pest control and disease prevention in commercial farming.

3. Development of Smart Pesticide Spraying Robot” by Pvr Chaitanya, Dileep Kotte, A. Srinath, K. B. Kalyan

This article discusses the management of food crops, emphasizing the importance of close surveillance, especially concerning the treatment of diseases that can have severe effects post-harvest. Plant diseases are characterized by changes or deficiencies in the plants’ normal functions, resulting in specific symptoms. Pathogenic agents, primarily responsible for these diseases, are often visible in the leaves, stems, and branches of the crops. Therefore, diagnosing diseases and assessing their prevalence in crops is essential for effective plant cultivation. This process can be achieved by capturing input images using cameras and analyzing them through machine learning techniques, which can identify diseases present.

4. Case study

The case study focused on the integration of agricultural robotics in precision farming, analyzing various real-world implementations and their impact on crop management. It examined specific projects where autonomous robots were deployed for tasks such as monitoring crop health, automating planting, and optimizing resource use. By evaluating the operational challenges and successes of these initiatives, the case study highlighted best practices and lessons learned from both effective and less successful deployments. This analysis provided insights into the practical considerations and technological requirements necessary for successful agricultural robot integration. The findings informed future innovations in robotic design and operation, ultimately aiming to enhance efficiency and sustainability in modern farming practices.

CHAPTER 3
METHODOLOGY

The methodology for the automatic solar-powered lawn skiver and pesticide-spraying robot focuses on creating an autonomous, eco-friendly device for garden maintenance. Powered by a solar panel, the robot operates independently, drawing energy from the sun to charge its battery, which then powers all components. The robot's movement and direction are controlled by a microcontroller, with sensors such as an ultrasonic sensor for detecting obstacles and a gyroscope for stability and orientation. For lawn maintenance, the robot uses a motorized cutter to trim grass, while a water pump is activated to spray pesticides as needed. The entire system is programmed to navigate a defined area, avoiding obstacles and following an efficient path. Remote control capabilities via Bluetooth allow users to monitor and adjust the robot's functions as needed. This methodology enables continuous, hands-free maintenance while promoting sustainability through solar power.

3.1 OVERVIEW OF SOLAR LAWN SKIVER ROBOT

The smart solar-powered lawn skiver and pesticide-spraying robot is an autonomous device designed to maintain lawns efficiently while minimizing human intervention. Powered by a solar panel mounted on top, it harnesses renewable energy, making it environmentally friendly and reducing dependence on external charging sources. The robot performs two primary functions: cutting grass and spraying pesticides. Equipped with a sharp cutting blade underneath for grass trimming and a pesticide tank with a rear-mounted sprayer, it manages both tasks as it moves across the designated area. Using pre-programmed controls and calculations based on the wheel diameter and area of the plot, the robot can systematically cover the entire lawn, ensuring even grass trimming and pesticide application. This integration of solar power, automated movement, and dual functionality makes the robot a cost-effective and sustainable solution for lawn maintenance.

3.2 SUBSYSTEMS AND MODULES

Solar Panels: These panels capture sunlight to generate power, making the robot eco-friendly and extending its operation time without reliance on external charging. During peak sunlight hours, the solar panels provide energy to the system while charging the onboard battery for use during low-light conditions.

Battery and Power Management: The battery stores excess energy generated by the solar panels to ensure the robot can function even when sunlight is limited. The power management system monitors energy levels and regulates power distribution, prioritizing essential functions and enabling the robot to conserve energy for uninterrupted operation.

Lawn Skiving Mechanism: This is the cutting or trimming tool of the robot, typically consisting of rotating blades or a similar mechanism. It is designed to cut grass efficiently while consuming minimal energy. The skiving mechanism is powered by the battery and operates under the control system, adjusting its activity based on battery levels and the robot's movement.

Obstacle Sensors: These sensors detect objects or barriers in the robot's path, triggering the obstacle avoidance system to prevent collisions. This helps maintain safe and continuous operation without user intervention.

Motors and Actuators: These components are responsible for the movement of the wheels and the activation of the skiving mechanism. They enable the robot to navigate various terrains and adjust its cutting mechanism as needed. The motors are controlled based on sensor data and navigation algorithms, ensuring accurate movement and efficient lawn coverage.

Control System: Often based on a microcontroller or microprocessor, the control system acts as the robot's "brain," processing data from the sensors and managing the entire operation. It controls navigation, obstacle avoidance, power management, and the skiving mechanism. The control system uses algorithms to plan paths, avoid obstacles, and monitor energy levels, optimizing performance for reliable and autonomous lawn care.

CHAPTER 4

SYSTEM DESIGN

4.1 CAD MODEL

Fig 4.1.1 Design of prototype

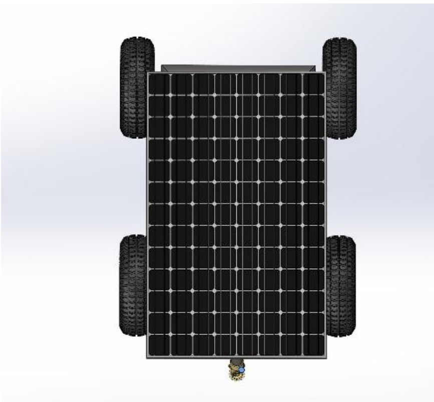

Fig4.1.2 Top view

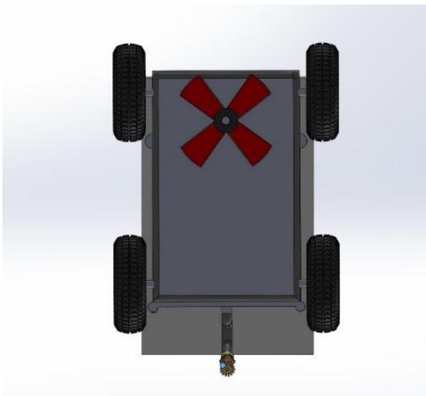

Fig4.1.3 Bottom view

Fig4.1.4. Side view

Computer-aided design (CAD) is the use of computer systems (or workstations) to aid in the creation, modification, analysis, or optimization of a design. CAD software is used to increase the productivity of the designer, improve the quality of design, improve communications through documentation, and to create a database for manufacturing. CAD output is often in the form of electronic files for print, machining, or other manufacturing operations. The term CADD (for Computer Aided Design and Drafting) is also used. Its use in designing electronic systems is known as electronic design automation (EDA). In mechanical design it is known as mechanical design automation (MDA) or computer-aided drafting (CAD), which includes the process of creating a technical drawing with the use of computer software. .

4.2 ASSEMBLY

The design of the solar-powered lawn skiver and pesticide-spraying robot is structured to maximize functionality and ease of operation. The solar panel is positioned at the top of the chassis, angled slightly to capture optimal sunlight throughout the day, which powers the robot and reduces the need for external charging. The rectangular chassis serves as a sturdy base for all components. The sprinkler or pesticide sprayer is mounted at the back of the robot, allowing for even distribution of pesticides across the area it covers, while keeping the sprayer clear of the cutting area to avoid interference. The grass-cutting blade is placed underneath the chassis, ensuring close contact with the ground for effective cutting. The wheels are attached to the sides of the chassis. This arrangement allows each component to function without obstruction, making the robot efficient for both grass cutting and pesticide spraying tasks. Inside the chassis, there are two compartments. The component box compartment contains the control system, battery, and wiring, ensuring these sensitive electronics are protected from environmental factors like moisture and dust. This compartment is designed with ventilation slots to prevent overheating, and it is positioned centrally within the chassis for balance and accessibility.

CHAPTER 5
WORKING PRINCIPLE

The working principle of the Smart Solar Lawn Skiver Robot is based on an automated, solar-powered system designed to independently manage grass cutting and pesticide spraying, with integrated safety and control features. It includes;

1.Solar Power System

Solar panels mounted on the robot capture sunlight, converting it into electrical energy. Rechargeable Battery produces energy, this energy is stored in a rechargeable battery, providing a continuous power source for the robot, even on cloudy days or when sunlight is minimal. This solar-powered approach reduces reliance on external power sources, making the robot eco-friendly and suitable for sustainable use.

2. Microcontroller Unit (MCU)

The microcontroller acts as the brain of the robot, coordinating all functions, such as movement, obstacle detection, grass cutting, and pesticide spraying. It takes inputs from sensors (e.g., obstacle sensors) and controls motors and actuators to ensure smooth, autonomous operation. Through programming, the microcontroller can be set to follow specific patterns or areas for mowing, allowing it to work in structured or unstructured environments.

3. Grass Cutting Mechanism

The robot uses a DC motor to drive the cutting blades. As the robot moves, the blades rotate, slicing through the grass and achieving a consistent cut height. The motor speed is optimized for efficient cutting while minimizing energy consumption. The cutting blades and motor are mounted on a chassis that supports the weight and movement of the robot. The chassis design ensures stability while allowing the robot to handle slight variations in terrain.

4. Obstacle Detection and Navigation

Ultrasonic sensors are installed on the robot to detect obstacles in its path. These sensors emit sound waves and measure the time it takes for them to bounce back after hitting an object. This information is used to calculate the distance between the robot and the obstacle. When an obstacle is detected, the microcontroller processes this information and instructs the robot to alter its path. This allows the robot to navigate around objects without user intervention, ensuring a smooth mowing process and reducing the risk of collisions.

5. Pesticide Spraying System

The robot is equipped with a pesticide sprayer that releases pesticides precisely as needed. This function is automated and controlled by the microcontroller, which can activate the sprayer based on pre-set conditions, such as the robot's location in the lawn or timing intervals. In some designs, sensors can be used to detect the presence of pests or plant health indicators, allowing for targeted pesticide application. This precision spraying minimizes waste and reduces the environmental impact of pesticide use.

6. Mobility Mechanism

The robot's movement is powered by wheels or tracks, depending on the terrain requirements. Wheels are suitable for smooth, even lawns, while tracks offer better traction on uneven or rough surfaces. A motor drives the wheels or tracks, enabling the robot to move forward, backward, or rotate. Combined with the obstacle detection system, this enables the robot to cover the lawn efficiently, following a structured path or navigating freely.

The movement of the robot is calculated based on the diameter of its wheels and the area it needs to cover. By measuring the diameter of the wheel, we can calculate the circumference—the distance the robot covers in one full rotation of the wheel. Knowing the total area of the plot to be covered, we can then determine the number of rotations needed for the robot to traverse the entire area. If the plot area is, for example, 100 square meters, we can divide this area into a series of linear paths that the robot will follow. By calculating the number of rotations required per path and adjusting for any turns or overlaps, the robot can be programmed to complete the full area efficiently.

This method ensures that the robot optimally covers the plot, minimizing overlap and ensuring both grass cutting and pesticide spraying are thorough. This approach, combined with the use of sensors for obstacle detection, allows the robot to cover the defined area accurately and autonomously.

7. User Interface

The robot may feature a remote control or app-based interface, allowing users to monitor and control it from a distance. Through the interface, users can adjust settings, activate specific functions (like pesticide spraying), or manually override the robot if needed. Some designs may allow the robot to provide feedback, such as battery status, coverage area, or any alerts related to obstacle detection, helping users stay informed about its operation.

5.1 BLOCK DIAGRAM

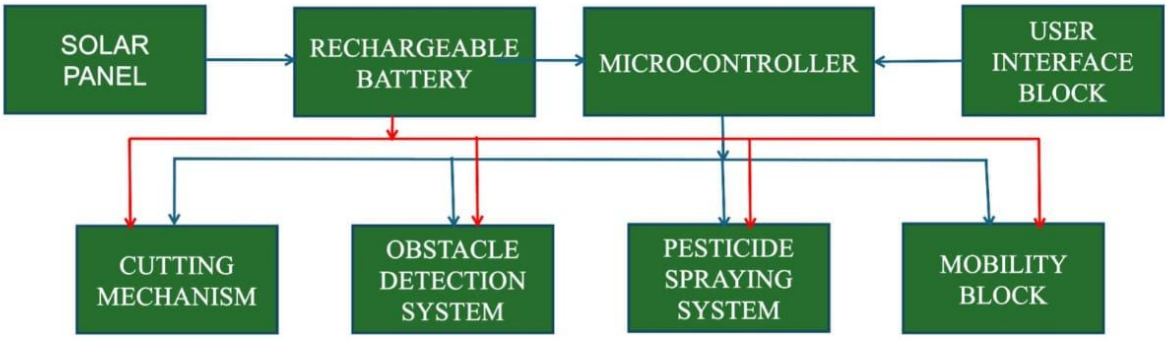

Fig 5.1.1: Block Diagram of solar lawn Skiver

Figure 5.1.1: This block diagram illustrates the core components and flow of energy and control in the solar-powered automatic lawn skiver with pesticide spraying. The system starts with a solar panel, which charges a rechargeable battery. This battery powers the microcontroller, which serves as the central control unit. The microcontroller receives input from the user interface block and manages various subsystems, including the cutting mechanism, obstacle detection system, pesticide spraying system, and mobility block. Each subsystem operates based on signals from the microcontroller, allowing the skiver to perform tasks autonomously while ensuring efficient energy use from the solar source.

The block diagram emphasizes the central role of the microcontroller in coordinating the lawn skiver's operations. The solar panel and rechargeable battery setup not only powers the entire system but also supports sustainable, uninterrupted operation in outdoor environments. The obstacle detection system allows the skiver to avoid obstacles autonomously, enhancing safety and efficiency. Meanwhile, the mobility block enables precise control over the skiver's movement across the lawn. The pesticide spraying system is integrated to ensure timely and uniform pesticide application, making this device multifunctional for lawn maintenance. The user interface block provides a point of interaction, allowing operators to input commands and monitor system status for a smoother and more controlled operation.

The integration of the pesticide spraying system and cutting mechanism within the same framework allows the skiver to perform dual functions, saving time and optimizing lawn care tasks in a single pass. This modular design also allows for future upgrades or replacements, enhancing the system's versatility and longevity.

5.2 CIRCUIT DIAGRAM

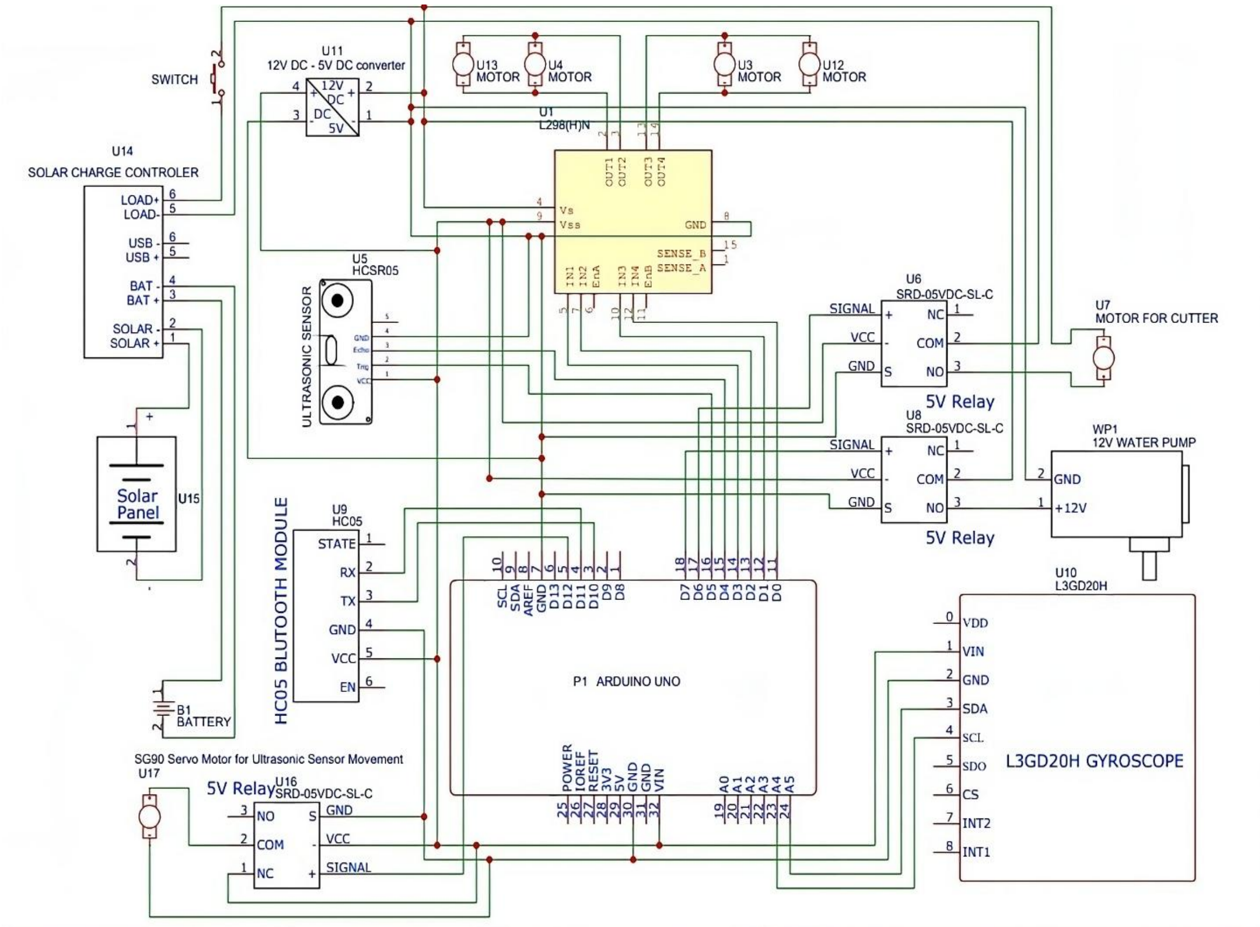

Fig 5.2.1: circuit diagram

Figure 5.2.1: The circuit diagram provides a detailed wiring layout for the system. It includes components like the solar panel connected to a charge controller, which regulates the battery's charging process. The microcontroller (Arduino Uno) interfaces with multiple sensors, including an ultrasonic sensor for obstacle detection, and a gyroscope for stability and orientation. The diagram shows the connection of motors (for movement and cutting) controlled by an L298 motor driver, along with 5V relays for switching the pesticide pump and cutter motor. Communication modules like Bluetooth enable remote control via user input, making the system flexible and adaptable for various operational commands. The circuit design focuses on efficient power management and safety features to support continuous outdoor operation. By using a solar charge controller, the system protects the battery from overcharging, ensuring a longer battery life and stable power output. The integration of both high-power components (such as motors for cutting and spraying) and low-power sensors (such as ultrasonic for

obstacle detection) is handled with careful isolation using relays. This design approach minimizes the risk of electrical interference, enabling the microcontroller to perform precise control without disruptions, even in demanding environments.

5.3 FLOWCHART

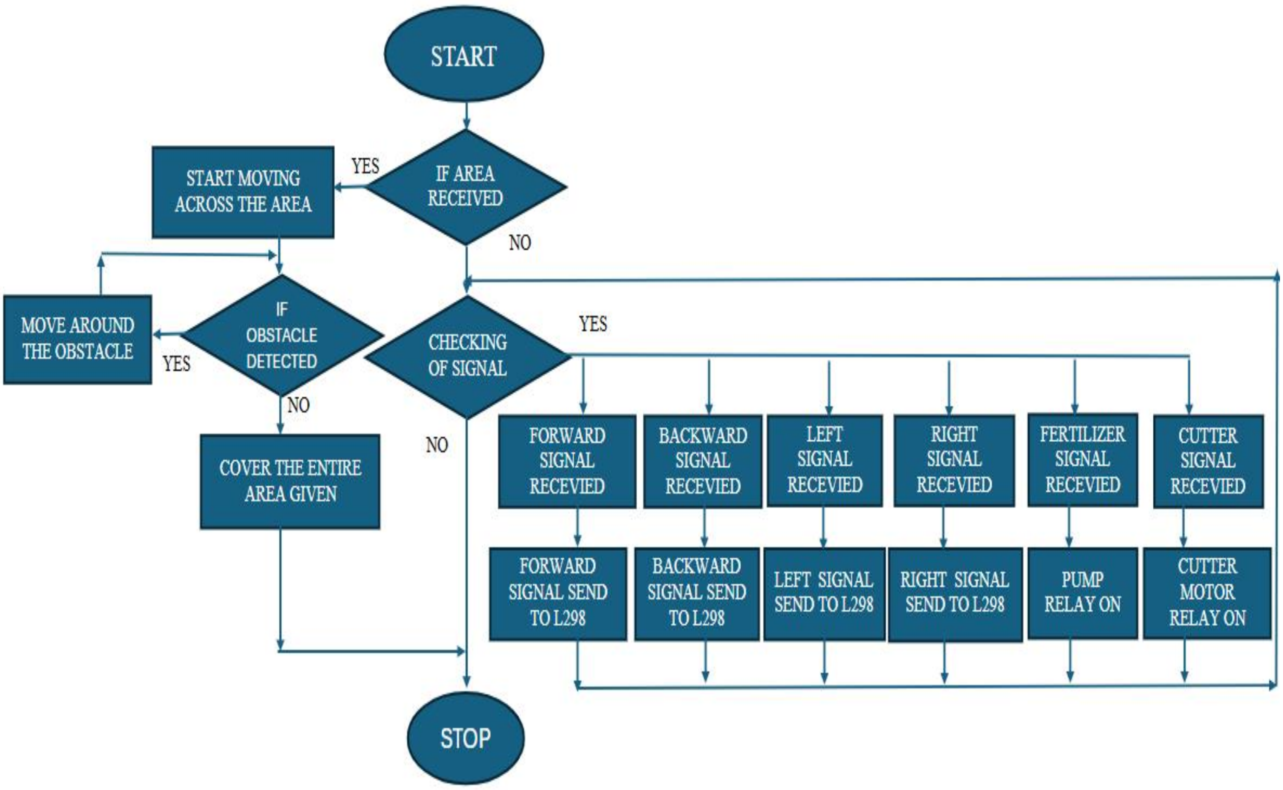

Fig 5.3.1 Flowchart

This flowchart illustrates the operation of a solar-powered automatic lawn skiver with pesticide spraying, divided into two sections: automated on the left side and manual on the right side.

Automated Side (Left): This side manages the autonomous movement of the skiver. It starts by checking if the area information is available. If it is, the skiver begins moving across the area. While navigating, it checks for obstacles. If an obstacle is detected, the skiver automatically navigates around it and continues its path. If no obstacles are detected, it covers the entire area on its own, ensuring efficient skiving.

Manual Side (Right): This side allows for manual control signals, such as forward, backward, left, and right movements. It also includes commands for activating specific functions like pesticide spraying (pump relay) and the skiver's cutter motor. Each received signal triggers a specific action, like sending commands to the L298 motor driver or turning on relevant relays. This manual section provides control flexibility for the operator, allowing intervention if necessary. The process concludes with the system stopping after the area is fully covered.

5.4 SYSTEM PROGRAMMING

```
#include <Ultrasonic.h> // Include Ultrasonic sensor library
// Motor control pins
Const int motorLeftPin1 = 5;
Const int motorLeftPin2 = 6;
Const int motorRightPin1 = 9;
Const int motorRightPin2 = 10;

// Ultrasonic sensor pins
Const int trigPin = 7;
Const int echoPin = 8;
Ultrasonic ultrasonic(trigPin, echoPin);

// Pesticide spray control pin
Const int sprayPin = 3;

// Variables for obstacle detection and plot navigation
Int distance;
Int safeDistance = 30; // Distance in cm to avoid obstacles
Unsigned long plotBoundaryTime = 5000; // Time to reach plot boundary in ms
Unsigned long startTime;

// Spray timing
Unsigned long sprayStartTime = 0;
Unsigned long sprayInterval = 1000; // Spray every 1000 ms

Void setup() {
  // Set motor pins as output
  pinMode(motorLeftPin1, OUTPUT);
  pinMode(motorLeftPin2, OUTPUT);
  pinMode(motorRightPin1, OUTPUT);
  pinMode(motorRightPin2, OUTPUT);

  // Set spray control pin as output
```

```
  pinMode(sprayPin, OUTPUT);
  digitalWrite(sprayPin, LOW); // Initially off

  Serial.begin(9600); // Initialize Serial monitor

  // Start time for row traversal
  startTime = millis();
}

Void loop() {
  Distance = ultrasonic.read(); // Read distance from ultrasonic sensor

  // Check if the robot has reached the end of the plot
  If (millis() – startTime > plotBoundaryTime) {
    reachPlotEnd(); // Perform 90-degree turns to go to the next row
    startTime = millis(); // Reset timer for the new row
  } else if (distance < safeDistance) {
    avoidObstacle(); // Avoid obstacle if within safe distance
  } else {
    moveForward(); // Continue forward if clear
    activateSprayNonBlocking(); // Non-blocking spray activation
  }

  Delay(50); // Small delay for sensor stabilization
}

// Function to move forward
Void moveForward() {
  digitalWrite(motorLeftPin1, HIGH);
  digitalWrite(motorLeftPin2, LOW);
  digitalWrite(motorRightPin1, HIGH);
  digitalWrite(motorRightPin2, LOW);
}

// Function to stop
```

```
Void stop() {
  digitalWrite(motorLeftPin1, LOW);
  digitalWrite(motorLeftPin2, LOW);
  digitalWrite(motorRightPin1, LOW);
  digitalWrite(motorRightPin2, LOW);
}

// Function to handle reaching the plot boundary and move to next row
Void reachPlotEnd() {
  Stop();
  Delay(500);

  // Turn right 90 degrees
  turnRight();
  delay(1000); // Adjust turn duration if needed

  // Move forward briefly
  moveForward();
  delay(1000); // Move forward duration

  // Turn right another 90 degrees to start the next row
  turnRight();
  delay(1000); // Adjust turn duration if needed

  stop();
  delay(500);
}

// Function to turn right 90 degrees
Void turnRight() {
  digitalWrite(motorLeftPin1, HIGH);
  digitalWrite(motorLeftPin2, LOW);
  digitalWrite(motorRightPin1, LOW);
  digitalWrite(motorRightPin2, HIGH);
}
```

```
// Function to turn left 90 degrees
Void turnLeft() {
  digitalWrite(motorLeftPin1, LOW);
  digitalWrite(motorLeftPin2, HIGH);
  digitalWrite(motorRightPin1, HIGH);
  digitalWrite(motorRightPin2, LOW);
}

// New obstacle avoidance function
Void avoidObstacle() {
  Stop();
  Delay(500);

  // Step 1: Move right briefly to create space
  turnRight();
  delay(1000); // Adjust for slight right movement to clear obstacle
  stop();
  delay(500);

  // Step 2: Turn 90 degrees to the right to move past the obstacle
  turnRight();
  delay(1000); // Adjust for 90-degree turn
  stop();
  delay(500);

  // Move forward to bypass the obstacle
  moveForward();
  delay(1000); // Adjust as needed based on obstacle size

  // Step 3: Turn left 90 degrees to get back on track
  turnLeft();
  delay(1000); // Adjust for 90-degree left turn

  stop();
```

```
  delay(500);
}

// Non-blocking function to activate pesticide spray at intervals

Void activateSprayNonBlocking() {
  If (millis() – sprayStartTime >= sprayInterval) {
    digitalWrite(sprayPin, HIGH); // Turn on spray
    delay(100); // Small delay to ensure spray is activated
    digitalWrite(sprayPin, LOW); // Turn off spray
    sprayStartTime = millis(); // Reset spray timer
  }
```

CHAPTER 6
CONCLUSION

A solar-powered lawn skiver robot represents a sustainable and innovative solution for lawn care. By harnessing renewable solar energy, the robot reduces reliance on traditional, energy-consuming equipment, minimizing carbon footprints and operational costs. With advancements in AI, sensors, and autonomous technology, these robots can efficiently and autonomously maintain lawns, offering both convenience and environmental benefits. As solar energy continues to evolve, the effectiveness, affordability, and scalability of solar-powered robots will improve, making them an increasingly viable option for homeowners and businesses alike. Overall, solar-powered lawn skiver robots are a promising step toward integrating smart technology with green practices, paving the way for more eco-friendly and efficient outdoor maintenance solutions.

Moreover, the adoption of solar-powered lawn skiver robots has the potential to transform the landscape of urban and suburban landscaping. These robots can operate autonomously for extended periods without human intervention, cutting down on the time and effort traditionally spent on lawn maintenance. By leveraging clean energy, they not only lower electricity consumption but also contribute to reducing noise pollution and harmful emissions associated with gas-powered lawn equipment. Further improvements in battery storage, solar efficiency, and robotics will enhance the reliability and performance of these systems, making them a practical and long-term solution for eco-conscious consumers seeking an efficient, low-maintenance way to care for their lawns.

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