



## Solar and Battery Based Automatic Grass Cutting Robot

<sup>1</sup>P. P. Belagali, <sup>2</sup>Pratiksha Ashok Mohite, <sup>3</sup>Vivek Ashok Patil, <sup>4</sup>Rushikesh Suresh kumbhar  
<sup>1,2,3,4</sup> Electronics & Telecommunication Engineering Department Dr. J. J. Magdum College of Engineering,  
Jaysingpur, India  
Email: <sup>4</sup>rushikeshkumbhar5603@gmail.com

Peer Review Information	Abstract
<p><i>Submission: 13 April 2026</i></p> <p><i>Revision: 05 May 2026</i></p> <p><i>Acceptance: 23 May 2026</i></p> <p><b>Keywords</b></p> <p><i>Autonomous Lawn Mower, Microcontroller Control, Ultrasonic Sensing, Obstacle Detection, Boundary Detection, Zigzag Navigation, Dual-Battery Management, Robotic Lawn Maintenance</i></p>	<p>The growing demand for automation in domestic and agricultural applications has led to the development of intelligent lawn maintenance systems. This paper presents the design and implementation of an autonomous lawn mower based on microcontroller technology, aimed at minimizing human effort while ensuring efficient lawn coverage. The proposed system employs ultrasonic sensors to detect obstacles and distinguish lawn boundaries without requiring prior physical setup or perimeter wiring. The robotic platform is equipped with a high-speed cutting blade and follows an optimized zigzag traversal algorithm to achieve complete area coverage. Real-time sensor feedback enables dynamic path correction, allowing the system to avoid obstacles and adapt to varying terrain conditions. A motor driver interface is utilized to precisely control the movement of DC motors based on decisions made by the microcontroller. To enhance operational continuity, a dual-battery management system is incorporated. This system utilizes a relay-based automatic changeover mechanism, ensuring uninterrupted operation by switching between active and charging batteries as needed. The integration of intelligent navigation, obstacle avoidance, and power management results in a fully autonomous, energy-efficient lawn mowing solution. Experimental analysis demonstrates that the proposed system effectively reduces manual intervention while maintaining reliable and consistent performance across different lawn environments.</p>

### Introduction

The fully automated solar grass cutter is a robotic lawn mower powered by solar energy that can cut grass and avoid obstacles without any human intervention. It runs on 12V batteries, which power both the motors that move the vehicle and the motor that drives the cutting blades. A solar panel charges the battery, so there is no need for external charging.

The motors are controlled by an ESP 32 microcontroller, which is also connected to an ultrasonic sensor for obstacle detection. When no obstacles are detected, the vehicle moves forward and the cutter operates normally. If an obstacle is detected, the sensor signals the

microcontroller, which stops the cutting motor to prevent any damage to objects, people, or animals. The vehicle then turns until it finds a clear path, after which cutting resumes.

This solar-powered automatic grass cutter makes lawn maintenance effortless for users, while also reducing noise and environmental pollution. With rising fuel costs, it is an efficient and eco-friendly alternative to conventional petrol-powered mowers. By using renewable solar energy, it not only saves money but also contributes to a cleaner environment.

### Literature Review

The first lawn mower, invented by Edwin

Budding in 1830, featured a 19-inch cutting width, iron frame, and gear-driven cylinder with adjustable height. Modern gasoline mowers contribute nearly 33% of urban air pollution, making battery-powered electric alternatives increasingly popular despite shorter runtimes. Autonomous mowers, such as Lawn Buddy, reduce human effort by using sensors to navigate and differentiate between cut and uncut grass, operating in spiral and random patterns to ensure complete coverage.

#### **Literature Review 1.**

##### **Self-Efficient and Sustainable Solar Powered Robotic Lawn Mower. (December 2015):**

The first lawn mower, invented by Edwin Budding in 1830, featured a 19-inch (480 mm) cutting width, an iron frame, and a gear-driven cutting cylinder with adjustable height. While mechanically ingenious, modern gasoline-powered mowers contribute nearly 33% of urban air pollution. Battery-powered alternatives offer a cleaner solution, though runtime and recharge limitations remain key performance factors.

The proposed Lawn Buddy system is an autonomous electric mower designed for minimal human intervention. Activated at the lawn center, it initially follows a spiral cutting pattern and switches to a randomized traversal upon detecting boundaries via onboard sensors. By combining autonomous navigation, adaptive cutting, and electric power, Lawn Buddy provides efficient lawn coverage while reducing environmental impact.

#### **Literature Review 2.**

##### **Automated Solar Grass Cutter (February 2017):**

Autonomous lawn mowers have evolved to integrate navigation, obstacle detection, and hybrid power management, combining 12V batteries with solar panels to reduce external charging requirements. Systems employ boundary wires and infrared sensors to differentiate cut and uncut grass, enabling complete lawn coverage. Control is implemented via an 8051 microcontroller, which coordinates the vehicle and cutting motors while interfacing with ultrasonic sensors for real-time obstacle detection. On obstacle detection, the microcontroller halts the cutting motor to prevent damage, ensuring safe and fully automated operation with minimal human intervention.

#### **Literature Review 3.**

##### **Design and Implementation of Automatic Solar Grass Cutter(April 2017) :**

Conventional manually operated lawn mowers are widely used but are associated with energy inefficiency and environmental pollution. To address these limitations, automatic solar-powered grass cutters have been developed to reduce human effort while leveraging renewable energy. These systems utilize solar panels to power both the drive and cutting mechanisms and incorporate multiple sensors for obstacle detection and safe navigation.

#### **Objective Of Proposed Work**

The main goal of this project is to design and build an efficient inverter system that can convert DC power into stable AC power with very little energy loss. The project focuses on:

- **Optimizing Performance:** Ensuring the inverter works reliably and efficiently with minimal energy waste.
- **Cost-Effectiveness:** Creating a system that is affordable without sacrificing quality.
- **Safety and Compliance:** Following relevant standards and including safety features to prevent any hazards.
- **Advanced Features:** Adding functions like overload protection, thermal management, and reducing electrical harmonics to improve performance.
- **Versatile Use:** Making the inverter suitable for both home and industrial applications.

#### **Working Principle:**

The smart lawn mower works on a hybrid system that uses both solar energy and a rechargeable battery. Solar panels generate electricity from sunlight, which can either power the mower directly or be stored in batteries for later use, ensuring it runs even when sunlight is not available.

A charge controller regulates the flow of power between the solar panels, battery, and the system. It protects the battery from overcharging and deep discharge, and in some cases uses Controller to improve the efficiency of solar energy conversion.

The mower uses motors to drive the wheels and cutting blades. These motors are controlled by motor drivers that adjust speed and torque depending on factors like grass thickness and terrain.

For autonomous operation, the mower is equipped with sensors such as ultrasonic sensors, and boundary wires. A microcontroller processes this sensor data and controls navigation, allowing the mower to avoid obstacles and cover the entire area efficiently.

The system can also adjust blade speed and cutting height based on the density of the grass.

When the battery level becomes low, the mower automatically returns to its docking station to recharge using solar energy.

Overall, the system combines solar power, energy storage, motor control, and embedded systems to achieve efficient, automated, and environmentally friendly lawn mowing.

### Working System of Various Departments of Solar and Battery-Powered Smart Lawn Mower:

#### 1. Power System

The mower is powered by solar energy, collected through panels placed either on the mower or at a docking station. These panels convert sunlight into electrical energy, which is stored in a rechargeable battery. This allows the mower to operate even when sunlight is not available. A charge controller regulates the flow of energy, preventing overcharging and excessive discharge, while maintaining a proper balance between the solar input and battery usage.

#### 2. Movement and Cutting System

The movement of the mower is achieved using wheel motors, while a separate motor drives the cutting blades. Motor controllers adjust the speed and power of these motors based on the terrain and grass density, ensuring smooth movement and effective cutting performance.

#### 3. Automation and Scheduling System

The mower runs automatically with minimal human input. You can set schedules for mowing at specific times, and the control unit uses sensor data to make real-time decisions. When the battery is low, the mower automatically returns to its docking station to recharge, ensuring continuous operation.

#### 4. Integrated System Functionality

All the mower's subsystems—power, movement, navigation, and automation—work together to provide a fully autonomous and energy-efficient lawn care solution. By using solar energy, smart motor control, sensor-guided navigation, and automated scheduling, the mower can operate continuously with minimal human involvement while reducing environmental impact.

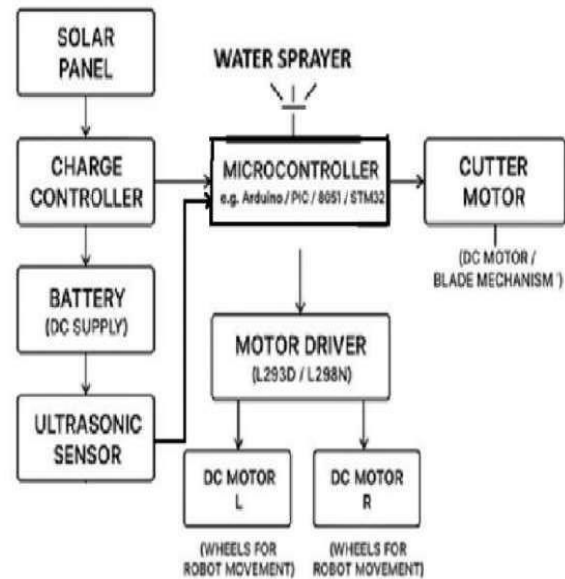
### Methodology and Planning of Work

This section explains the step-by-step approach used to design and build the solar and battery-powered smart lawn mower.

#### 1. System Design and Component Selection

First, we selected the main components:

**Solar Panels and Battery:** Solar panels that generate enough energy to run the mower, paired with a rechargeable battery to store energy for continuous operation.



**Microcontroller:** A microcontroller capable of managing the motors, reading sensor data, and handling wireless communication.

**Motors and Drivers:** Efficient DC motors for driving the wheels and cutting blades, with motor drivers that provide precise control over speed and direction.

#### 2. Hardware Integration

Next, the hardware components were assembled and tested:

A **power management system** was set up to safely control charging from the solar panels to the battery and to distribute power efficiently throughout the mower.

**Motor drivers** were connected to the wheel and blade motors and controlled by the microcontroller to ensure smooth movement and cutting operation.

**Bluetooth modules** were added to enable remote control and monitoring of the mower using a smartphone.

#### 3. Software Development

We built software to make the mower work smoothly and intelligently. The small computer inside the mower (the microcontroller) does several jobs: it controls how fast the motors run and which way they turn, reads sensors to avoid obstacles and stay within the lawn's boundaries, adjusts the blade depending on the grass, and handles WIFI so it can receive commands from a phone.

We also made a mobile app that lets users set

mowing schedules, check the mower’s status, and even control it remotely if needed.

**4. Testing and Validation** We tested the lawn mower in steps:

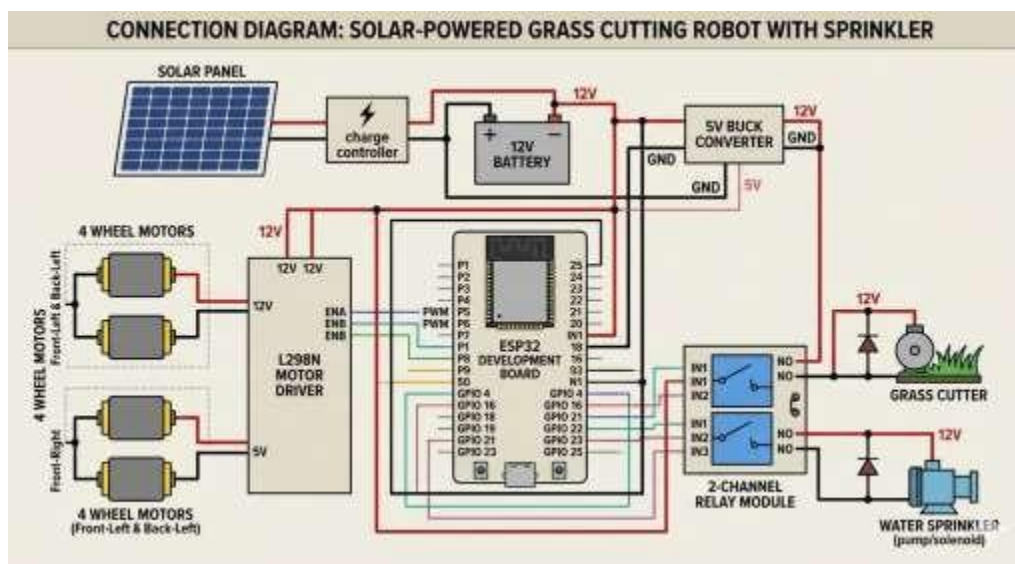
- First, each part was checked individually — the solar charging system, battery, motors, sensors, and WIFI— to make sure they all worked properly.
- Then, the entire system was tested on a real lawn to see if it could operate autonomously and reliably.
- We looked at how well it mowed, how

long the battery lasted, how well it avoided obstacles, and its overall performance.

**Summary of how it works:**

- The solar panel generates electricity and charges the battery.
- The battery safely supplies power to the microcontroller and motor controllers.
- The microcontroller gets commands from the WIFI Module.
- It uses this information to control the motors, moving the mower and spinning the blades.

**Connection Diagram**



**1. ESP 32 Microcontroller**

The ESP32 acts as the brain of the solar-powered smart lawn mower. It controls the motors and blades, watches the sensors to avoid obstacles, manages power from the battery and solar panel, and connects to a smartphone via Bluetooth for easy remote control. Its wireless features, many connection pins, and low power use make it perfect for an autonomous mower.

**2. Motor Drivers (H-Bridge Circuits)**

- **Role:** Interface between microcontrollers and motors. Motor drivers provide the power and direction control signals to DC motors or stepper motors.
- **In this system:** The motor driver boards control the mower’s wheel motors and blade motor(s).

**3. DC Motors / Wheel Motors**

- **Role:** Provide the mechanical movement for the mower wheels and

blades.

- **In this system:** Usually 2-4 motors are used — some for driving the wheels and at least one for spinning the cutting blades.

**4. Power Supply / Battery Management System**

- **Role:** Provides regulated voltage and current to all components, protects batteries from overcharge/discharge, and ensures stable operation.
- **In this system:** Powers the motors, microcontrollers, sensors, and communication modules.

**5. Sensors**

**• Typical Sensors**

**Ultrasonic Sensors:** Detect obstacles to avoid collisions.

**In this system:** The sensors feed real-time data to the Arduino or Raspberry Pi for decision-making.

## 6. Bluetooth/Wi-Fi Module

**Role:** Enables wireless communication between the mower and an external device (like a smartphone or PC).

**In this system:** Allows remote control and monitoring of mower status.

## 7. Relays and Switches

**Role:** Used to safely switch higher current loads or isolate parts of the circuit.

**In this system:** May control power to motors or other heavy-load components.

## Result And Discussion

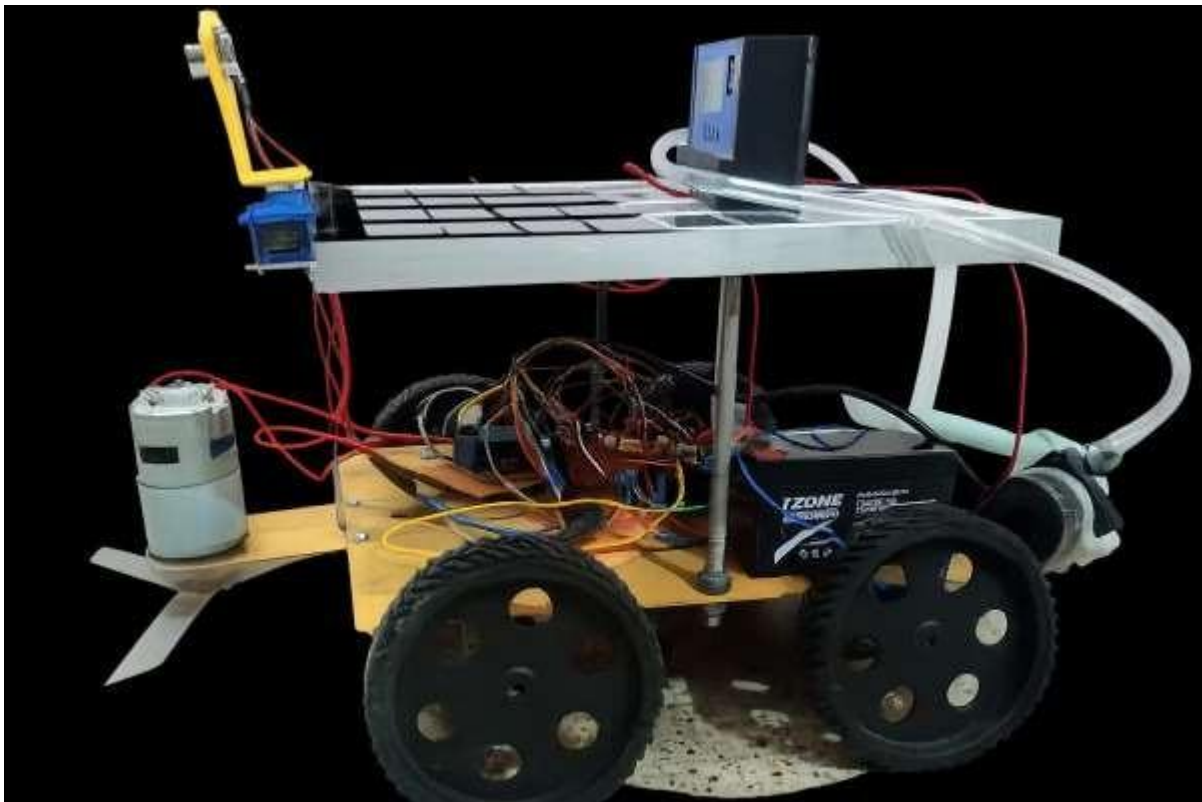
The solar-powered smart lawn mower worked well, generating and storing energy efficiently. The solar panels produced around 5 W, and the battery allowed the mower to run for about 2

hours even when sunlight was low.

It could navigate the lawn on its own, using ultrasonic and infrared sensors to avoid obstacles and make sure the whole area was covered. The motor controllers automatically adjusted the blade speed depending on how thick the grass was, keeping the cut consistent across different types of terrain.

WIFI connectivity made it easy to monitor and control the mower from a smartphone.

Overall, the system proved to be efficient, environmentally friendly, and reliable for autonomous operation. In the future, it could be improved by increasing battery capacity, using more advanced sensor technology, and adding more connectivity options for better control.



## Conclusion

This project introduced a smart lawn mower powered by both solar energy and a battery. It combines renewable energy use, efficient battery storage, and autonomous operation.

The system managed energy well, controlled the motors precisely, and avoided obstacles reliably using built-in sensors. Wifi connectivity allowed users to monitor and control the mower remotely.

Overall, this mower provides an eco-friendly, intelligent way to maintain a lawn, reducing the need for traditional power sources while offering convenient autonomous operation. In

the future, it could be improved by making it more energy-efficient, using advanced sensor technologies, and adding better connectivity for even smoother performance.

## Acknowledgement

I would like to express my sincere gratitude to my guide, Dr. P. P. Belagali, of the Electronics & Telecommunication Engineering Department, for providing me with the opportunity to work under her guidance on this thesis. I greatly appreciate and value her expert guidance and encouragement throughout the entire project. I am deeply thankful for her

support, knowledge, and presence during challenging moments, which I will remember throughout my career.

### **Reference**

Srishti Jain, Amar Khalore, Shashikant Patil. Self-Efficient and Sustainable Solar Powered Robotic Lawn Mower in International Journal of Trend in Research and Development(IJTRD). Vol.2(6), December 2015.

Ms. Rutuja A. Yadav, Ms. Nayana V. Chavan, Ms. Monika B. Patil, Prof. V .A. Mane. Automated Solar Grass Cutter in International Journal of Scientific Development and Research(IJSDR). Vol.2, February 2017.

Bidgar Pravin Dilip, Nikhil Babu Pagar, Vickey S. Ugale, Sandip Wani, Prof. Sharmila M. Design and Implementation of Automatic Solar Grass Cutter in International Journal of Advanced Research in Electrical(IJARE). Vol.6, April 2017.

Ms. Bhagyashri R. Patil, Mr. Sagar S. Patil. Solar Based Grass Cutting in International Journal of Electrical and Electronics Engineers (IJEEE). January-June 2017.