IJIREEICE ISSN (O) 2321-2004, ISSN (P) 2321-5526

International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering

Impact Factor 8.414 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 12, December 2025

DOI: 10.17148/IJIREEICE.2025.131203

Smart IOT Based Solar Robotic Grass Cutter and Water Sprinkler

Mrs. Bhavya K B[1], Disha Reddy K R[2], Dyuthi C[3], Hemanth P[4]

Assistant Professor Dept. of ECE, Bangalore Institute of Technology, Bangalore, India[1]

Student, Dept. of ECE, Bangalore Institute of Technology, Bangalore, India[2-4]

Abstract: Traditional grass-cutting machines depend on manual operation and the use of fossil fuels, which leads to environmental pollution, increased operational costs, and greater physical effort. To overcome these limitations, this project proposes the design and implementation of a solar powered grass cutter integrated with a water sprinkler system. The robot operates wirelessly through a Bluetooth-based mobile application that enables remote control of its movement and functionality. The core of the system is the Arduino UNO microcontroller, which coordinates motor control, blade operation, and sprinkler activation. A solar panel is used to charge the onboard rechargeable battery, ensuring continuous operation using renewable energy. The drive mechanism employs DC motors for mobility, and the cutting blade is powered through a high-torque motor for efficient grass trimming. The water sprinkler system is interfaced with a mini water pump that can be activated as required. This system minimizes human intervention, promotes energy efficiency, and eliminates dependency on fossil fuels. The portable design and eco-friendly operation make the robot suitable for home gardens, institutional lawns, and small-scale agricultural fields. The integration of solar energy and wireless control enhances both sustainability and ease of use, contributing to smart automation in agricultural and domestic maintenance applications.

Keywords: Solar-powered, Bluetooth based, portable design, high-torque.

I. INTRODUCTION

This robot is designed as an eco-friendly and energy-efficient solution that operates entirely on renewable energy sourced from a solar panel, thereby eliminating dependence on fossil fuels and significantly reducing air and noise pollution.[1] The system employs a rechargeable 12V battery that stores energy from the solar panel to power all components, including the drive motors, cutting mechanism, and water sprinkler. This integration promotes sustainability and minimizes operational energy costs.[2] The entire system is controlled wirelessly via a Bluetooth-enabled mobile application, allowing the operator to control the robot's movement and remotely activate or deactivate both the grass cutting blades and the water sprinkler system.[3] An Arduino UNO microcontroller serves as the central processing unit, interpreting signals received from the Bluetooth module and coordinating motor functions, blade operation, and sprinkler control with precision. The grass-cutting robot is designed to be compact, portable, and user-friendly, making it suitable for a wide range of applications such as home lawns, gardens, educational institutions, and smallscale agricultural fields.[4] Its design prioritizes efficiency, ease of use, and low maintenance requirements. Key advantages of this system include reduced manual labor, cost-effectiveness, and an environmentally sustainable design. Overall, this solar-powered, Bluetooth-controlled grass cutter and water sprinkler robot represents a practical and modern alternative to conventional manual grass-cutting equipment, contributing to the advancement of automation in eco-friendly maintenance applications[5].

II. LITERATURE REVIEW

A. Automatic Solar Grass Cutter Systems

- Several studies have developed fully automated solar-powered lawn cutters using microcontrollers and sensors (e.g., Arduino, ultrasonic sensors) to enable autonomous navigation and obstacle detection.
- These systems aim to reduce human intervention, improve safety, and eliminate hazards associated with conventional gasoline-based mowers.

B. Robotic Grass Cutting Technologies

- Robotic devices were introduced to cut grass automatically using ultrasonic sensors for obstacle detection and LDR sensors for direction following.
- Some models allow users to input area dimensions (length and breadth) for autonomous trimming within specified boundaries.

IJIREEICE ISSN (O) 2321-2004, ISSN (P) 2321-5526

International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering

Impact Factor 8.414 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 12, December 2025

DOI: 10.17148/IJIREEICE.2025.131203

C. Solar-Powered Multipurpose Agricultural Robots

- Various designs explored solar-powered robots that combine grass cutting with pesticide spraying, irrigation, and weed removal.
- These systems are intended to reduce manual labour and replace machines dependent on non-renewable energy sources.

D. Solar-Based Pesticide Sprayers

- Multiple studies discuss solar agricultural sprayers as environmentally friendly alternatives to diesel-based sprayers, improving farmers' health by reducing exposure to chemicals.
- These sprayers often use DC pumps and reduce 5. Automated Irrigation Systems
- Research also includes fuzzy-logic-based automatic irrigation systems aimed at optimizing water management in agricultural fields, ensuring higher yield and efficient use of water resources.

E. Electric and Battery-Powered Agricultural Machines

- Some works designed battery-operated robotic agricultural vehicles capable of grass cutting without colliding with obstacles, integrating sensors and microcontrollers (Arduino, PIC).

F. Mechanical Innovations in Grass Cutting

- Alternative mechanical designs such as Scotch yoke mechanisms and linear blades were proposed to enhance cutting performance and reduce power consumption.

G. Solar Grass Harvester Designs

- Studies examined solar grass harvesters using sliding blades to maintain lawns uniformly, promoting eco-friendly and low-cost maintenance in public and private landscapes.

H. IoT-Based Garden Maintenance Robots

- IoT-enabled grass trimming and watering robots have been developed for easy operation, low maintenance, and uniform cutting, especially useful in gardens and parks.

I. Multipurpose Agriculture Machines

- Several studies propose multi-function agricultural devices capable of weeding, seeding, spraying, and cutting, reducing manpower requirements and enhancing farming efficiency.

J. Solar-Powered Lawn Mowers

- Research focuses on solar-powered lawn mowers designed to reduce pollution, noise, and fuel dependency.
- These devices often include gear motors for torque enhancement and solar batteries for longer operation.

K. Autonomous Vehicles for Field Tasks

- Some works highlight voice-controlled multipurpose agricultural robots, integrating communication technologies for flexible operation in the field.

L. Economic and Environmental Benefits

- Many studies emphasize the cost-effectiveness, eco-friendliness, and ease of operation of solar-powered grass cutters, making them suitable for farmers, schools, hospitals, malls, and parks.

III. TOOLS AND TECHNOLOGIES

A. *Architecture*

The architecture of the smart grass-cutting and water-sprinkling robot is designed using a modular hardware–software framework. The model consists of:

1. Power Architecture
   - A 12V solar panel charges a rechargeable 12V, 3.3Ah battery.
   - Power distribution provides supply to the Arduino UNO, motor drivers, DC motors, blade motor, and water pump.
2. Control Architecture
   - Arduino UNO serves as the central processing unit.
   - It receives commands from the Bluetooth HC-05 module.
   - It controls Motor Driver 1 (movement) and Motor Driver 2 (blade + sprinkler).
3. Actuation Architecture
   - Motor Driver 1 (L298N): Controls left/right wheel motors for movement.
   - Motor Driver 2 (L298N): Controls grass-cutting blade motor and sprinkler pump.
4. Communication Architecture
   - Bluetooth communication between the mobile app and HC-05.
   - Commands transmitted as characters processed by Arduino.
5. Mechanical Architecture
   - Chassis with mounted motors, wheels, cutting blade, water tank, pump, and sprinkler nozzle.

IJIREEICE ISSN (O) 2321-2004, ISSN (P) 2321-5526

International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering

Impact Factor 8.414 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 12, December 2025

DOI: 10.17148/IJIREEICE.2025.131203

This architecture enables wireless, solar-powered lawn maintenance with integrated motion, cutting, and irrigation.

B. Compilation

In embedded system terminology, compilation refers to:

- Writing the microcontroller program in Arduino IDE using embedded C/C++.
- Compiling the code into machine-level instructions (hex file).
- Verifying the program for errors and optimizing timing constraints.

The Arduino IDE compiles the logic that includes:

- Reading Bluetooth commands
- Mapping commands to robot actions
- Controlling PWM output for motor speeds
- Switching blade and pump ON/OFF
- Ensuring safe and synchronized operations

The compiled code is uploaded to the Arduino UNO through USB, enabling the hardware to execute the required behavior.

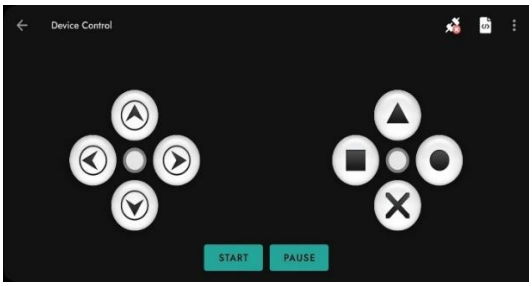

Fig1: Arduino Bluetooth control application in Mobile Phone

C. Training

Although the project does not involve AI/ML, "training" can be interpreted as system calibration and tuning, which includes:

1. Motor Calibration
   - Adjusting PWM values for smooth forward, reverse, left, and right motion.
   - Testing wheel alignment and torque balance.
2. Blade Mechanism Calibration
   - Optimizing blade speed for efficient grass cutting.
   - Ensuring stable rotation without vibration.
3. Sprinkler Calibration
   - Adjusting water flow rate.
   - Optimizing pump pressure and nozzle spray angle.
4. Bluetooth Command Testing
   - Ensuring commands map correctly to actions.
   - Eliminating response delays or signal drops.
5. Solar Charging Calibration
   - Measuring charging rates at different sunlight intensities.
   - Ensuring stable power output to the system.

Through repeated testing and adjustments, the system "learns" optimal working parameters that ensure high efficiency and reliability.

D. *Deployment*

Model deployment refers to integrating all hardware and software components into a fully functional field-ready prototype.

Deployment steps include:

1. Mounting all hardware on the mechanical chassis
   - Motors, wheels, battery, solar panel, blade, pump, and motor drivers.
2. Connecting all components to Arduino
   - Ensuring solid wiring and correct polarity.
3. Uploading the compiled microcontroller code
   - Activating wireless communication.
4. Testing functional modules

IJIREEICE ISSN (O) 2321-2004, ISSN (P) 2321-5526

International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering

Impact Factor 8.414 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 12, December 2025

DOI: 10.17148/IJIREEICE.2025.131203

- Movement controls
- Blade operation
- Water sprinkler system

5. Outdoor Deployment
   - Testing in an actual lawn environment to ensure real-world performance.

After deployment, the robot is capable of autonomous operations controlled wirelessly via a mobile application while powered by solar energy.

E. *Evaluation*

Model evaluation measures how well the developed robot performs. The evaluation is based on:

1. Operational Performance
   - Smooth forward, reverse, and turning movements
   - Reliable Bluetooth range (~10 meters)
   - Proper response time to commands
2. Cutting Efficiency
   - Ability to cut grass uniformly
   - Blade motor torque adequacy
   - Performance on different grass densities
3. Water Sprinkler Efficiency
   - Spray coverage
   - Pump flow stability
   - Water consumption levels
4. Energy Efficiency
   - Solar charging speed
   - Battery backup duration
5. Stability and Safety
   - No overheating of motors
   - Blade safely enclosed
   - Stable movement on uneven terrain
6. User Experience
   - Easy control via mobile app
   - Minimal manual effort required
   - System reliability during continuous use

The evaluation confirms whether the prototype meets project objectives such as eco-friendliness, wireless control, reduced human labor, and cost-effectiveness.

IV. SYSTEM IMPLEMENTATION

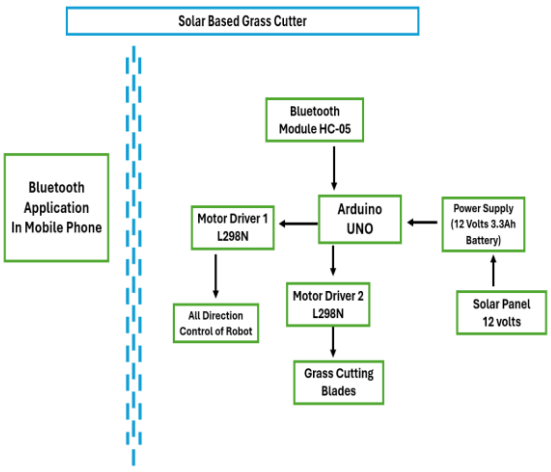

Fig 2: Functional block diagram

The system implementation involves integrating the solar power unit, cutting mechanism, spraying mechanism, and wireless control unit into a functional proto-vehicle capable of performing grass cutting and water/pesticide spraying simultaneously.

IJIREEICE ISSN (O) 2321-2004, ISSN (P) 2321-5526

International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering

Impact Factor 8.414 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 12, December 2025

DOI: 10.17148/IJIREEICE.2025.131203

A. Solar Energy Conversion and Storage

The system begins with a 75W solar panel mounted on the top frame. When exposed to sunlight, the photovoltaic (PV) cells convert solar radiation into electrical energy. This energy is then stored in a 12V, 7Ah lead-acid rechargeable battery, which supplies continuous power to the motors and electronic components. The battery ensures uninterrupted operation for 2–3 hours even under varying sunlight conditions.

B. Propulsion and Wheel Drive System

Movement of the vehicle is achieved using geared wiper motors mounted on the rear wheels. These motors operate at 12V and provide high torque at low speed (45 rpm), making the vehicle stable and suitable for grass cutting conditions. The motors are connected through relays and controlled through the RF wireless receiver unit.

C. Grass Cutting Mechanism

A 12V DC motor running at approximately 1600 rpm drives a sharp mild steel cutting blade located beneath the frame. As the
motor rotates, the blade cuts grass evenly due to high rotational kinetic energy. The blade is securely mounted and balanced to minimize vibration. The cutting system can be activated or deactivated remotely using the RF remote switches.

D. Water/Pesticide Spraying System

A rotary water pump (12V, 300 L/hr flow rate) is installed at the bottom of the storage tank. The pump draws water/pesticide through hoses and expels it through spray nozzles positioned at the rear of the vehicle. The spraying mechanism ensures uniform coverage across the field or garden area. Like the cutter motor, the pump is also controlled wirelessly through the RF receiver module.

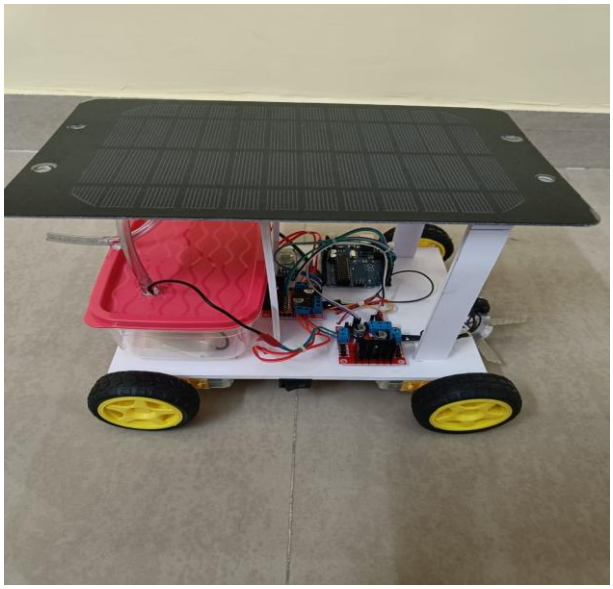

Fig 3: Working Model of proposed prototype

E. RF-Based Wireless Control Unit

The system uses an RF transmitter (remote) and RF receiver (on vehicle) operating at 434 MHz to control all operations wirelessly.

- The encoder IC in the transmitter converts user inputs (switch presses) into coded signals.
- The RF transmitter sends these signals to the receiver.
- The decoder IC in the receiver interprets the signals and activates the correct relays.
- The relays switch ON/OFF the motors (wheel motors, blade motor, pump).

LED indicators on the receiver side display the status of each operation.

F. Mechanical Frame Assembly

The prototype frame is fabricated using square mild steel rods, providing strength, durability, and ease of mounting components. The frame supports the solar panel, battery, motors, water tank, blade assembly, and pump. Handles are attached for manual support during testing. Proper cutouts and bolt locations are provided to secure components firmly.

DOI: 10.17148/IJIREEICE.2025.131203

G. Integration and Testing

After assembly, all electrical, mechanical, and control units are interconnected using appropriate wiring and connectors. System testing includes:

- Blade rotation and cutting height effectiveness
- Water/pesticide spray coverage
- Vehicle movement and turning capability
- RF remote range and response
- Battery charging and discharging cycle.

V. CONCLUSION

The development of a solar-powered robotic grass cutter and automatic water sprinkler system demonstrates an effective integration of renewable energy, automation, and IoT technology for sustainable lawn maintenance. The system successfully performs grass cutting and irrigation operations with minimal human intervention, utilizing solar energy as its primary power source to reduce dependency on conventional electricity and fossil fuels. The inclusion of Bluetooth and IoT-based control enables wireless operation and remote monitoring, enhancing convenience and user accessibility. Obstacle detection and soil moisture sensing further improve the efficiency and intelligence of the system. Overall, this project provides an eco-friendly, energy-efficient, and cost-effective alternative to traditional manual grass-cutting methods. It contributes to environmental conservation by promoting renewable energy utilization and represents a practical solution for smart gardening, landscaping, and small-scale agricultural applications.

ACKNOWLEDGEMENT

We would like to express our heartfelt gratitude to our institution, Bangalore Institute of Technology for generously supporting throughout this study by providing all the resources and facilities required. We also extend our sincere thanks to the Department of Electronics and Communication Engineering for their invaluable guidance.

REFERENCES

[1]. Sanjana A., Shreyas A., Rasmika V., and Nivetha N., “Design and Implementation of Automatic Lawn Cutter”, International Journal of Science Technology and Engineering, Vol. 2, Issue 11, pp. 202-207, May 2016.

[2]. E. Naresh, Boss B., and G. Rahul, “Grass Cutting Machine by Solar Energy Power”, International Journal and Magazine Of Engineering, Technology, Management & Research, Vol. 3, Issue 5, pp. 302-307, May 2016.

[3]. Argade P. P., Bhosale S. B., Khadke S. S., Phadtare N. V., and Kale R. U., “Solar Powered Automatic Grass Cutter and Pesticide Spreading Robot”, International Research Journal of Engineering and Technology, Vol. 4, Issue 5, pp. 3372-3375, May -2017.

[4]. V. Kubendran, S. G. Fernandez, K. Vijayakumar, and K Selvakumar, “A Fully Automated Lawn Mower Using Solar Panel”, Journal of Advanced Research in Dynamical & Control Systems, Vol. 10, Issue 07, pp. 977-982, 22 May 2018

[5]. Gokul T. S., and Arunkumar C., “Solar based Robot for Garden Grass Cutting and Watering Plants”, GRD Journals, Global Research and Development Journal for Engineering, pp. 19-22, May 2019.

[6]. Harshhal K., Ganesh K., Akshay R., Pravin B., Swapnil P., and Radhika B., “Grass Cutting & Sprayer Machine Using Solar Energy”, IJSRSET, Vol. 4, Issue 4, pp. 806-809, March-April-2018.

[7]. J. Anand, and J. R. P. Perinbam, “Automatic Irrigation System using Fuzzy Logic”, AE International Journal of Multidisciplinary Research, Vol. 2, Issue 8, pp. 1-9, August 2014.

[8]. R. Joshua, V. Vasu and P. Vincent, “Solar Sprayer - An Agriculture Implement”, International Journal of Sustainable Agriculture, Vol. 2, pp. 16-19, 2010.

[9]. Dhiraj N. K., Vishal S., Prashik W., Altaf A., Vikas T., and R. D. Gorle, “Fabrication of Automatic Pesticides Spraying Machine”, International Research Journal of Engineering and Technology, Vol. 03, Issue 04, pp. 912-916, April 2016.

[10]. Ajay D. S., Sahil J. M., Pratik R. S., and Saurabh R. P., “Solar Powered Intelligent Grass Cutter Robot”, International Journal of Scientific Development and Research, Vol. 5, Issue 4, pp. 229-234, April 2020.