International Journal of
Energy and Thermal Applications

Volume 4, Issue 1, 2026
January–June
DOI (Journal): 10.37591/IJETA

https://journals.stmjournals.com/ijeta

Review IJETA

# Design and Simulation of Solar Powered Semi-Automatic Grass Cutter

Sachin S. Raj[1,*], R. A. Kapgate[1], Kasabe Smitha D.[1], Sakhare Sakshi[1], Wagh Shantanu S.[1], Pawar Rushikesh S.[2]

**Abstract**

*The maintenance of large area of grass lawns has always been a tedious task considering continuous human labour and long hours of work. Inorder to reduce the fatigue human work a novel design of automated grass cutting machine powered with a solar panel is designed and simulated for remote operated functioning. The mechanism works with the skeletal frame of a normal grass cutting machine face lifted with ultrasonic sensor for distance and obstacle detection, a 12 V 3 watt poly-crystalline solar panel integrated 9 V battery powering the dual motors relatively one driving the unmanned machine and the other responsible for the cutting operation contolled by a L293D motor drive chip. An AT mega 32A microcontroller plays a major role in operating the automated system. The entire prototype is connected through arduino wifi modem access to a mobile phone through which the machine is operated hassle free. At a maximum rpm of 1000 rpm the grass is cut precisely and a follower steel brush arm fitted at the back ensures that the cut grass is removed from the path way of the machine. The design and simulation is performed through software and efficiency data is cloud monitored through thingspeak platform. The goal of the suggested solar-powered semi-automatic grass cutter is to offer a green and energy-efficient lawn care option. The device lowers carbon emissions and depends less on traditional fuel-powered machinery by combining a photovoltaic solar panel with a rechargeable battery system. Real-time obstacle detection is made possible by the ultrasonic sensor, guaranteeing safe and seamless operation. Remote monitoring and control via a smartphone is made possible by the ATmega32A microcontroller's coordination of motor control, sensor input processing, and wireless communication via an Arduino Wi-Fi module. While cloud-based monitoring with the ThingSpeak platform improves data accessibility and system optimization, simulation is used to examine performance factors including motor speed, power consumption, and operational efficiency.*

**Keywords:** Simulation, automated grass cutter, solar powered, CREO, lawn mover

***Author for Correspondence**
Sachin S Raj
E-mail: sachinsraj1991@gmail.com

[1]Students, Department of Mechatronics Engineering, Sanjivani College of Engineering, Kopargaon, Ahmednagar, Maharashtra, India
[2]Professor, Department of Mechatronics Engineering, Sanjivani College of Engineering, Kopargaon, Ahmednagar, Maharashtra, India

Received Date: January 24, 2026
Accepted Date: February 26, 2026
Published Date: March 12, 2026

**Citation:** Sachin S Raj, R A Kapgate, Kasabe Smitha D, Sakhare Sakshi, Wagh Shantanu S, Pawar Rushikesh S. Design and Simulation of Solar Powered Semi-Automatic Grass Cutter. International Journal of Energy and Thermal Applications. 2026; 4(1): 17–24p.

## INTRODUTION

In recent years, growing environmental concerns and the increasing cost of fossil fuels have emphasized the importance of sustainable alternatives for everyday equipment, including lawn care tools [1]. Conventional lawn mowers, typically powered by gasoline or electricity from the grid, contribute to both air and noise pollution and often require frequent maintenance [2]. These challenges have encouraged the development of solar-powered lawn mowers, offering a cleaner and more efficient solution. A solar-powered grass cutter harnesses solar energy through photovoltaic (PV) panels, which convert sunlight into electrical energy. This power is stored in batteries and used to drive electric motors—one dedicated to the blade mechanism and two for locomotion—under the control of an Atmega328 microcontroller [3]. An ultrasonic sensor is integrated to automatically detect and avoid obstacles, ensuring safe and uninterrupted operation. Since the system operates independently of fossil fuels and external power sources. This innovation addresses the ecological drawbacks of traditional mowers while also enhancing convenience and usability for home gardens, public parks, and small agricultural plots [4, 5].

The project also considers blade material improvements to enhance safety and performance, aiming to develop a more reliable and user-friendly system. These mowers use high-efficiency ATMEGA328 microcontroller responsible for controlling both movement and blade operations [6–8]. Obstacle detection is handled by ultrasonic sensors, and the preference for ATMEGA328 over Arduino UNO reflects the need for better multitasking capabilities and system efficiency. Material selection plays a crucial role in ensuring the structural integrity of the mower [1, 3, 7, 9].

Various designs incorporate DC motors for cutting. Essential components include solar charge controllers, voltage regulators to prevent overcharging, and LCD displays for real-time voltage monitoring [10, 11]. Some versions are manually operated and feature spiral blades, adjustable cutting heights, and lightweight, compact frames.

An enhanced model has an estimated total power usage of 55.8W, with each rear wheel motor drawing between 10 and 14.4W. It operates on a 12V, 7Ah battery with an energy capacity of 84Wh, enabling approximately 2.6 hours of use—1.1 hours powered directly by solar input and 1.5 hours from stored battery energy. Full battery recharging takes around 8.43 hours [12]. The mower's design was partially developed and simulated using Creo software, which supported modeling, assembly, and performance analysis [13–15]. Table 1 provides an overview of various components used in different research work.

## METHODOLOGY

### Major Components

#### *Power Management*

Figures 1 and 2 shows the solar panel used in the project and the rechargable battery system respectivelly. The Silicon based solar panel converts sunlight into electrical energy, The equipment had a specification of Operating voltage - 12 V, Mono-crystal PV cell, Charging Time 5 To 6 Hours, Solar charger – 12v, 10AH. The rechargeable battery functions to store the energy from the solar panel and had the following specifications, type Lead Acid / Lithium-Ion, Voltage: 12V, Capacity: 7Ah to 12Ah and rechargeable. It acts as a power supply to the motors, microcontroller, and sensors [27].

#### *Motor*

Figures 3 and 4 shows the DC motors drives used for the wheels as well as the cutting blade and had the following specifications, Voltage: 12V, RPM of 100–300. the motor consisting of a voltage of 12V, RPM between 1200–1500 RPM, was considered for the blade rotation. It is a powerful DC motor able to generte high torque to cut the grass and is powered by the solar powered battery. The cutting blade material was Stainless Steel having a size of 6 to 8 inches in diameter and mounted to high-speed motor shaft.

#### *Microcontroller (Arduino / 8051)*

Figure 5 shows the main function of the arduino controller is to control the unit of the system. Arduino Uno (ATmega328P) / 8051 Microcontroller with an operating Voltage of 5V, I/O Pins of both Digital and Analog were used to processes sensor input and controls outputs like motors.

The L200 series micro controller controls the direction and speed of DC motors. The input Voltage was 5V logic from micro-controller for the motor output voltage was upto 36V, a max current with 2A per channel and the channels had dual controls 2 motors. The controller acts as an interface between micro-controller and motors.

 

**Table 1.** Summary of component specifications.

| S. No. | Component | Description | Reference |
|---|---|---|---|
| 1 | Solar panel | Solar power concentration using LFR, Angular error correction and performance, varying width reflector. | [16–18] |
| 2 | Frame design | Thermal analysis barrier, modified frame system, barrier coatings, | [19-21] |
| 3 | Sheet metal body work | Explicit dynamics on sheet metal simulator strength analysis. | [22] |
| 4 | Motor | Slow stirrer motor with high torque | [23] |
| 5 | Energy sources to move the device | Wireless method, power plant using magnets | [24, 25] |
| 6 | Microprocessor and IoT | Cloud monitoring, sensor and Arduino usage | [26] |

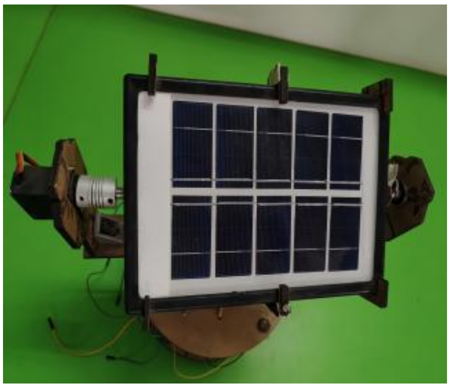

**Figure 1.** Solar panel.


**Figure 2.** Rechargable batteries.

**Figure 3.** DC motor.

**Figure 4.** Blade motor.

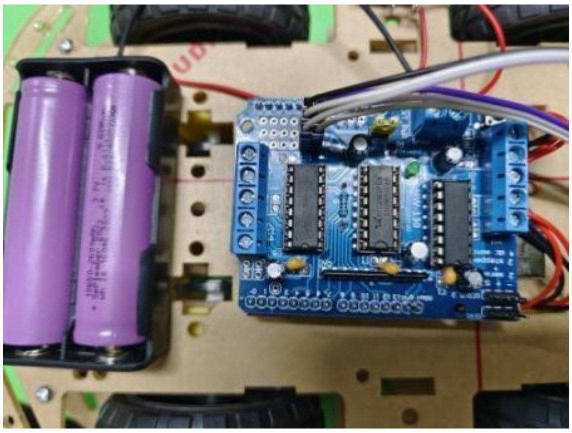

**Figure 5.** Arduino control kit.

 

***Circuit Diagram***

Figure 6 displays the circuit diagram for the proposed project. Various components that are used to build the system are depicted.

Smart solar grass cutters can function in both autonomous and manual modes. Among the key performance aspects, efficiency stands out as a critical factor. Achieving optimal efficiency depends heavily on the careful selection and placement of materials and components [12]. The system's micro-controller is programmed to synchronize the speeds of the rear wheel motors during straight movement. When directional changes are needed—such as turning right—the micro-controller increases the speed of the left motor while reducing the speed of the right one, and vice versa for a left turn [13].

## EXPERIMENTAL SETUP

### Software Simulation

As illustrated in Figure 7, this project features a common belt drive system automated, solar-powered lawn mower managed via the Blynk application and built around a NodeMCU (ESP8266) microcontroller. It employs geared DC motors (3–12V, approximately 120 RPM), L298 H-bridge motor drivers, a voltage distributor, and a relay to manage power efficiently. The mower is powered by a 10W solar panel (18V, 580mA), which charges two separate 12V rechargeable batteries—one dedicated to powering the system and the other for the cutting blade.

A charging circuit incorporating a voltage regulator, diode, and transistor maintains stable voltage during charging. For obstacle avoidance, an 8051 microcontroller receives input from ultrasonic sensors to guide navigation. The drive system uses two 100 RPM DC motors controlled by an L293D motor driver, while a high-speed 1400 RPM motor is responsible for rotating the cutting blade. The mower receives commands via Bluetooth, after which it can autonomously carry out lawn maintenance—navigating obstacles and halting upon task completion. Figure 8 shows the common belt drive designed for the motor operation of both the wheels and the blade. Motor operations are handled using an H-bridge driver, allowing for hands-free functionality and improved efficiency [11–13].

A flat-shaped cutting blade was selected due to its heavier mass, which better complements the motor's torque and minimizes operational instability. Although tapered and sickle bar blades generate higher cutting pressure, their lighter mass makes them less ideal for this setup. The mower deck is specially engineered to enhance airflow and lift, which assists in effective grass discharge. Given the intermittent nature of solar energy, a storage system is essential. Photovoltaic (PV) modules composed of doped silicon cells absorb solar radiation (approximately $6.33 \times 10^7$ W/m² at the sun's surface) and convert it into direct current (DC) [16–18].

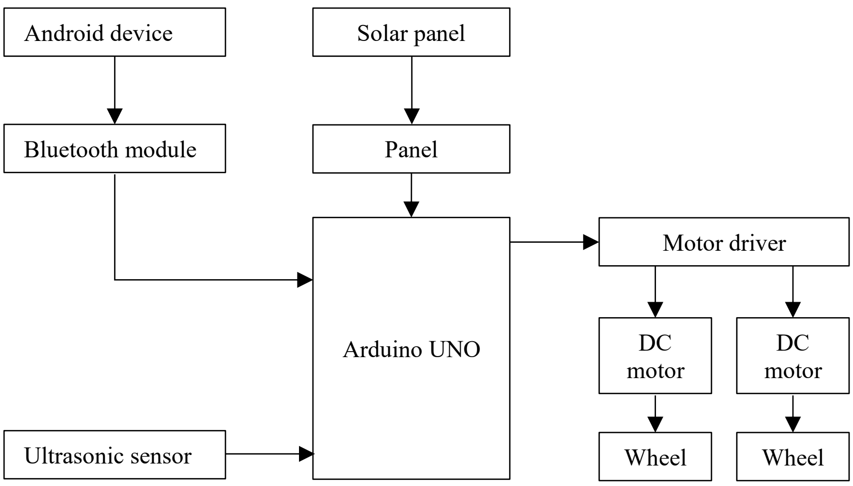


**Figure 6**. Circuit diagram of the setup.

 

Figure 7 Simulated design in software.

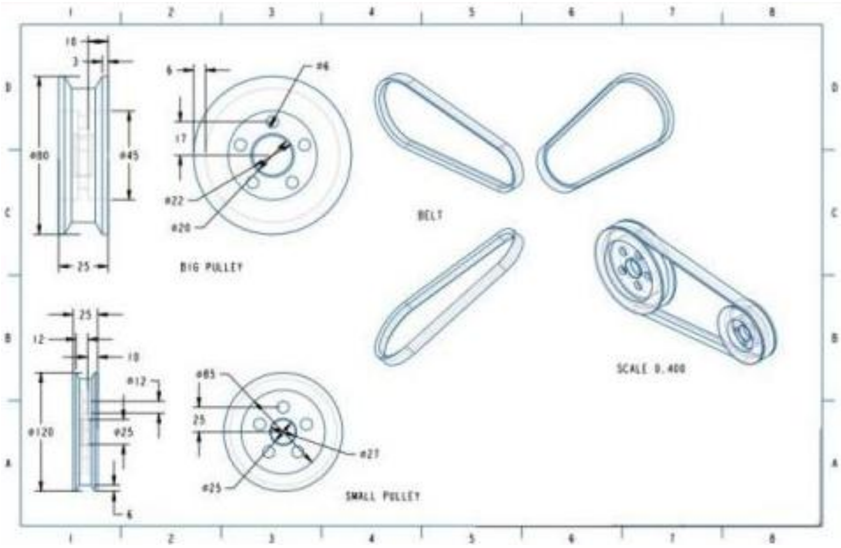


**Figure 8.** Common belt drive design for wheels and blade.

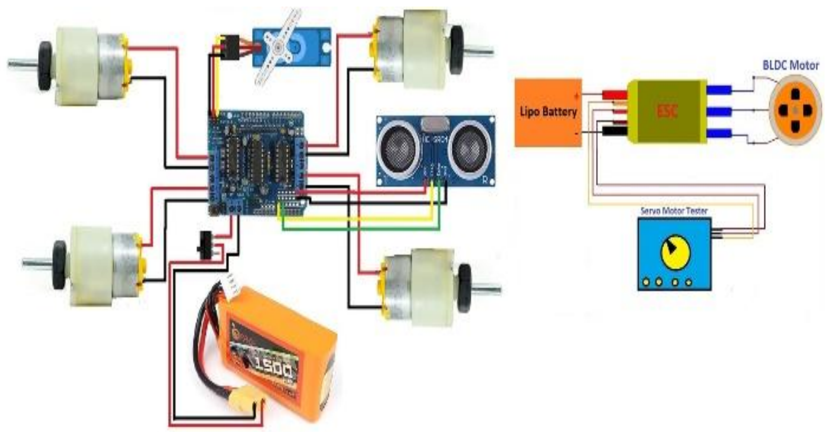


**Figure 9**. Production drawing design of mechanism for blade motor drive.

**Design Simulation Circuit Diagram**

While the system is capable of detecting and avoiding obstacles, its response time may lag slightly. To improve functionality, features like self-docking and rain sensors have been introduced. Figure 9 represents the components arranged according to the circuit diagram proposed.

 

**Figure 10.** Rootoype of the design.

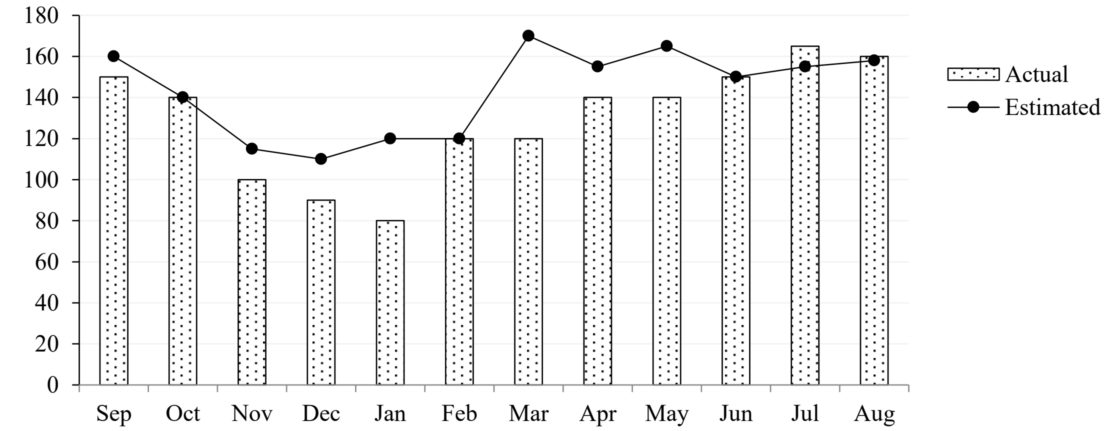


**Figure 11.** Power output based on solar energy availability.

Other designs feature manually operated mowers with spiral blades, focusing on improved energy efficiency, quieter operation, and reduced environmental impact [13, 14]. Figure 10 depicts the simulated design using CREO software and the prototype designed for practical testing.

The solar-powered mower includes a 12V, 1400 RPM DC motor to drive the cutting blades, supported by a 12V, 7Ah battery. An integrated alternator allows battery charging during operation. The blade is engineered to deliver a cutting force exceeding 10 Newtons—adequate for mowing grass based on its height, density, and surface contact (Figure 11). Stainless steel was chosen for the blade due to its robustness and mass, ensuring effective energy transfer from the motor while minimizing frictional losses [21]. The successful working of the proposed mechanism was simulated through CREO software. The parts were generated, assembly was done and the simulation mechanism using the various options were mechanically tested.

## CONCLUSION

In the modern era, a growing emphasis is placed on developing machines that help reduce or eliminate greenhouse gas emissions—key drivers of climate change. Among such innovations, the solar-powered grass cutting machine emerges as a practical and eco-conscious solution for everyday users. It offers several notable benefits, including the elimination of fuel costs, zero emissions, the absence of hazardous fuel byproducts, and reduced mechanical wear due to fewer moving parts. By utilizing solar energy as its primary power source, this mower provides an environmentally friendly and cost-efficient alternative to traditional models. It is particularly well-suited for use in residential lawns and smaller properties where bulky, tractor-operated mowers are not feasible. With a cutting capacity tailored to its target application, this machine proves to be a promising substitute for conventional gasoline-based mowers. This paper outlines the design and development of a "Solar Grass Cutting Machine," highlighting how solar panels successfully power the cutting system while advancing the adoption of sustainable technologies.

**REFERENCES**

1. Shaikh Mohd Sameer M.S, Venkatesh S. Thevar, Suraj K. Patil, Nitish S. Mangalpawar, Pramod G. Rahate. Design of Solar Grass Cutter in International Research Journal of Engineering and Technology, 8 (7), 2021.
2. Tanmay Bhalodi, Nikhil Bhujbal, Karan Doshi, Rahul Goregaonkar, Sheetal Jagtap.Environmental. Friendly Solar Grass Cutter in International Journal of Research in Engineering, Science and Management, 3(7), 2020.
3. Digambar Rane, Akash Jamdhade, Krushna Thete, Ashitosh Kasab. IoT Based Grass Cutter Using Solar System, IJIRT, 10, 2023.
4. Vorugnti.Bharath Kumar, N.Sravani, SA.Sowmya, B.Venu, D.Harshed, Automatic Solar Grass Cutter, Advanced Science Letters E-ISSN:1936-7317.
5. Pushpendra Tyagi, Aman Agarwal, Aman Singh Kalhans, Alok Kumar, Amit Kumar, Automated Solar Grass Cutter, Global Journal For Research Analysis, 7(2), 2018.
6. P. S. Chaudhari, Sanchit J. Mhashakhetri, Achal R. Panchbhai, Aman V. Kadu, Sachin S. More, Jatin H. Rahangdale, Solar Grass Cutter in International Journal of Advanced Research in Science, Communication and Technology (IJARSCT), 2(2), 2022.
7. Subhash chaurasiya, Vindhyachal Gupta, Vipin Kumar, Ankit Sharma, Karunakar Singh, Manisha Singh Chauhan, Solar Powered Grass Cutter, Journal of Emerging Technologies and Innovative Research (JETIR), 9(4), 2022.
8. Firas B. Ismail, Nizar F.O. Al-Muhsen, Fazreen A. Fuzi, A. Zukipli. Design and Development of Smart Solar Grass Cutter in International Journal of Engineering and Advanced Technology (IJEAT), 9(2), 2019.
9. Prasanna Titarmare, Shital Yende, Priyanka Gaurkhede, Ankit Salunke. Research Paper On Solar Automated Grass Cutter, IJARIIE, 7(3), 2021.
10. Shubham R. Khillare, Deepak P. Morey, Bhagyashri A. Ghoti, Shaileja S. Fully Automated Grass Cutter Using Solar Power in International Journal of Progressive Research in Science and Engineering, 1(4), 2020.
11. Sayan Das, M.V. Pranav Chandran, Design And Fabrication Of Solar Powered Grass Cutter, 2021.
12. [12] Muhammad Waqas Jabbar, Muhammad Noman, Asad Muneer, Ali Abbas and Adnan Mazhar. Solar Powered Grass Cutter for Domestic Utilization in Eng. Proc., 12, 105, 2022.
13. K. Naresh, M. Yashwanth Kumar, R. Prashanth, M. Venkata Ramana Reddy. Design and Fabrication of Solar Grass Cutter in IJARSCT, 3(1), 2023.
14. Mothibeli Joseph Pita, Peter Baonhe Sob, Design Of Solar -Powered Grass Trimmer, 2021.
15. Kevin Vaishnav, Harshit Vyas, Dhruvil Patel, Kashyap Nayee, Solar Grass Cutter, 2018.
16. M. Babu, P. Sekhar Babu, S.R. Sachin, S. Saravanan, Theoretical design, material study and material selection for compact linear frensel reflector concentrating system, Mater. Tod. Proc. 45 (2020) 1671–1678.
17. M. Babu, M.K. Anton, P. Sekhar Babu, S.R. Sachin, C. Thiruvasagam, Angular error correction and performance analysis of linear frensel reflector solar concentrating system with varying width mirror reflector, Mat. Tod. Proc. 45 (2020) 2348–2353.
18. M. Babu, S.R. Sachin, A.A. Valan, Experimental analysis on linear frensel reflector solar concentrating hot water system with varying width reflector, Case Stud. Ther. Eng. 14 (2019) 100444.
19. [19] S.P. Chowdavaram, M. Babu, S.R. Sachin, Thermal analysis on exhaust valve with thermal barrier, International research journal of automotive technology. 1 (6) (2018) 18–32.

 

20. S.R. Sachin, M. Babu, C. Kumaresan, S. Sivaprakash, S. Sivasuriyan, S. Sridharnath, Investigations on ceramic wool packed catalytic converter modified exhaust system, Mukt shabd. 9 (4) (2020) 4500–4505.
21. V. Sandeep, M. Babu, S.R. Sachin, Thermal analysis on Al-Si piston using different heat barrier coatings, International research journal of automotive technology. 1 (6) (2018) 33–48.
22. P Mohan Babu, M Saravanan, S Krishnakumar, SR Sachin, Explicit Dynamic Analysis of Multilayer Sheet Metal Forming–A Simulatory Analysis, Strength of Materials, 56, 2, 386-399, 2024
23. Loganathan J and Maniraj S Sachin S Raj, Babu M, Madhankumar K, Kishore S Design and Fabrication of Slow Stirrer Device for Stir Casting of Polymer Composites, Mukt Shabd Journal, 9,, 4, 4484-4487, 2020
24. Dhileepkumar G Sachin S Raj, Rathish R, Arul Murugan P, Boopathi R, Deepan G, The power plant using pair of magnet, International Journal of Innovative Research in Technology, 3, 111, 55-57, 2017
25. Silpa Krishnaveni P S Sachin S Raj, Prabhu P, Parthipan M, Rakeshvarma S, Design and Fabrication of magnetic tricycle for disabled people, International Journal of Advanced Research Methodology in Engineering & Technology, 1, 2, 81-84, 2017
26. Pradeep R Sachin S Raj, Mohanasundaram G, Mohanraj C, Poovarasan M, Design and Fabrication of Wireless Vaccum cleaner, International Journal of Research, 5, 12, 1440-1443, 2018
27. Sachin Sumathy Raj Manakattupady Amarnath Madhusudhananj; Darshan Sunil Somase; Shubham Vijay Lad; Siddart Bimashankar Lokhande; Jaydeep B Ashtekar, Cloud monitoring of temperature and humidity in 3DFDM printer using ESP32 node MCU interfaced with Thingspeak using arduino IDE, AIP Conference proceedings, 3175 (1), 2025


 