Solar Powered Smart Lawn Mower

[1]Shubhangi Manwatkar [2]Yash Desale, [3]Pradnya Waghmare, [4]Vedakshi Gurav, [5] Manish Bhadane,
[1]Professor, [2,3,4,5]Student,
[1,2,3,4,5]Department of Mechanical Engineering, Indira College of Engineering and Management Pune, Maharashtra, India.

Abstract: The Solar Powered Smart Lawn Mower is an eco-friendly and automated grass cutting system designed to reduce human effort and dependency on conventional fuel-based machines. The system uses solar energy stored in a battery to power DC motors, enabling blade rotation and movement. The integration of a microcontroller allows smart control, obstacle detection, and efficient operation. This project demonstrates the application of renewable energy and automation in agricultural and domestic lawn maintenance.

Keywords: Solar Energy, Smart Lawn Mower, Renewable Energy, Grass Cutting Machine, Arduino Controller, Ultrasonic Sensor, DC Motor

I. INTRODUCTION

The solar powered smart lawn mower is an advanced and eco-friendly system that operates with minimal noise, vibration, and environmental impact. It is designed to perform grass cutting operations efficiently using renewable solar energy. The mower utilizes solar panels to convert sunlight into electrical energy, which is stored in a battery and used to power the DC motors, control system, and cutting mechanism. A microcontroller-based system (such as Arduino) is used to control and automate the operation of the mower.In this system, the cutting blade rotates at high speed using a motor, enabling effective grass cutting through shear action. The movement of the mower is controlled by drive motors, and sensors such as ultrasonic sensors help in obstacle detection and navigation, making the system smart and semi-autonomous or fully autonomous. The integration of electronic components ensures precise control, energy efficiency, and safety during operation.

II. SYSTEM OVERVIEW

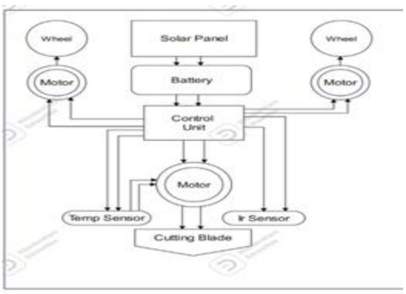

Fig -1: Schematic diagram

The diagram represents the working of a solar powered smart lawn mower system, where all components are integrated to achieve automatic grass cutting using renewable energy. The solar panel captures sunlight and converts it into electrical energy, which is stored in the battery for continuous operation. This stored energy is supplied to the control unit, which acts as the brain of the system and manages all functions. The control unit sends signals to the wheel motors, enabling the movement of the mower in forward, backward, or turning directions. At the same time, a separate motor is used to rotate the cutting blade at high speed to trim the grass. The system is equipped with an IR sensor that detects obstacles in the path and sends signals to the control unit, allowing the mower to stop or change direction automatically to avoid collisions. Additionally, a temperature sensor monitors the system's temperature to prevent overheating and ensure safe operation. Overall, the system combines solar energy, embedded control, motorized movement, and sensor-based automation to provide an efficient, eco-friendly, and intelligent grass cutting solution.

III. ACTUAL MODEL

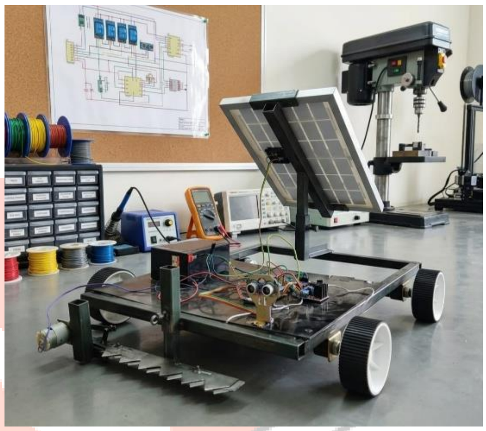

Fig – 2 : Model

The above image represents the actual working model of the solar-powered smart lawn mower developed during the project. The machine is fabricated using a mild steel frame, which provides structural strength and stability. The solar panel is mounted on the top to capture maximum sunlight, while the battery and control unit are securely placed within the frame for protection and balance. The cutting mechanism, driven by a DC motor, is positioned at the bottom to ensure effective grass cutting. The wheel motors enable smooth movement of the machine across the surface. All components are properly assembled and connected, demonstrating successful integration of mechanical and electrical systems. The model was tested under real conditions and showed satisfactory performance.

IV. RESULT AND COMPARISON

The developed solar-powered smart lawn mower was tested under normal working conditions to evaluate its performance and compare it with conventional lawn mowing machines. The results clearly show that the proposed system offers a practical and sustainable alternative, especially for small-scale applications such as residential lawns and gardens.

Unlike traditional lawn mowers that depend on petrol or diesel engines, this system operates using solar energy, which is converted into electrical energy and stored in a battery. During testing, the mower was able to run for approximately one to two hours depending on the charge level and sunlight conditions. Although this duration is slightly lower than fuel-based machines, it eliminates the need for continuous fuel consumption. This directly reduces operating cost and makes the system economically beneficial over long-term use.

One of the most noticeable differences observed during operation was the noise level. Traditional lawn mowers produce a significant amount of noise due to engine combustion, which can be disturbing, especially in residential areas. In contrast, the solar-powered mower operates very quietly since it uses a DC motor. This makes it more comfortable to use and suitable for environments where noise reduction is important.

From an environmental perspective, the advantage of the solar-powered system is very significant. Conventional lawn mowers emit harmful gases such as carbon dioxide and other pollutants, contributing to environmental degradation. The developed mower, on the other hand, produces no emissions during operation, making it completely eco-friendly. This aligns with the growing demand for sustainable and green technologies.

In terms of performance, the mower demonstrated satisfactory cutting efficiency for small and medium grass densities. The blade mechanism provided uniform cutting, and the movement of the machine was smooth due to the geared wheel motors. While traditional mowers offer higher power and can handle dense or wet grass more effectively, the developed system is sufficiently capable for its intended application.

Maintenance is another area where the solar mower shows clear benefits. Since it does not use an internal combustion engine, there is no need for fuel handling, oil changes, or complex servicing. The system consists of fewer moving parts, which reduces wear and tear and increases reliability. This makes it more user-friendly, especially for individuals who prefer low-maintenance equipment.

An additional advantage of the developed system is the inclusion of smart features. The integration of an ultrasonic sensor allows obstacle detection, and the Arduino controller enables semi-automatic operation. These features are generally not present in conventional lawn mowers, which are mostly manually operated. This adds a level of intelligence and convenience to the system.

Overall, the results indicate that while the solar-powered mower may not completely replace traditional machines for heavy-duty applications, it provides a highly efficient, eco-friendly, and cost-effective solution for everyday lawn maintenance.

Parameter	Solar Lawn Mower	Traditional Lawn Mower
Energy Source	Solar	Petrol/Diesel
Cost	Low	High
Pollution	None	High
Noise	Low	High
Maintenance	Low	High
Efficiency	Moderate	High
Automation	Available	Limited

Table no – 1: Comparison

V. LITERATURE REVIEW

Over the years, researchers and innovators have proposed various designs of solar powered lawn mowers with a common goal of minimizing environmental impact while improving cutting efficiency. One such foundational study by et al. involved the design and fabrication of a basic solar-operated lawn mower powered by a 12V, 40Ah battery and a 100W solar panel, with a blade mounted on a DC motor shaft. The mower featured a simple push design, controlled by an onboard switch, and operated for approximately 50 minutes on a full 5-hour charge. Although it demonstrated 85% efficiency under ideal conditions, it lacked autonomy or obstacle detection features, relying entirely on manual propulsion and control. In contrast, our project improves on this by integrating Arduino- based automation, ultrasonic obstacle sensors, and Bluetooth connectivity, enabling both manual and autonomous operation[1]. The work by D. Satwik et al. introduced a lever-operated solar lawn mower with height adjustable blades through a spur gear mechanism. The mower used an ultrasonic sensor and Arduino board to improve user safety and control, featuring a 10W solar panel and a battery setup requiring four days to charge fully under 6-hour sunlight exposure. While their design provided flexibility in blade height adjustment and some level of automation, the long charging time and limited cutting duration (45 minutes) were notable drawbacks. Compared to this, our design offers faster battery charging, better power efficiency due to a higher wattage panel (100W) and enhanced real-time obstacle avoidance using multiple ultrasonic sensors[2]. In Gemeda et al.'s work, a solar mower was built using locally sourced materials in Nigeria, featuring a 12V, 35Ah battery, 1 HP DC motor, and a sickle- shaped blade for improved cutting performance. Their system also allowed simultaneous battery charging and cutting operations. A notable design feature was the incorporation of multiple air inlets that created lift under the deck, improving maneuverability. While this inspired our blade shape considerations, our mower distinguishes itself by offering electronic automation and smart control features, as opposed to their mechanically focused solution [3]. In this paper, clock gating (CG) is applied to a 16-bit ALU as a preliminary step toward low-power PE design, with simulations conducted using QuestaSim, implementation and synthesis on a 45nm Spartan 6 FPGA using Precision, and power analysis via Xilinx XPower Analyzer, showing reduced clock and dynamic power at lower frequencies but revealing device limitations at higher frequencies [4]. Nagarajan et al. presented a manually pushed spiral blade lawn mower with no external power source. Their focus was to reduce power consumption by utilizing human energy and mechanical gearing. While this low-energy model was ecofriendly and economical, it lacked the technological and user- friendly automation features found in Indira college of Engineering and Management, BE Mechanical 5 our design. Their approach, although energy-efficient, fails to reduce human labor or adapt to modern automation trends [5]. The solar-powered golf cart by Thomas R. McCoy introduced a modular solar cell design using parallel arrangements for fast charging, along with diodes for electrical separation to prevent reverse current. This concept significantly influenced our battery charging circuit, especially the integration of charge controllers to manage current flow. However, McCoy's system was intended for large vehicles and did not address grass cutting, obstacle avoidance, or compact design—areas central to our project [6]. A lawn mower with electric motor-driven blades powered by a solar panel mounted above the motor. His system featured voltage regulation and an electric clutch for enhanced safety. While efficient in terms of power management, the absence of intelligent navigation or automation differentiates it from our Arduino-based autonomous system. Moreover, our design is more compact and includes wireless remote operation features [7]. The shift toward smart systems challenges the automation of conventional devices, prompting the development of smart energy meters to reduce manual intervention, manpower, and cost. In this work, an ARM-based LPC2148 controller processes sensor data to calculate energy consumption, generates bills based on tariff plans, communicates usage via GSM to users and a web server, and enables online payments, with automated supply disconnection upon non-payment[8]. A designed a dual- motor lawn mower using both AC and DC motors interconnected with a clutch and gear system. Although robust, their mechanically heavy setup focused more on high-torque and high-efficiency mowing and lacked features like solar input, autonomous operation, and sensor feedback, which are key innovations in our project [9]. A solar-electric lawn mower controlled electronically with feedback mechanisms to optimize energy use. It used sensors to monitor grass density and dynamically adjust power usage. This advanced feature provided insight into the potential of adaptive power regulation, which could be integrated in future versions of our mower to enhance energy conservation during light-duty operation [10]. A featured photovoltaic panel mounted on the handle and a direct battery connection. The system compared favorably with gasoline-powered mowers in terms of noise and efficiency but lacked automation. While his design was efficient and quiet, our project integrates sensor- based navigation and Bluetooth remote control, making it smarter and more adaptable [11]. Advancements in daily life have driven the evolution of smart technologies, including smart devices that operate through user or device-generated signals. This paper focuses on Smart Energy Meters—devices that provide electricity consumption and time-of Indira college of Engineering and Management, BE Mechanical 6 use data—by outlining the components, specifications, and increasing complexity involved in their development [12]. Shukitis et al. focused on deck lifting mechanisms using lever systems to reduce manual force during height adjustments. This inspired our use of adjustable cutting height mechanisms, though our project advances this by possibly automating blade height control in future iterations. A blade geometry and slicing mechanics, finding that a higher slice-to-push ratio yields better cutting performance. We applied these principles when selecting blade type and shape (flat vs. sickle vs. helix) to achieve optimal cutting with minimal power consumption [13]. The use of DC motors for precision torque delivery and highlighted the role of current field interaction in generating mechanical energy. These insights guided our selection of motor rating and power transmission strategy to achieve efficient torque for grass cutting [14]. Jean-Paul Lalonde's blade and shroud housing innovations were focused on mulching and safety, minimizing external ejection of debris. While our design doesn't yet include mulching, we noted the safety benefits of such systems and plan to incorporate enclosed decks and directional grass ejection in future versions [15]. This paper presents an analysis of lossy video compression techniques, which reduce file size by eliminating less perceptible data to optimize storage and transmission efficiency. The study evaluates various compression algorithms based on factors such as quality degradation, compression ratio, and computational complexity [16].

VI. CONCLUSIONS

A substantial review of the research and development in AJM is presented in this paper. There is great scope on material behavior to determine optimum values of crucial governing parameters like stand-off distance, pressure and feed rate for a variety of materials. Nozzle design can be optimized for faster production. A wide range of experimental investigation can be performed to understand the relationship between various process parameters.

There is much scope of research in AJM to study the effect of abrasive particle size, shape, hardness and abrasive flow rate. The Optimized models can be developed by using various optimization techniques.

VII. ACKNOWLEDGEMENT

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