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SOLAR POWERED GRASS CUTTING ROBOT WITH LIVE STREAMING

[1]B.Sarika,[2]A.Sreelekha,[3]D.Charan Teja,[4]K.Charan Sumanth,[5]A.Lokesh,[6]K.Priyanka, [7]Dr B.Siva Prasad

[1,2,3,4,5] B.Tech student Department of ECE, NSRIT, Vizag, AP, India

[6]Assistant Professor, Department of ECE, NSRIT, Vizag, AP, India

[7]Professor, Head of Department of ECE, NSRIT, Vizag, AP, India

ABSTRACT: The major objective of this project is to develop and construct an Android-operable autonomous robotic lawnmower. Here, a ESP32 Cam connects to Arduino uno to the phone. Grass-cutting machinery formerly required costly fuel to operate. In this instance, a solar panel is employed to replenish the battery, obviating the requirement for an additional power source. Solar energy is easier to adopt and more cost-effective than other energy sources. Utilizing solar panels allows us to capture the sun's energy for the production of free power. The solar panel charges the battery that provides power to the lawnmower. Everything the machine performs is controlled via an Android application. Arduino uno is the controller of the system. Through a variety of connections, Arduino uno can communicate with a Bluetooth module and DC motors. The solar grass cutter's DC motor is controlled by a Arduino uno that gets data from an Android app through a Bluetooth module. In addition, an water sprinkler also we can control with Bluetooth module. The system is engineered to be energy-efficient, eco-friendly, and cost-effective, eliminating the need for conventional fuel-based cutting machinery.

KEYWORD:

Solar Powered, ESP32 Cam, Grass Cutting Robot, Smart Lawn Mower, Renewable Energy, Arduino Based, Wireless Control, DC Motors, Motor Driver (L298N), Battery.

1.Literature Survey

The increasing demand for automation in agriculture and home maintenance has led to the development of smart robotic systems. Among these, grass cutting robots are gaining popularity due to their convenience, efficiency, and ability to reduce human labor. Integrating renewable energy sources like solar power and wireless control technologies like Bluetooth enhances the sustainability and usability of such robots. [1] Firas B. Ismail, Nizar F.O. Al-Muhsen, Fazreen A. Fuzi,A.Zukipli,"Design & Development of Smart Solar Grass Cutter". The conventional grass cutters have been widely used recently by workers in the gardening and agricultural industries. However, the manual handled grass cutters are consuming a lot of energy and producing air pollution which can directly affect the workers' health.

ISSN 2347–3657
Volume 13, Issue 2, 2025

The conventional grass cutters are also creating a high level of noise and vibration which can cause serious health issues such as grip strength, decreased hand sensation and dexterity, finger blanching or 'white fingers' and carpal tunnel[1].In order to address these issues, a new design of a grass cutter machine has been proposed. This device can be fueled by solar energy and smartly controlled, which has been named as a Smart Solar Grass Cutter that has three main systems which are smart control system, solar system, and the grass cutter. According to the national air space association (NASA), there is a 1.361kW/m² of solar irradiance received at the top of Earth's atmosphere[2].Approximately1.8/10 MW amount of power from the sun has been interrupted by the planet Earth, which is thousands of times larger than the present global consumption rate of the energy. This has motivated the governments, researchers and power industries to increase their investments in the renewable energy industry aiming to utilize more this clean energy and relief the global warming. Many researchers have proposed new designs of autonomous and non-autonomous solar grass cutters[3] [4].Moreover, a automated designs using sensors to detect obstacles and avoid any harm or injuries have been also proposed[4, 5].Patil S.M. et al. proposed a solar grass cutter called Smart Solar Grass Cutter with Lawn Coverage [5]. The proposed design aimed to develop an automatic grass cutting machine that could be remotely Controlled, and able to charge the used batteries while the solar powered grass cutter is operating during daytime. Dilip B.P. et al. used several sensors in their prototype design providing the proposed solar grass cutter the capability to avoid the unnecessary objects and/or obstacles in the field during operation [6]. This literature review indicates significant progress in developing solar-powered and Bluetooth-controlled robots for grass cutting. However, most projects are still in prototype stages or lack full automation. Future work should focus on enhancing autonomy, integrating IoT features, and improving energy efficiency. Nowadays, grass cutting machine becomes a very popular in urban India. This machine is most commonly used for furnishing the grass. DC motor, drivers circuits for controlling motors, battery, solar panel, blades, etc. are the some main parts of our project. It is placed in a suitable structure in our project. The motors are connected to the electric supply by using wires. The linear cutter blades are attached to the motor. 'Providing a high speed rotation to the blades, it helps to cut the grass' is main working principle of Grass cutter.

2.Introduction:

The basic project idea is to develop a grass-cutting robot controlled with help of the android application. Here the ESP32 CAM is used to connect Arduino Uno with the phone and in which the reading of the ultrasonic sensor is stored on IOT platform i.e think speak. Previously the grass cutter machines are operated by fuel which is costly. Here the solar panel is utilized to charge the battery so that it doesn't have to be charged externally. The sun-based energy source is more straightforward to utilize, more profitable contrasted with other energy and it is not difficult to work. By the use of solar panels, we can use sunlight to generate electricity free of cost.

ISSN 2347–3657
Volume 13, Issue 2, 2025

The solar panel is used to charge the battery for grass cutting purposes. The movement of the machine is totally controlled by using the Android app. The controlling device of the system is Arduino Uno. ESP32 Cam and DC motors are interfaced to the Arduino Uno. The data received from the android phone application by the Bluetooth module is given as an input to the Arduino Uno and the controller acts accordingly on the DC motor of the solar grass cutter. And also here at the input, we have connected an ultrasonic sensor for obstacle detection whenever the obstacle is detected the raspberry pi sends the command to stop the machine in its place and the reading of the ultrasonic sensor is stored on the cloud. Robotization is beneficial at many stages of human life. The attractiveness of any hotel, residence, park, meeting hall, etc. is enhanced by the finely shaped trimmed grass. As a result, maintaining the status of any house or hotel requires consistent lawn trimming. Manual grass cutting is feasible with humans, but it generally takes a lot of their time and energy. Furthermore, manual grass mowing is inefficient and frequently results in non-uniform grass structure. To prevent all of these problems, it is preferable to utilize an automatic grass-cutting robot that can be controlled via a smartphone. [4]. And also nowadays the rate of the fuel is increased and using grass cutter which uses fuel will be costly. So to reduce the cost of fuel solar panels are used. In this, we have described the latest features and technology used in grass cutters with help of IoT and Bluetooth. The Thing in IoT may be someone with a screen, for instance, protests that are given out an information science address and can aggregate and move information over a relationship without manual assistance. This grass cutter has a unique function in that it can be work from an Android phone and will automatically stop when an impediment is identified. And the reading of the sensor is stored in the cloud with help of a wifi module. We can even operate it using our mobile phone, which is a very ubiquitous device that everyone has in their pockets. To control the movement of the machine in this device, we utilize a ESP32 Cam terminal app. A mechanism known as a servo motor is being offered for the up and down motion of grasscutter. An ultrasonic sensor is utilized to identify the obstacle's location and signal the arm to react. Finally, we've come to talk about the energy consumption of this device. We utilized a solar panel and a battery with a 12V capacity.

3.Methodology

3.1 Hardware Components

3.1.1 Arduino Board

In our project, the Arduino Uno acts as the brain of the system. It is a microcontroller board based on the ATmega328P and is responsible for receiving signals, processing commands, and controlling various components like the motors and Bluetooth module and it stands as one of the most widely used platforms in the realm of electronics, embedded systems, and DIY projects. Developed as part of the open-source Arduino project, the Uno board provides a simple and accessible interface for beginners, students, hobbyists, and even professionals to create interactive electronic systems. One of the most notable features of the Arduino Uno is its ease of use. It comes equipped with 14 digital input/output pins (6 of which can be used for PWM output), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header, and a reset button. These features allow users to connect sensors, actuators,

ISSN 2347–3657
Volume 13, Issue 2, 2025

and other devices easily. The board can be powered either through the USB connection or an external power supply, making it suitable for both stationary and portable applications. The Arduino Uno is programmed using the Arduino IDE, a user-friendly development environment that supports C and C++ with simplifications. It allows users to write code (called "sketches"), compile it, and upload it to the board with minimal effort. the Arduino Uno has a broad range. It can be used for simple tasks like blinking LEDs or complex systems such as robots, home automation, weather stations, and Internet of Things (IoT) devices. Its flexibility and modularity are enhanced by the availability of shields and modules, such as motor drivers, Wifi modules, and Bluetooth modules, which extend its capabilities without requiring intricate wiring or deep hardware knowledge. The open-source nature of Arduino has led to a large and active global community. This means that users have access to countless tutorials, code examples, libraries, and forums where they can seek help or share their projects.

3.1.2. Regulated Power Supply

A regulated power supply is a type of power supply that maintains a constant output voltage or current regardless of variations in the input voltage or load conditions. It is one of the most fundamental and essential components in electronics, providing the necessary and stable power required for the operation of various electronic devices and systems. The basic components of a regulated power supply include a transformer, rectifier, filter, and voltage regulator. The transformer steps down the high-voltage AC from the mains to a lower level. The rectifier converts this AC into pulsating DC, which is then smoothed by the filter, typically using capacitors. Finally, the voltage regulator ensures that the output voltage remains steady, even if the input voltage or load changes. There are two main types of regulated power supplies: linear and switching. Linear regulators are simple and provide clean output, but they are less efficient and can dissipate a lot of heat. Switching regulators, on the other hand, are more efficient and suitable for high-power applications, though they are more complex and may introduce noise. They protect devices from voltage fluctuations that could cause malfunction or damage. Regulated power supplies are widely used in laboratories, communication equipment, embedded systems, and other sensitive electronics.

3.1. 3. ESP32 CAM

The rapid advancement of the Internet of Things (IoT) and embedded systems has led to the development of affordable yet powerful microcontroller platforms. One such innovation is the ESP32-CAM, a compact, cost-effective module that combines wireless communication and image processing capabilities in a single board. Manufactured by AI-Thinker, the ESP32-CAM is based on the popular ESP32-S microcontroller and is equipped with a 2MP OV2640 camera, making it an ideal solution for projects that require both connectivity and vision. The ESP32-CAM is built around the dual-core 32-bit Xtensa® LX6 microprocessor, which is part of the ESP32 series developed by Express if Systems. It supports both Wi-Fi and Bluetooth, enabling wireless data transmission and integration into IoT networks. The module includes an OV2640 camera, capable of capturing

ISSN 2347–3657
Volume 13, Issue 2, 2025

images at resolutions up to 1600x1200 pixels, and supports real-time video streaming at lower resolutions. It supports image capture, video streaming, and face detection. Despite its rich feature set, the ESP32-CAM is remarkably affordable, often priced under $10, making it accessible for hobbyists, students, and developers alike. the ESP32-CAM finds use in a variety of applications. One of the most popular use cases is DIY surveillance systems, where the module can stream video over Wi-Fi and store footage on an SD card. It is also employed in smart doorbells, access control systems, and facial recognition applications, leveraging its onboard camera and processing power.

3.1.4. Solar cell/Plate

A solar cell or photovoltaic cell is a device that converts solar energy into electricity by the photovoltaic effect. Sometimes the term solar cell is reserved for devices intended specifically to capture energy from sunlight, while the term photovoltaic cell is used when the source is unspecified. Assemblies of cells are used to make solar panel, solar modules, or photovoltaic arrays. Photovoltaic is the field of technology and research related to the application of solar cells for solar energy. Solar cells can also be applied to other electronics devices to make it self-power sustainable in the sun. Solar cell efficiencies vary from 6% for amorphous silicon-based solar cells to 40.7% with multiple-junction research lab cells and 42.8% with multiple dies assembled into a hybrid package. Solar cell energy conversion efficiencies for commercially available multicrystal Si solar cells are around 14-19%. Solar cells can also be applied to other electronics devices to make it self-power sustainable in the sun. There are solar cell phone chargers, solar bike light and solar camping lanterns that people can adopt for daily use. A solar battery is one of the most important energy sources available to save energy consumption, and serves as a spare source while normal power supply shuts down. Systems using solar batteries have various scales from a few watts to a few thousands of kilowatts, and also have various types.

3.1.5. D.C. Motor

A dc motor uses electrical energy to produce mechanical energy, very typically through the interaction of magnetic fields and current-carrying conductors. The reverse process, producing electrical energy from mechanical energy, is accomplished by an alternator, generator or dynamo. Many types of electric motors can be run as generators, and vice versa. The input of a DC motor is current/voltage and its output is torque (speed). The DC motor has two basic parts: the rotating part that is called the armature and the stationary part that includes coils of wire called the field coils. The stationary part is also called the stator.

3.1.6. Motor Driver

In robotics and automation projects, motors are essential for movement and operation. However, microcontrollers like Arduino cannot supply the required current and voltage directly to the motors. This is where a motor driver comes into play. A motor driver acts as an interface between the microcontroller and the motors, allowing control over their speed and direction without damaging the controller. A motor driver is an electronic circuit or module that controls the operation of a motor using low-power control signals from a microcontroller.

ISSN 2347–3657
Volume 13, Issue 2, 2025

3.2 Hardware Implementation

3.2.1. Working of the Project

The solar-powered grass cutting robot with live streaming is designed as an eco-friendly and semi-autonomous machine capable of trimming lawns efficiently while being powered by renewable energy. The robot's core functionality revolves around converting solar energy into electrical energy using photovoltaic panels mounted on its body. These solar panels continuously charge a rechargeable battery, typically a lithium-ion or lead-acid type, which then powers the motors responsible for both movement and the cutting blades. The use of solar power significantly reduces dependency on grid electricity or fossil fuels, making the system cost-effective and sustainable in the long run. The robot harnesses solar energy through a photovoltaic panel mounted on top of its chassis. This panel converts sunlight into electrical energy, which is stored in a rechargeable battery. The stored energy powers the motors, sensors, Wi-Fi module, and camera system. This solar-based energy source eliminates the need for external power supply or frequent battery. The robot uses DC motors for mobility and blade rotation. A motor driver circuit is employed to control the direction and speed of the wheels, allowing the robot to navigate across the lawn. Depending on the design, the robot may follow a predefined path or be manually controlled by wireless communication. Sensors such as IR or ultrasonic sensors may be integrated to detect obstacles and edges, enabling basic autonomous navigation and ensuring safety during operation. To enable live telecasting, the robot is equipped with an ESP32-CAM module—a microcontroller with built-in Wi-Fi and a camera This module captures live video of the robot's surroundings and operations, and streams it wirelessly to a smartphone or web browser over a local Wi-Fi network. This allows users to monitor the robot in real-time, even from a distance, enhancing safety and usability.

3.2.2. Web Dashboard

The solar-powered grass cutting robot's controller dashboard is designed for intuitive monitoring and controling, featuring a live video streaming interface that provides real-time visuals from the robot's onboard camera. This central feed allows operators to monitor cutting. progress, identify obstacles, and verify the robot's location, with options to toggle night vision, capture snapshots, or overlay operational data like battery status and GPS coordinates Surrounding the video panel, the dashboard displays critical status information including solar charging efficiency, battery levels, motor temperatures, and blade performance metrics. Users can switch between autonomous and manual control modes, with a virtual joystick for direct navigation and scheduling tools for programmed mowing sessions.

3.3 Software Implementation

3.3.1. Express PCB

Express PCB is a software tool to design PCBs specifically for manufacture by the company Express PCB (no other PCB maker accepts Express PCB files). It is very easy to use, but it does have several limitations. It can be likened to more of a toy then a professional CAD program. It has a poor part library (which we can work around) It cannot import or export files in different formats. It cannot be used to make prepare boards for DIY production Express

ISSN 2347–3657
Volume 13, Issue 2, 2025

PCB has been used to design many PCBs (some layered and with surface-mount parts. Print out PCB patterns and use the toner transfer method with an Etch Resistant Pen to make boards

3.3.2. Preparing Express PCB for First Use

Express PCB comes with a less then exciting list of parts. So before any project is started head over to Audio logical and grab the additional parts by morsel, ppl, and tangent, and extract them into your Express PCB directory. At this point start the program and get ready to setup the workspace to suit your style. Click View -> Options. In this menu, setup the units for “mm” or “in” depending on how you think, and click “see through the top copper layer” at the bottom. The standard color scheme of red and green is generally used but it is not as pleasing as red and blue.

3.3.3. The Interface

When a project is first started you will be greeted with a yellow outline. This yellow outline is the dimension of the PCB. Typically after positioning of parts and traces, move them to their final position and then crop the PCB to the correct size. However, in designing a board with a certain size constraint, crop the PCB to the correct size before starting. The select tool: It is fairly obvious what this does. It allows you to move and manipulate parts. When this tool is selected the top toolbar will show buttons to move traces to the top / bottom copper layer, and rotate buttons. The zoom to selection tool: does just that. The place pad: button allows you to place small soldier pads which are useful for board connections or if a part is not in the part library but the part dimensions are available. When this tool is selected the top toolbar will give you a large selection of round holes, square holes and sauce mount pads. The place component: tool allows you to select a component from the top toolbar and then by clicking in the workspace places that component in the orientation chosen using the buttons next to the component list. The components can always be rotated afterwards with the select tool if the orientation is wrong. The top toolbar allows you to select the top or bottom layer to place the trace on.

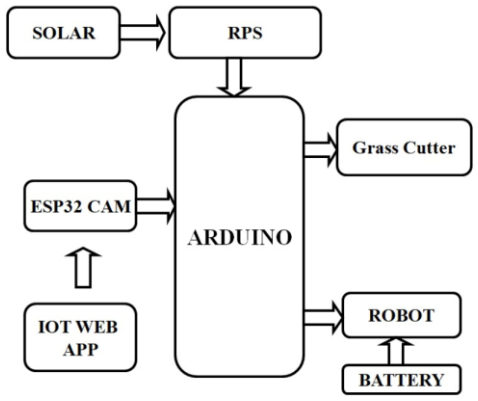
3.3.4. Design Considerations

When making a PCB you have the option of making a single sided board, or a double sided board. Single sided boards are cheaper to produce and easier to etch, but much harder to design for large projects. If a lot of parts are being used in a small space it may be difficult to make a single sided board without jumpering over traces with a cable. While there’s technically nothing wrong with this, it should be avoided if the signal travelling over the traces is sensitive (e.g. audio signals). A double-sided board is more expensive to produce professionally, more difficult to etch on a DIY board, but makes the layout of components a lot smaller and easier. It should be noted that if a trace is running on the top layer, check with the components to make sure you can get to its pins with a soldering iron. Large capacitors, relays, and similar parts which don’t have axial leads can NOT have traces on top unless boards are plated professionally. When using a double-sided board, you must consider which traces should be on what side of the board. Generally, put power traces on the top of the board, jumping only to the bottom if a part cannot be soldiered onto the top plane (like a relay), and vice versa.

International Journal of Information Technology & Computer Engineering
ISSN 2347–3657
Volume 13, Issue 2, 2025

Some projects like power supplies or amps can benefit from having a solid plane to use for ground. In power supplies this can reduce noise, and in amps it minimizes the distance between parts and their ground connections, and keeps the ground signal as simple as possible. However, care must be taken with stubborn chips such as the TPA6120 amplifier from TI. TheTPA6120 datasheet specifies not to run a ground plane under the pins or signal traces of this chip as the capacitance generated could affect performance negatively.

4.Block Diagram



5.Applications and Future Scope

The Solar Powered Grass Cutting Robot with live streaming has great potential for future enhancement and real-world applications. With growing demand for automation and sustainable technology, this project can be improved and adapted in multiple ways to increase its efficiency, functionality, and market relevance. Integration with IoT and Smart Home Systems: In the future, the robot can be upgraded to connect with IoT platforms, allowing users to control and monitor the robot remotely via mobile apps or web dashboards. Real-time tracking, status updates, and automated scheduling can be implement to enhance user convenience. AI-Based Decision Making: The robot can be equipped with machine learning algorithms to identify areas with taller grass, optimize cutting patterns, and improve performance over time. AI can help the robot adapt to different terrains and grass conditions. Wireless Charging and Docking Station: In the future, a self-charging dock can be introduced. The robot would automatically return to its docking station when the battery is low, recharge via solar panels or wireless charging pads, and resume operation afterward.

6. Conclusion

This research shows the implementation of smart phone operated grass cutter. This grass cutter can be operated using android smart phone within a 10meter range. The user can perform horizontal and vertical movement of grass cutter using android application in smart phone. This system uses 12V 7.5AH lead acid battery. This battery can be charge by solar energy. To charge this battery the 12V, 10Watt solar panel is connected with this system. This system is cheaper, rugged and durable. With the use of this system human efforts for grass cutting are highly minimized. Also, manual grass cutting can create non-uniform grass size. But with the use of this system the grass cutting is uniform, and one can use this system to cut the grass of any playground. Here we get pollution free and hazard free grass cutting machine.

ISSN 2347–3657
Volume 13, Issue 2, 2025

Some of the features of this machine is very unique and innovative. The height adjustment feature is really helpful for the user. The Bluetooth control provides remote access to the user. It is equipped it the advanced technology like the Bluetooth. Solar panel makes charging of the battery effortless. One of the most beneficial aspects of this machine is its ability to significantly reduce human effort and eliminate the inconsistencies typically associated with manual grass cutting. Manual operation often results in non-uniform grass heights, whereas this automated system ensures consistent and precise cuts, enhancing the aesthetic quality of lawns and playgrounds. Moreover, the inclusion of advanced features such as solar charging and mobile application control highlights the innovative and technologically advanced nature of the design. The system is pollution-free, as it operates without fossil fuels, and hazard-free, since it reduces direct human involvement in the cutting area.The system is designed to be rugged, cost-effective, and durable, ensuring long-term usability under various environmental conditions. Unique and user-centric features such as adjustable cutting height allow the user to customize the operation based on specific requirements. Additionally, the Bluetooth-based control system enhances the user experience by enabling wireless operation, increasing safety by keeping the user at a distance from the cutting blades. By combining automation, green energy, and user convenience, this grass cutter exemplifies the potential of modern engineering solutions to solve everyday problems

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