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Solar Based Automatic Grass Cutter

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ABSTRACT: The goal of this research study is to improve sustainable lawn management through the construction of an autonomous grass cutter that runs on solar power and uses Arduino technology. The system is equipped with an Arduino microcontroller and Bluetooth module with mobile app for automatic operations, a rechargeable battery for energy storage, and a photovoltaic (PV) panel for harnessing solar energy. The grass cutter requires less human intervention to run because it is outfitted with sensors for obstacle identification and navigation as well as electric motors to drive the cutting blades. When compared to traditional gas-powered mowers, the integration of solar energy greatly lowers the carbon impact and operating expenses. The device's efficacy in tending to small to medium-sized lawns is validated by experimental results, underscoring its potential as an environmentally friendly substitute for automated lawn care. The feasibility of integrating intelligent automation and renewable energy sources to advance environmental sustainability and energy efficiency in daily applications is highlighted by this breakthrough.

KEYWORDS: Arduino UNO, Solar PV panel, Electric Motors, Sensors, etc.

I. INTRODUCTION

In light of the pressing environmental issues facing the world, finding sustainable and effective solutions to daily problems has become more and more important. The need for more environmentally friendly options is highlighted by the fact that traditional gas-powered lawn mowers, despite their effectiveness, contribute greatly to air pollution, noise pollution, and operating costs. In order to provide a greener and more effective method of lawn care, this research explores the construction of an Arduino-powered solar-powered autonomous grass cutter. The environmental effect of traditional lawn mowers can be greatly reduced by using solar energy, which is a plentiful, clean, and sustainable resource. The proposed grass cutter may function independently by utilizing photovoltaic (PV) panels to harvest energy, so decreasing its need on fossil fuels and mitigating greenhouse gas emissions. The Arduino microcontroller is the brains behind this innovation; it integrates different parts to ensure smooth operation and acts as the system's brain. Rechargeable batteries are used to store the electrical power generated by the photovoltaic panels as they absorb solar radiation. Electric motors and blades, which perform the cutting motion, are powered by this stored energy. Using effective algorithms to limit energy consumption and guarantee dependable performance in a range of environmental circumstances, the Arduino microcontroller orchestrates these activities. In order to ensure safe and efficient operation, the grass cutter must be able to handle obstacles and uneven terrain. This is made possible by sensors, such as infrared and ultrasonic detectors. This study has four key goals: to minimize the negative environmental effects of lawn care; to improve user convenience by automating tasks; to maximize solar energy use; and to guarantee the device's dependability and safety. The solar-powered lawnmower encourages people to embrace renewable energy sources in their daily lives by automating the process of mowing grass, saving time and effort. With the ability to spur wider uses of solar energy in automated systems, this project constitutes a noteworthy technological breakthrough in sustainable lawn care. In order to show the system's viability and efficacy as a green substitute for conventional lawn mowers, the ensuing sections of this article will offer a thorough review of its design, installation, and performance evaluation.

II. METHODOLOGY

To charge the battery, we utilize a solar panel. This system, which regulates the operation of every motor, is built using Arduino UNO microcontrollers. Additionally, we employ a Bluetooth module and a smartphone app to operate the grass cutter. The system is supplied with power from the battery. The Arduino UNO is utilized to control a motor by being connected between a battery and the motor. Here, we're also utilizing an ultrasonic sensor to find objects. If there are no obstacles in front of the car, the Arduino Uno microcontroller advances the motors. For the vehicle's safety, an ultrasonic sensor detects obstacles and a microcontroller halts the grass cutter motor. The Arduino Uno microcontroller

then rotates in a new direction to the cleared space before moving the grass cutter forward once more. Through the use of solar panels, the solar grass cutter transforms solar radiation from sunlight into electrical energy that powers spinning blades.

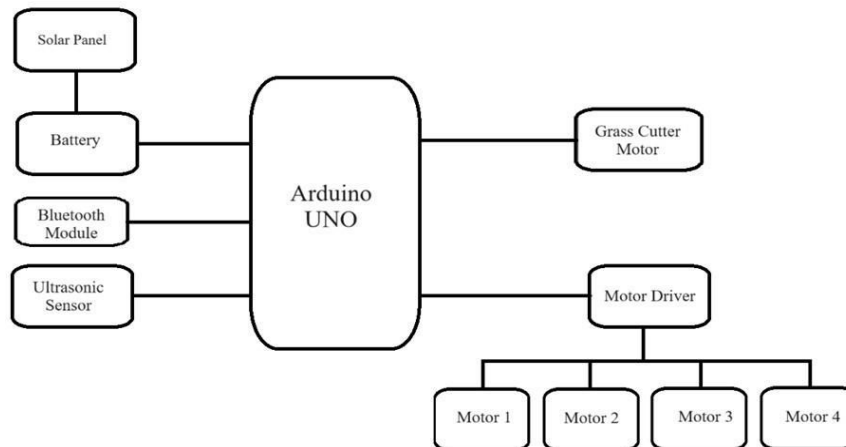


Figure 1: Block Diagram

III. MATERIAL AND METHOD

1. Arduino UNO

Our idea utilises the Arduino Uno microcontroller board, an open-source electronics project creation platform. There are countless possibilities with it, including the ability to interface several sensors and actuators, such as motors, without the need for a dumper kit to load the software onto the board. It comes with a physical board as well as a unique, simplified programming language. Regarding the specifications of the Arduino Uno micro controller board, the Atmega328p-pu is the core micro controller. The board operates at 5 volts, and the suggested and limit input voltages are 7 v-12 v and 6 v-20 v, respectively. It has six PWM digital input/output pins, six analog input pins, and fourteen digital input/output pins. The dc current acquired from the input/output pins is 20 ma, and from the 3.3v pin is 50 ma. A text editor for writing code, a text console, a tool bar with buttons for frequently used functions, and other menus are all included in the Arduino programming environment. In order for programmes to be uploaded and communicated with, the Arduino hardware and software are linked here. We can build circuits similar to other platforms, the Arduino software is comprised of libraries that offer additional functionality for use in sketches. These libraries can be created or downloaded independently. listed below. Through investigation of the transform's symmetry, the residual coefficients are computed.



Figure 2: Arduino UNO

2. Motor Driver

The L298N motor driver module is a flexible and depend- able component for regulating the direction and speed of one stepper motor or two DC motors. The L298N dual H-bridge motor driver integrated circuit serves as its basis which enables bidirectional control of two motors with a 5V to 35V operational voltage range and a 2A peak current per channel on each channel. For effective thermal management, the module has built-in heat sink and over-temperature protection. In addition, it offers simply interfaceable logic pins with microcontrollers such as Arduino and handy screw terminals for power and motor connections. Because it provides dependable and simple motor control, the L298N

module is a popular choice for robotics and do-it-yourself electronics projects. It is a vital tool for applications requiring accurate motor operation and control.

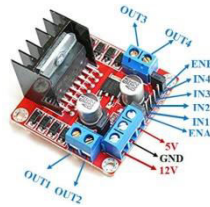


Figure 3: Motor Driver

3. Bluetooth Module

The HC-05 Bluetooth module is a widely available, cost-effective component that enables wireless device connectivity. Using a Bluetooth-enabled smartphone or tablet, the HC-05 module in the context of an Arduino solar-powered automatic lawn cutter enables remote control and monitoring of the apparatus. Interface with the Arduino is simple because this module runs on a 3.3V power source and communicates using the UART protocol. It allows for flexible network architectures by supporting both master and slave modes. Users no longer need to physically engage with the grass cutter to start or stop it, change its settings, or get real-time feedback on how it is operating thanks to the integration of the HC-05 Bluetooth module. The automatic lawn cutter's wifi capabilities improves its use and efficiency while also adding convenience and functionality.

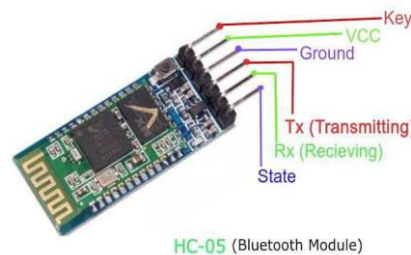


Figure 4: Bluetooth Module

4. Ultrasonic Sensor

With an accuracy of around 2 cm to 3 meters, the ultrasonic distance sensor offers non-contact, accurate distance readings. With just one I/O pin needed, connecting to Micro Controllers, propeller chips, or Arduino is quite simple. Three male pins on the sensor are utilized to supply power, signal, and ground. Either a standard 3-wire extension cable or a solderless bread-board can be used to plug the header in. By "listening" for the echo after emitting a brief ultrasonic burst, the sensor finds objects. The sensor emits a brief 40 KHz burst when it is controlled by a host micro controller. This explosion leaves the sensor, passes through the air, strikes an object, and then returns. The sensor's output pulse width, which ends when the echo is detected, is correlated with the target's distance from the host.



Figure 5: Ultrasonic Sensor

5. Solar Panel

A solar panel is a device made to collect solar radiation and use it as a source of energy to heat or create electricity;

Most solar installations consist of multiple modules since the maximum power that a single module can produce is restricted. An array of photovoltaic modules, an inverter, a storage battery pack, connection wire, and an optional solar tracking device are the conventional parts of a photovoltaic system. A solar panel, or photovoltaic (PV) panel, converts sunlight into electricity using the photovoltaic effect in semi-conductor materials, typically silicon. Comprising many solar cells, solar panels are used in various applications including residential, commercial, and industrial settings. There are three main types: monocrystalline, polycrystalline, and thin-film, each varying in efficiency and cost. Benefits include renewable energy generation, reduced electricity bills, and minimal operating costs, though they require significant initial investment and adequate sunlight. The usage of solar panels is essential for cutting greenhouse gas emissions and developing sustainable energy sources.



Figure 6: Solar Panel

6. Relay Module

A relay module is an essential part of electronic circuits and automation systems, enabling low-power signals to control high-power devices. It usually comprises a relay, a driver circuit (often with a transistor or optocoupler), a protection diode to guard against back EMF damage, terminal blocks for connections, and an LED indicator to show the relay status. Relays come in various forms, including electromechanical relays (EMR) with moving parts and solid-state relays (SSR) that use semiconductors for quicker switching and greater durability. Key specifications of relay modules include control voltage (such as 5V, 12V, or 24V), current rating, number of channels (single, dual, four, etc.), and contact configurations like SPST, SPDT, or DPDT. They are widely utilized in applications ranging from home automation (controlling lights and appliances) to industrial automation (operating motors and machinery), as well as in robotics and safety systems. Proper wiring involves connecting control signals to input pins and the devices to be controlled to output terminals, while ensuring the relay's ratings suit the application requirements and employing protective measures for safety.



Figure 7: Relay Module

7. Battery

A 12-volt, 3-ampere-hour (3Ah) lead-acid battery is a common type of rechargeable battery known for its reliability and wide range of applications. Sponge lead (Pb), lead dioxide (PbO) serves as the positive plate, sulfuric acid (H₂SO₄) serves as the electrolyte, and these batteries function on the basis of lead-acid chemistry. Each cell in a lead-acid battery produces approximately 2 volts, so a 12-volt battery typically consists of six cells connected in series. The capacity of the battery, rated at 3Ah, means it can deliver 3 amperes of current for one hour, or 1 ampere for three hours, under ideal conditions. However, the actual discharge time may vary depending on the load and the battery's condition, as high discharge rates can reduce the effective capacity. To ensure optimal performance and longevity, the battery should be charged correctly. A typical charging voltage for a 12-volt lead-acid battery is around 14.4 to 14.7 volts, with a float charging voltage of approximately 13.2 to 13.8 volts for maintaining a full charge. Charging current is usually recommended at a rate of 0.1C to 0.3C (where C is the battery's capacity), which translates to 0.3 to 0.9 amps for a 3Ah

battery.



Figure 8: Battery

8. DC motor (cutter)

A specific kind of electric motor intended to run on direct current (DC) power at a voltage of 12 volts is called a 12-volt DC motor. These motors are frequently utilised in numerous applications, from tiny electrical gadgets to automobile systems. Usually, they are made up of a rotor, stator, brushes, and commutator. The rotor generates mechanical energy by rotating inside the stator. These motors are favored for their simplicity, reliability, and ease of use, making them suitable for both hobbyist projects and industrial applications.

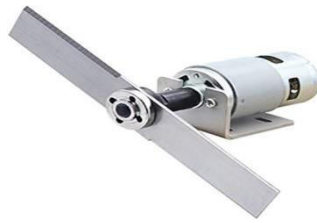


Figure 9: DC motor (cutter)

IV. CALCULATIONS

- Motor for drive wheels

$$V = 12 \text{ V}$$

$$I = 0.9 \text{ A}$$

$$P = 10.8 \text{ W}$$

We utilize four motors to drive the wheels, thus the necessary power is

$$P = 10.8 * 4 = 43.2 \text{ W.}$$

- Motor for cutter

$$V = 12 \text{ V}$$

$$I = 1.2 \text{ A}$$

$$P = 14.4 \text{ W}$$

Thus, the total amount of power needed to run each motor is

$$\text{Total power} = 43.2 + 14.4 = 57.6 \text{ W.}$$

- Battery

$$\begin{aligned} \text{Ah of battery} &= \text{Total power} / \text{Voltage of motor} * \text{Hr.} \\ &= 57.6 / 12 * 2. \end{aligned}$$

$$\text{Ah of battery} = 9.6$$

We needed a 9.6 AH battery to run all the motors for two hours. So, a 9-AH battery is used by us.

- Solar Panel

$$P = 10 \text{ w}$$

$$V = 17,4 \text{ V}$$

$$I = 0.57 \text{ A}$$

i. Charging Time = Wh of battery / solar panel watt

$$= 108 / 10$$

$$= 10.8 \text{ hr.}$$

ii. Discharging Time = Battery current / total Current drawn by motor

$$\begin{aligned} &= 9 / 4.8 \\ &= 1.87 \text{ hr.} \end{aligned}$$

V. ADVANTAGES

1. It minimizes the efforts of human being
2. It saves human time.
3. It saves electricity and money
4. Uses advanced technology.
5. Less maintenance
6. Cost effective
7. Eco friendly
8. Pollution free
9. Portable
10. No long wires connected

VI. RESULTS

Enhancing the efficiency and simplicity of lawn management, the solar-powered automatic grass cutter with Bluetooth control and an Arduino Uno embedded into it, all managed by a smartphone app, showed encouraging results. Users may operate the grass cutter remotely and modify its path through the mobile app interface. We can also evaluate its performance over the course of a single charging cycle. Reducing dependency on conventional energy sources and mitigating environmental impact are achieved by the integration of solar power, which guarantees sustainable operation. The system has certain noticeable benefits, as evidenced by performance analysis: improved precision in grass cutting, decreased labor, and increased user accessibility. With the help of the mobile app's real-time monitoring features, users may oversee the cutting process remotely and guarantee ideal outcomes. Furthermore, reliable functioning is ensured by the smooth communication made possible by the Arduino Uno between the Bluetooth module and the grass cutter. The solar-powered automatic grass cutter, which provides an effective, environmentally responsible, and user-friendly way to cut grass, is a major technological improvement in lawn care. Its applications could grow, and its performance in different environments could be improved with additional improvements and refinements.

VII. CONCLUSION

An appropriate solar grass cutter design is created by bringing back all of the literature reviews and by understanding our needs. In order to satisfy every restriction, the components used are determined by the design specification and take into account a limited number of additional factors. Using an Arduino UNO, an ultrasonic sensor, a Bluetooth module (remote mode), a mobile app, and a prototype model of the hardware and software system, the necessary output was produced during demonstration. In both the auto and remote modes, the developed prototype functions effectively. The grass cutter is engineered to trim the required height of grass. Positioning a solar panel ensures that it receives the most energy possible from the sun. Therefore, this gadget is the most effective eco-friendly lawn cutter available.

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