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Fabrication Of Semi-Automated Solar Grass Cutter

HARNESSING THE SOLAR ENERGY

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Abstract: Semi-Automated Solar Grass Cutter is an innovative and eco-friendly solution for lawn maintenance, designed to operate semi-autonomously using solar energy. This project combines advanced technologies to develop a sustainable lawn mower, addressing challenges associated with traditional mowing methods, such as reliance on fossil fuels, high maintenance requirements, and labor-intensive operations.
The system's main components include an Arduino Uno microcontroller, a motor driver, a BLDC motor for cutting, and a Bluetooth module for wireless control. Energy efficiency is achieved through solar panels that charge lithium-ion batteries, ensuring continuous operation without external power. Additionally, a Type-C charging setup, incorporating a charging module and step-down module, provides an emergency power source. Durable tires and a robust solar panel mounting system enhance its functionality as a compact, mobile unit.
Historically, conventional lawn mowers have faced issues like greenhouse gas emissions and noise pollution due to internal combustion engines. This solar-powered alternative addresses these concerns by utilizing renewable energy. Its semi-automated control system, enabled by the Bluetooth module, allows users to steer and control the vehicle remotely via a mobile phone. This enhances flexibility, operational ease, and safety by allowing real-time maneuvering across various terrains without physical interaction.

***Index Terms*- Solar energy, Solar panel, Lawn mower, Eco-friendly, Bluetooth module, Microcontroller**

I. INTRODUCTION

Pollution poses a significant threat to both living organisms and the environment, with traditional gas-powered lawn mowers contributing significantly to this issue through harmful emissions, noise pollution, and rising fuel expenses. As the world becomes more conscious of environmental challenges, there is an increasing need for sustainable and eco-friendly alternatives in various fields, including lawn care. Solar-powered automated grass cutters address these concerns by offering an innovative, pollution-free, and user-friendly solution that aligns with modern environmental standards and the growing adoption of renewable energy sources. [et.al. E. Naresh]

The history of lawn mowing dates back to 1830 when Edwin Beard Budding invented the first lawn mower, a mechanical device primarily designed for use on sports fields and in large gardens. Over the years, lawn mowers have evolved significantly in terms of technology and functionality. However, it was not until 1995 that the first fully solar-powered robotic lawn mower was introduced, marking a revolutionary leap in lawn maintenance technology. This groundbreaking device set the foundation for integrating robotics, artificial intelligence, and clean energy into lawn care solutions. [et.al. Pushpendra Tyagi]

Solar-powered semi-automated grass cutters offer an efficient and eco-friendly approach to lawn maintenance. These machines are powered by renewable energy through solar panels that charge lithium-ion batteries, reducing both energy costs and environmental impact. A built-in Type-C charging port ensures uninterrupted operation in low-sunlight conditions.

The system is equipped with a Bluetooth module, allowing users to control and steer the grass cutter remotely using a mobile phone. This remote-control functionality provides easy navigation and manoeuvrability across various terrains, eliminating the need for physical effort.

A high-speed brushless DC motor drives the cutting mechanism, delivering precision and durability. The adjustable blade height enables customized grass trimming, enhancing the device's versatility. With its simple operation, energy efficiency, and reduced maintenance needs, the grass cutter offers a practical and sustainable solution for modern lawn care.

This report delves into the development, and fabrication of the Semi-automated solar grass cutter, exploring the engineering and technological principles behind its operation. It covers a broad spectrum of topics, including energy management, component selection, and future improvements. By addressing these aspects, this report aims to highlight the potential of solar-powered grass cutters in revolutionizing lawn care, contributing to a greener, cleaner, and more sustainable future.

II. WORKING PRINCIPLE

The Semi-automated solar grass cutter integrates various components to perform efficient, eco-friendly, and Semi-autonomous lawn maintenance. Below is a detailed explanation of its working principle, divided into sections based on functionality.

2.1 Power Supply and Charging Mechanism

The grass cutter is powered by a 3S lithium-ion battery pack, which can be charged in two ways:

- ***Solar Charging:*** The device features a solar panel that harnesses sunlight and generates electrical energy. The voltage from the solar panel is stepped down using a **voltage step-down module** to match the battery's charging requirements. This regulated power is then routed through a **Type-C charging module** connected to the battery pack.
- ***Type-C Charging:*** In the absence of sunlight or for faster charging, the batteries can also be charged directly via the Type-C port.

This dual charging capability ensures uninterrupted operation by providing renewable energy and flexibility with conventional charging methods.

2.2 Control and Navigation System

The central control of the grass cutter is managed by an **Arduino Uno R3 microcontroller**, which acts as the brain of the system. The Arduino is programmed using custom code to execute various tasks, including navigation and cutter operation. Key components involved in this process are:

- **Motor Driver:** The Arduino is connected to an **L298N motor driver**, which controls the four DC motors that drive the wheels of the grass cutter. The motor driver allows the system to adjust the speed and direction of the wheels, enabling smooth movement and turns.
- **Bluetooth Module (HC-05):** The **HC-05 Bluetooth module** is integrated into the grass cutter to enable wireless communication with a **mobile phone**. This module allows users to control the movement and direction of the grass cutter remotely using a mobile app. The vehicle can be steered manually through on-screen controls or by using the phone's built-in **gyroscope** for motion-based (tilt) navigation. This setup provides flexibility, ease of control, and the ability to add extra features such as speed adjustment, motor control, and system monitoring, all through the mobile interface.

This intelligent control system, managed by the Arduino Uno and Bluetooth connectivity, ensures smooth and responsive operation across various terrains, allowing users to navigate the grass cutter safely and efficiently using a mobile device.

2.3 Cutting Mechanism

The cutting module is powered by a **BLDC motor (Brushless DC motor)** controlled by an **Electronic Speed Controller (ESC)**. The BLDC motor is mounted on the underside of the chassis and spins at high speeds to operate the cutting blade. Key features include:

- **Blade Adjustment:** The cutting height can be manually adjusted, allowing users to customize the grass height as per their preferences.
- **High-Speed Operation:** The BLDC motor provides sufficient torque and speed to ensure effective grass cutting, even in dense or uneven patches.

This system ensures a clean and uniform cut while maintaining energy efficiency.

2.4 Structural Components

The grass cutter's structural integrity and functionality are supported by various components, including:

- **Chassis:** A sturdy frame that houses all the components and provides stability to the system.
- **Wheels:** Four wheels powered by DC motors enable the grass cutter to move across the lawn.
- **Blade and Brackets:** The cutting blade is securely mounted on the BLDC motor with brackets for safe and stable operation.
- **Additional Components:** The assembly includes **cell holders, nuts and bolts, ribbon wires, jumper wires, and an on-off switch** for easy operation and maintenance.

2.5 Integration and Workflow

2.5.1 Energy Management: The solar panel or Type-C port charges the battery, ensuring the system is powered.

2.5.2 Initialization: The Arduino microcontroller initializes the motor driver, Bluetooth module (HC-05), and other components.

2.5.3 Navigation: The grass cutter is controlled remotely via a mobile phone connected through the Bluetooth module. The user can steer the vehicle using on-screen controls or by tilting the phone using its gyroscope sensor, allowing precise movement and direction control.

2.5.4 Grass Cutting: The BLDC motor operates the cutting blade, trimming grass as the vehicle moves forward. The height of the blade can be adjusted based on user preferences.

2.5.5 Continuous Operation: The system can operate continuously under user control, efficiently covering the lawn with flexibility in navigation and minimal physical effort.

III. COMPONENTS

Table 1: Components

SL.NO.	ITEMS	QUANTITY	REMARK	SPECIFICATIONS
1.	Solar Panel	1	Power supply for the battery	17V, 0.6A
2.	Battery	6	Power supply for the Vehicle	LI-Ion 18650 26E 3.7V 2600mah
3.	Motor driver	1	Direction controller	L298N Motor Driver
4.	DC gear motor (Wheels)	4	Rotating the wheels	300 RPM, 12V DC 3Kg-cm Torque
5.	BLDC Motor	1	Rotating the Blade	1200kv A2212 Brushless
6.	Microcontroller	1	Controller for the whole unit	Arduino UNO R3 microcontroller

7.	Bluetooth Module	1	Direction and speed control of the vehicle	HC-05 Bluetooth Module
8.	Servo Tester	1	Speed adjuster for BLDC	Multi servo tester ppm generator
9.	ESC (Electronics speed controller)	1	DC-AC Converter and speed controller for BLDC	Simonk 30A ESC
10.	Charging module	1	Charging the batteries	3S-2A l 18650 Li-Ion Charger Type C
11.	Step down module	1	Step down in the voltage	LM2596 3A DC to DC Step Down Adjustable voltage regulator
12.	Chassis	1	Foundation for the entire system	Galvanise iron welded chassis
13.	Cell Holder	2	Housing and connector for the batteries	18650 3S Li-Ion Battery holder
14.	Wheels	4	For mobility	100x40mm 6mm Shaft
15.	Jumper Wires and Ribbon Wires	3	Connecting components	20cm All Types, 10 Core Flat Ribbon
16.	Rocker switch, L bracket, Blade, Nut and bolt	4-6	Power ON/OFF, Motor Mounting, Cutting, Tightening.	Rocker switch, El bracket, S type Blade, Nut and Bolts

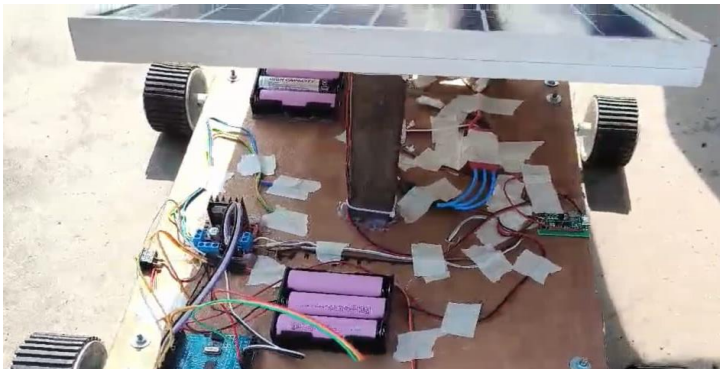

Figure 1: Semi-automated solar grass cutter Mechanism

Figure 2: BLDC Motor Grass Cutting

IV. METHODOLOGY

The development of the semi-automated solar grass cutter follows a structured process involving design, component integration, programming, and testing. The system is controlled via a Bluetooth module (HC-05), connected to a mobile app for remote navigation, speed control, and feature customization.

Step 1: Concept & Requirements

- Utilize solar energy for eco-friendly operation.
- Enable mobile-controlled navigation through Bluetooth.
- Ensure efficient grass cutting with minimal manual effort.

Step 2: Component Selection

- **Solar Panel & Lithium-ion Battery** – For energy storage and sustainable operation.
- **Arduino Uno R3** – Main controller for logic and system control.
- **HC-05 Bluetooth Module** – Allows wireless control via a mobile phone.
- **Motor Driver (L298N)** – Controls the DC wheel motors.
- **BLDC Motor** – Drives the grass-cutting blade.
- **Type-C Charging Module & Step-Down Module** – For alternate charging and voltage regulation.
- **Chassis, Wheels, Blade Assembly** – Mechanical structure and mobility.

Step 3: Circuit Design

A circuit diagram is created showing connections between Arduino, Bluetooth module, motor driver, power units, and motors.

Step 4: Programming

Arduino is programmed using the Arduino IDE to:

- Control wheel movement via Bluetooth commands.
- Operate the BLDC cutting motor.
- Switch between solar and Type-C power input.
- Use phone gyroscope (if available) for direction control.

Step 5: Assembly

- **Mechanical:** Chassis, wheels, and blade unit are installed.
- **Electrical:** Components are wired as per the circuit. Bluetooth and motors are connected to the microcontroller.

Step 6: Testing & Debugging

- Test Bluetooth connectivity and mobile control.
- Verify cutting performance and power management.
- Ensure smooth navigation across different terrains.

Step 7: Improvements

- Refine mobile app features for better control.
- Adjust motor speeds and steering response.
- Strengthen chassis for real-world use.

V. CIRCUIT DIAGRAM

A detailed circuit diagram illustrating the connections between all components (solar panel, batteries, microcontroller, motor driver, Bluetooth module, etc.) will accompany this methodology. The diagram will serve as a visual representation of the system's electrical setup and will be finalized alongside the fully developed model.

This methodology outlines the structured approach adopted for developing the semi-automated solar grass cutter, ensuring a balance of innovation, functionality, and sustainability.

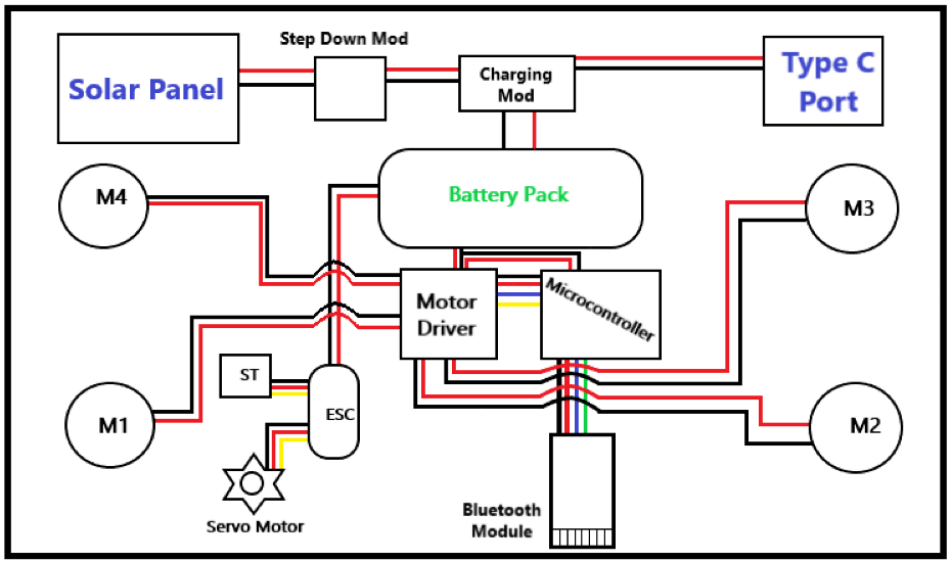

Figure 3: Circuit Diagram

VI. ESTIMATING & COSTING

Table 2: Estimating & Costing

SL.NO	ITEMS	QUANTITY	PRICE/PIECE(RS)	TOTAL COST(RS)
1.	Solar Panel	1	800	800
2.	Battery	6	129	774
3.	Motor Driver	1	200	200
4.	DC gear Motor (wheels)	4	300	1200
5.	BLDC Motor	1	520	520
6.	Microcontroller	1	500	500
7.	BT Module	1	200	200
8.	Servo Tester	1	90	90
9.	ESC	1	200	200
10.	Charging Module	1	55	55
11.	Step Down Module	1	60	60
12.	Wheels	4	115	460
13.	Chassis/Frame	1	500	500
14.	Cutting Blade	1	100	100
15.	Jumper Wires and Ribbon Wire	5	30	150
16.	Metal Bracker	4	50	200
17.	Nut and bolts	5-10	50	50
18.	Rocker Switch	5	10	50
19.	Cell Holder	2	15	30

Total Estimated Cost-

6239 Rs

After careful analysis and detailed assessment, we have estimated the total cost of our innovative semi-automated solar grass cutter to be **₹6300**. This comprehensive costing includes all essential components, such as high-efficiency solar panels, a reliable battery for energy storage, a sophisticated microcontroller for seamless operation, powerful motors, durable wheels, advanced BT Module for navigation, precision-engineered rotating blades, and a robust chassis to ensure longevity and stability. This investment ensures that our product is both affordable and of high quality, providing an eco-friendly, efficient, and autonomous solution for lawn maintenance.

VII. Conclusion

The semi-automated solar grass cutter successfully demonstrates a sustainable and efficient solution for lawn maintenance. With Bluetooth-based remote control and solar-powered operation, it minimizes manual effort while promoting eco-friendly technology. Minor improvements will further enhance its performance and reliability.

VIII. Future Scope

In the future, the system can be enhanced by integrating features like automated path mapping, obstacle detection using sensors, and solar tracking panels for improved charging efficiency. A dedicated mobile application with advanced controls and diagnostics can also increase usability.

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