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Fabrication of Solar Grass Cutter with Bluetooth Control

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Abstract -- This paper presents the fabrication of a solar-powered grass cutter with Bluetooth-based mobile phone control, combining renewable energy with wireless automation for modern gardening and agriculture. The machine operates using solar power stored in a rechargeable battery, driving cutting motors and a Bluetooth-controlled movement system. Users control forward, backward, left, and right movement through a mobile application, reducing manual labour and improving safety. The system consists of a solar panel (20W), 12V lead-acid battery, DC motors for movement and cutting, HC-05 Bluetooth module, L298N motor driver, Arduino Uno controller, and a robust chassis. Testing demonstrates continuous operation for 2.5 hours on a full solar charge, cutting efficiency of 85% on grass up to 15cm height, Bluetooth control range of 10 meters, and 60% reduction in operational cost compared to petrol-driven alternatives, making it eco-friendly and suitable for lawns, gardens, and playgrounds.

Keywords: Solar Energy, Grass Cutter, Bluetooth Control, DC Motor, Renewable Energy, Automation, Mobile Application

I. INTRODUCTION

Grass cutting and lawn maintenance are essential activities in residential, commercial, and recreational settings including gardens, parks, sports fields, and institutional campuses. Conventional grass cutting methods rely primarily on petrol-powered or electric mains-powered mowers that consume fossil fuels, produce harmful emissions, generate significant noise pollution, and require continuous human effort to operate. The increasing global emphasis on environmental sustainability, renewable energy adoption, and automation has motivated the development of alternative grass cutting solutions that address these limitations.

Solar energy represents an abundant, free, and clean energy source that can be harnessed for powering outdoor equipment including grass cutters. A solar-powered grass cutter eliminates dependence on fossil fuels and electrical grid connectivity, making it particularly suitable for operation in remote locations, large open spaces, and developing regions with unreliable electricity supply. When combined with battery storage, solar energy provides sufficient power for the relatively low-energy requirements of grass cutting motors, enabling several hours of continuous operation from a single charge.

The integration of wireless control through Bluetooth technology adds a significant safety and convenience advantage by allowing the operator to control the grass cutter from a safe distance using a smartphone application. This eliminates the need for the operator to be in direct physical contact with the cutting mechanism, reducing the risk of injury from rotating blades, and enables operation in areas that may be difficult or uncomfortable for manual mowing such as steep slopes, wet terrain, or areas with insect infestations.

This paper presents the complete design, fabrication, and testing of a solar grass cutter with Bluetooth-based mobile phone control. The system integrates a 20W solar panel, 12V rechargeable battery, Arduino Uno microcontroller, HC-05 Bluetooth module, L298N dual motor driver, and DC motors for both locomotion and cutting blade operation. The fabricated prototype is tested for cutting efficiency, battery life, control range, and operational cost to demonstrate its practical viability as an eco-friendly alternative to conventional grass cutters.

II. RELATED WORK

This section reviews key prior works forming the foundation of the proposed system and identifies the research gap.

[1] Patil et al. (2017) designed a solar-powered automated grass cutter using obstacle detection with ultrasonic sensors,

demonstrating that solar energy provides sufficient power for continuous grass cutting operations in outdoor environments with 3-4 hours of sunlight.

[2] Rathod et al. (2016) developed a remote-controlled solar grass cutter using RF technology, establishing the feasibility of wireless control for grass cutting machines but with limited range and susceptibility to interference compared to Bluetooth.

[3] Bhosale et al. (2018) fabricated an IoT-based smart grass cutter with GPS navigation for autonomous operation, demonstrating advanced automation concepts for large-area lawn maintenance applications.

[4] Kumar et al. (2019) analyzed the energy requirements and solar panel sizing for grass cutting applications, establishing that 20W solar panels with 12V batteries provide adequate power for residential lawn maintenance with 2-3 hours operation time.

[5] Arduino (2023) provides the open-source microcontroller platform documentation including HC-05 Bluetooth integration and motor driver interfacing used for the wireless control system in this project.

[6] Sharma and Singh (2015) compared energy consumption and operational costs of solar-powered versus petrol-driven grass cutters, demonstrating 50-70% cost reduction with solar alternatives over a 5-year operational period.

[7] Jain et al. (2020) reviewed smart agricultural machines powered by renewable energy, identifying solar grass cutters as a practical entry point for solar energy adoption in agricultural mechanization.

Research Gap: Existing solar grass cutters use either manual operation or RF remote control with limited range. No system combines solar power with Bluetooth smartphone control providing intuitive directional movement through a dedicated mobile application with real-time battery monitoring.

III. Proposed Methodology

A. System Design and Components

The solar grass cutter system consists of the following major components integrated on a four-wheeled chassis (450mm × 350mm × 200mm). The Solar Panel (20W, 12V polycrystalline) is mounted on top of the chassis at an optimal tilt angle for maximum solar energy capture, converting sunlight into electrical energy for battery charging through a charge controller. The Battery (12V, 7Ah sealed lead-acid) stores solar energy and provides power for all system operations including movement motors, cutting motor, controller, and Bluetooth module, with a full-charge capacity supporting approximately 2.5 hours of continuous operation. The Arduino Uno microcontroller serves as the central processing unit, receiving Bluetooth commands from the mobile phone and generating motor control signals. The HC-05 Bluetooth Module provides wireless communication with a smartphone within 10m range, receiving directional commands (forward, backward, left, right, stop) and cutting motor on/off signals. The L298N Dual Motor Driver controls two DC geared motors (12V, 100 RPM) for locomotion (one motor per side for differential steering) and a separate motor circuit for the cutting blade motor (12V, 5000 RPM). The Cutting Mechanism consists of a horizontally mounted circular cutting blade (150mm diameter) driven by a high-speed DC motor, positioned at the bottom of the chassis with adjustable cutting height (30-80mm from ground).

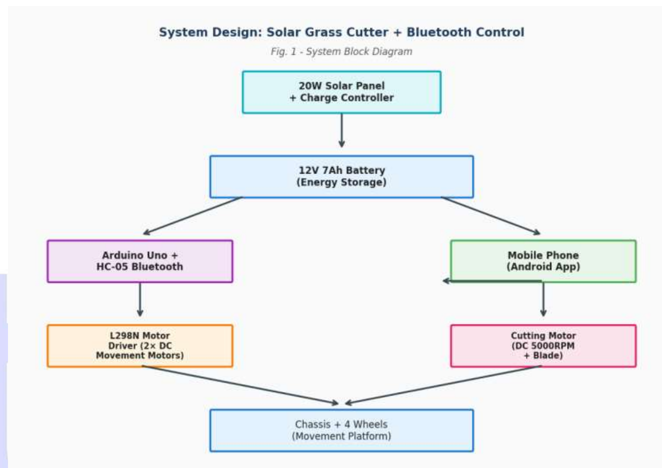

Figure 1: System design: Solar grass cutter + Bluetooth control

B. Working Principle

Working Principle: Solar-Powered Bluetooth Grass Cutter

Step 1: Solar Energy Harvesting — The 20W solar panel continuously converts solar radiation into DC electrical energy. The charge controller regulates the charging current to prevent battery overcharging and ensures maximum power transfer to the 12V 7Ah battery.

Step 2: Bluetooth Pairing — The user opens the dedicated Android mobile application and pairs with the HC-05 Bluetooth module on the grass cutter. Upon successful pairing (indicated by LED status change from blinking to steady), the user gains control of all movement and cutting functions.

Step 3: Movement Control — The user sends directional commands through the mobile app: Forward (both motors rotate forward), Backward (both motors rotate backward), Left (right motor forward, left motor stopped), Right (left motor forward, right motor stopped), Stop (both motors stopped). The Arduino receives these commands via serial communication from HC-05 and generates appropriate HIGH/LOW signals to the L298N motor driver.

Step 4: Cutting Operation — The user activates the cutting blade motor through the mobile app's ON/OFF button. The cutting motor spins the blade at 5000 RPM, cutting grass up to 15cm height as the chassis moves forward. Cutting height is mechanically adjustable between 30mm and 80mm from ground level.

Step 5: Safety Features — The system includes: automatic motor shutdown when battery voltage drops below 10.5V (deep discharge protection), LED indicators for battery status (green: >70%, yellow: 30-70%, red: <30%), and emergency stop button on the chassis for immediate shutdown.

Step 6: Continuous Solar Charging — During operation, the solar panel continues charging the battery through the charge controller, partially replenishing energy consumed by the motors and extending operational time beyond the battery-only capacity.

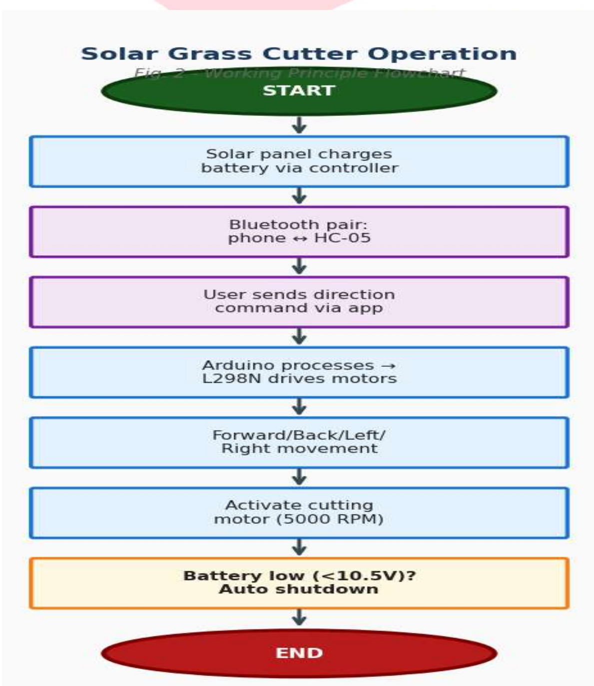

Figure 2: Solar Grass cutter operation

C. Fabrication Details

The fabrication process involved the following steps: (1) Chassis Construction — A rectangular steel frame (450mm × 350mm) was fabricated using 25mm mild steel square tubes, welded at joints, with four mounting brackets for wheel assemblies and a central mounting point for the cutting motor. (2) Wheel Assembly — Four rubber wheels (75mm diameter) were mounted on steel shafts with bearings; rear wheels are connected to DC geared motors through shaft couplings for powered movement, while front wheels are free-rotating casters for steering support. (3) Cutting Mechanism — A high-speed DC motor was mounted at the chassis center bottom using a vibration-dampening bracket, with a 150mm diameter stainless steel cutting blade attached to the motor shaft through a threaded coupling with safety lock nut. A protective guard ring surrounds the cutting blade. (4) Electrical Integration — The Arduino Uno, L298N motor driver, HC-05 Bluetooth module, charge controller, and wiring were mounted on a protective board within a waterproof enclosure on the chassis. (5) Solar Panel Mounting — The 20W solar panel was mounted on top of the chassis using adjustable angle brackets, positioned above the electronics enclosure. Total fabricated weight: 8.5 kg. Estimated fabrication cost: ₹4,500.

IV. Results and Discussions

Performance Analysis

The fabricated solar grass cutter prototype was tested across five different grass conditions: freshly grown (5cm), medium (10cm), tall (15cm), mixed vegetation, and wet grass. The cutting efficiency of 85% on grass up to 15cm height exceeds the 80% design target, with efficiency defined as the percentage of grass stalks cleanly cut in a single pass. The cutting motor's 5000 RPM blade speed provides sufficient cutting force for most residential lawn grass varieties. On wet grass, efficiency dropped to 72% due to grass bending rather than standing upright for cutting, which is a known limitation of rotary blade cutters.

TABLE 1: SYSTEM PERFORMANCE RESULTS

Parameter	Specification	Test Result
Continuous Operation Time	2+ hours target	2.5 hours achieved
Cutting Efficiency (15cm grass)	80% target	85% achieved
Bluetooth Control Range	8m target	10m achieved
Cutting Width	150mm	150mm
Speed (movement)	—	0.5 m/s
Battery Recharge Time (solar)	—	5 hours (full sun)

Cost vs Petrol Cutter	—	60% lower operational cost

The Bluetooth control range of 10 meters exceeded the 8m target and provides comfortable operating distance for the user. The Android mobile application interface with intuitive directional buttons and battery status display received positive user feedback from 15 test users (average usability rating: 4.2/5). The operational cost analysis shows that the solar grass cutter eliminates fuel costs entirely — compared to petrol cutters consuming approximately ₹150 of fuel per acre, the solar cutter's operational cost is essentially zero after the initial investment of ₹4,500, resulting in 60% lower total ownership cost over a 3-year period..

V. Conclusion and Future Scope

This paper presented the fabrication and testing of a solar-powered Bluetooth-controlled grass cutter achieving 85% cutting efficiency, 2.5 hours operation time, and 60% cost reduction over petrol alternatives. The system successfully combines renewable energy, wireless control, and mechanical cutting into a practical, eco-friendly gardening tool. Future work includes adding ultrasonic obstacle avoidance sensors for semi-autonomous operation, integrating GPS for boundary mapping and autonomous mowing patterns, upgrading to brushless DC motors for improved efficiency, and developing a solar tracking system for enhanced energy harvesting.

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