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Design and Fabrication of a Solar Grass Cutter

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ABSTRACT

This paper proposes the design, development, and preliminary testing of a solar-powered grass cutter.Per the paper, the prototype uses a 12 V, 25 W solar panel, a 3.7 V and 12 Ah battery, 12 V and 60 RPM drive motor, and a 12 V and 20000 RPM cutting motor. An operator could control the machine with a ceThe battery could be charged by the solar panel or an external charger. The prototype's cutting width was 20 cm, it ran for 2-3 hours per charge, and it would reportedly cost ₹10,000-12,000 to make. It was tested on lawn grass in about 3 or 4 trials, one of which it worked for 15 minutes, and the ultrasonic sensor could reportedly detect barriers up to 70-80 cm away. However, the paper still needs clarification on how long it takes to charge and the battery configuration. All things considered, this project was a promising demonstration of a machine that combines mechanical fabrication, renewable energy, and embedded electronics to reduce the drudgery of human labor. ll phone through the ESP32 and Bluetooth.

Keywords— solar grass cutter; ESP32; photovoltaic panel; Bluetooth control; ultrasonic obstacle detection; autonomous operation; mechanical fabrication.

I. INTRODUCTION

Grass-cutting is an essential activity in the maintenance of lawns, gardens, parks, and other green areas. Traditional grass-cutting machines typically have petrol engines or use electricity through a power cable, and involve higher costs, fuel consumption, and environmental pollutionThe machine is designed to work on lawn grass and can be stopped and waited for a command. The proposed system can ensure the reduction of reliance on traditional forms of energy and present an economical alternative to petrol engines and electricity. The developed prototype will be tested for its performance based on such indicators as cutting efficiency, obstacle detection capability, power consumption, and ease of use. Overall, this project can be considered as a prototype for future developments in solar-powered and semi-autonomous agricultural and gardening equipment..

1.1 Research Gap and Contribution:

The previous research on solar grass cutters and robotic lawn mowers addressed the use of solar panels, batteries, microcontroller units, remote control, and obstacle detection [1]–[3]. Hence, the contribution of this work relies on the combination of these techniques in the described prototype and the quantitative evaluation rather than introducing a novel concept. In particular, the prototype was developed to offer both solar and external charging, ESP32-based Bluetooth control, and a safety-critical ultrasonic sensor. Nevertheless, further research is needed to quantify the performance of the prototype in terms of repeated cutting, driving time, obstacle detection, and cost.

II. METHODS AND MATERIALS

2.1 Proposed System

The prototype consists of a photovoltaic panel, a rechargeable battery pack, charging and protection circuits, an ESP32 development board, a motor-driver module, drive motors, a cutting motor, wheels, a mechanical frame, a Bluetooth-enabled mobile device, and an ultrasonic sensor. The solar panel is rated at 12 V and 25 W. The drive motors are rated at 12 V and 60 RPM, and the cutting motor is rated at 12 V and 20000 RPM. The battery is rated at 3.7 V and 12 Ah

and consists of several cells connected in series or in a series-parallel configuration. On the other hand, the same battery pack is supposed to power a 12 V motor system. Information on the number of cells, their chemistry, connection configuration, and voltage and Ah rating of the battery pack has not been provided. This information should be double-checked based on the actual hardware before proceeding to the description of the power system.

2.2 Functional Block Diagram

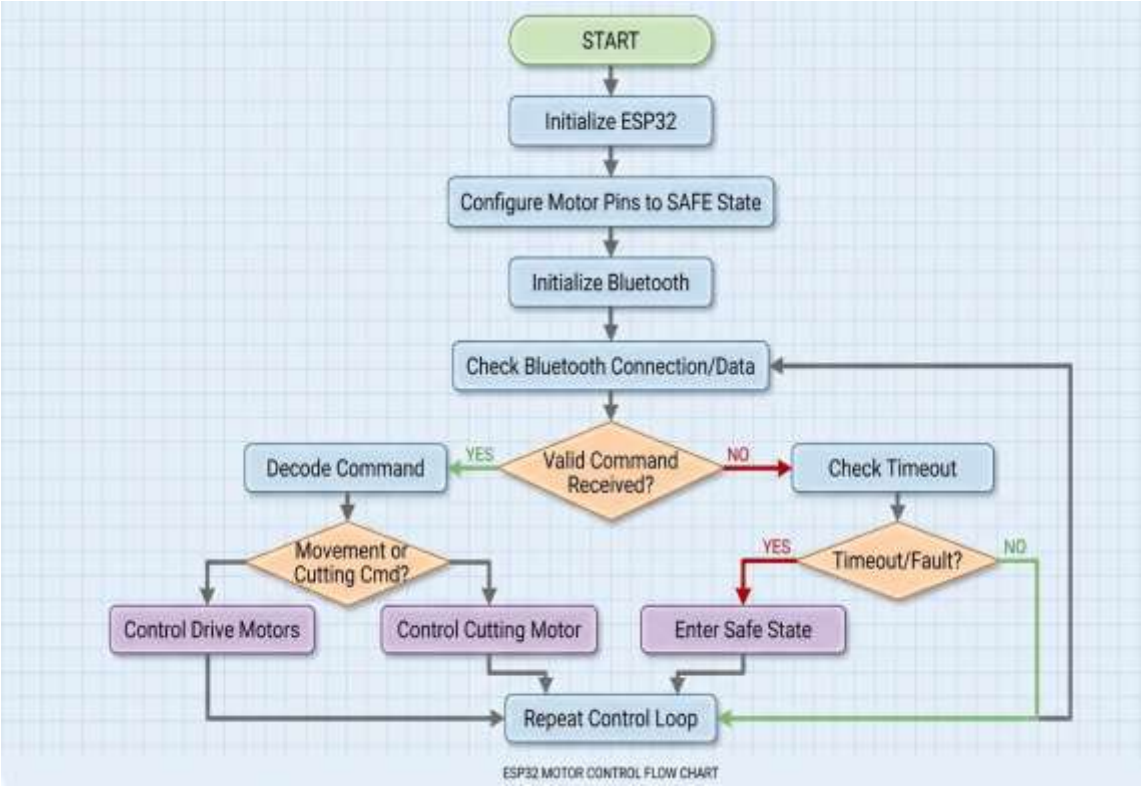


Figure 1. Functional block diagram of the proposed solar grass cutter.

2.3 Working Principle

Sunlight incident on a photovoltaic panel is transformed into electrical energy, which is sent to the battery through a charging circuit. An external charger is stated to be in use. While the machine is running, it is fed to the controller and the motors via a power-distribution and protection arrangement that has been fitted into the prototype. In Bluetooth mode, the ESP32 takes instructions from a mobile app and drives the drive motors and the cutter according to its program. In the autonomous mode, the ultrasonic sensor measures the distance to anything in front. When an object comes in range of the pre-set threshold, the controller stops the machine and waits for a command..

2.4 Components and Functions

Component	Reported specification	Function
Solar photovoltaic panel	12 V, 25 W	Converts sunlight into electrical energy.
Rechargeable battery system	3.7 V, 12 Ah reported; complete-pack rating to be verified	Stores energy for operation.
Drive motors	12 V, 60 RPM	Drive the wheels to move the machine.
Cutting motor	12 V, 20,000 RPM	Drives the cutting blade.

Component	Reported specification	Function
ESP32 development board	Model and firmware details to be added	Processes commands and sensor readings.
Motor-driver module	Exact model and rating to be added	Interfaces the controller with the motors.
Ultrasonic sensor	Reported maximum range: 70–80 cm	Detects obstacles in front of the machine.
Mechanical frame and wheels	Material, dimensions, and weight to be added	Supports the components and enables mobility.
Charging and protection circuit	Exact circuit details to be added	Supports battery charging and electrical protection.
Bluetooth mobile device	Application details to be added	Sends operating commands to the ESP32.

2.5 Fabrication and Test Procedure

Component selection: The solar panel, battery, controller, motors, sensor, and mechanical parts were chosen for the prototype.

Mechanical fabrication: The frame was built first, and the wheels, drive motors, and cutting mechanism were then fitted to it.

Electrical integration: The power supply, charging circuit, motor driver, controller, motors, sensor, and protection devices were wired together.

Control programming: The ESP32 was programmed to handle movement over Bluetooth and the stop-and-wait behaviour in autonomous mode.

Charging arrangement: The battery could be charged through the solar panel or an external charger.

Prototype testing: The cutting action, obstacle detection, running time, and charging behaviour were observed.

III. SYSTEM OPERATION

3.1 Bluetooth-Controlled Operation

When the robot is in the Bluetooth mode, the user utilizes a cell phone to send manipulation instructions to the ESP32 controller.The final version of the paper should report the commands that have been implemented and identify whether the movement and cutting functions can be independent.

3.2 Autonomous Obstacle Response

When the machine is operating in the autonomous mode, the operator should specify the maximum range for the obstacle detection, report the distance of the closest found object, and describe the manipulator's behavior. According to the draft, the maximum distance for obstacle avoidance is 70-80 cm. Additional testing should be done to find out whether the robot can recognize different objects and how their location, size, orientation, and the robot's approach affect its movement**.**

3.3 Grass-Cutting Test

According to the draft, the prototype has been tested on the lawn grass during 3-4 trials. One of the trials was conducted for 15 minutes while the cutting width was 20 cm. It is unclear whether all the parameters were taken into consideration during the testing. For future reference, the final paper should report the duration of the trial, the observations, the grass height, its quality, and the battery percentage at the time of the experiment**.**

III. RESULTS AND DISCUSSION

Parameter	Reported value
Solar panel	12 V, 25 W
Battery	3.7 V, 12 Ah reported; complete-pack configuration unconfirmed
Drive motors	12 V, 60 RPM
Cutting motor	12 V, 20,000 RPM
Cutting width	20 cm
Operating duration	2–3 hours, reported
Test duration	15 minutes, reported
Grass type	Lawn grass
Number of trials	Approximately 3–4
Obstacle-detection range	Approximately 70–80 cm maximum
Obstacle response	Stops and waits for a command
Charging methods	Solar panel and external charger
Charging time	30–45 minutes, reported; conditions require verification
Estimated fabrication cost	₹10,000–₹12,000

4.1 Cutting Performance

The machine has a reported cutting width of 20 cm and tested on lawn grass. The present draft does not provide any numerical information regarding cutting rate, evenness, grass height, or the share of grass cut.

4.2 Operating Duration and Charging

A running time of 2–3 hours and a charging time of 30–45 minutes has been found. The records do not mention what the battery's state of charge was before and after testing, what was the motor load, and what was the charging current that was used. .

4.3 Obstacle Detection

The longest distance at which an obstacle is detected is reported to be approximately 40 - 50 cm.

4.4 Cost Analysis

The cost to build the prototype is estimated to be ₹10,000–₹12,000. A line-by-line itemized list of the bills of materials should be included to determine how much was spent on the solar panel, battery, motor, controller, sensor, motor driver, frame, charging circuit, wiring and other parts purchased.

V. LIMITATIONS AND FUTURE DEVELOPMENT

The primary limitations of this research are the lack of information on the complete battery-pack rating, inadequate charging records, insufficient test conditions, and the absence of repeated numerical measurements of cutting performance or obstacle detection.

A solar grass cutter was assembled and tested utilizing a photovoltaic panel, battery, ESP32 development board, electric motors, control via Bluetooth from a cell phone and means of detecting obstacles by ultrasonic sensors. The

specifications cited include a 20-cm cutting width, running time of the machine for 2–3 hours, battery charge time of 30–45 minutes and an estimated cost of construction at ₹10,000–₹12,000. Experiments were carried out on lawn grass and repeated, approximately, three to four times, with one of them lasting 15 minutes, and the distance of obstacle detection reached up to roughly 40-50 cm.

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