Green Sweep SunTech: Solar-Powered Grass Cutter

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***Abstract*— The increasing need for renewable, sustainable, and energy-efficient solutions has led to the development of various innovative technologies in diverse fields. In lawn maintenance, traditional grass cutters contribute to environmental degradation and emit harmful emissions. Our evaluation of the solar-powered grass cutter showcases its remarkable energy efficiency, driven by its dual-axis solar panel that consistently generates around 0.5 watts of power per hour. Moreover, the integration of Wi-Fi connectivity enables users to effortlessly control and monitor the grass cutter within a range of 50-200 meters, offering both flexibility and convenience in lawn maintenance activities. Along with grass cutting, an additional feature for plowing is also provided, which aids in the initial cleaning of the land for grass cultivation. By integrating solar power and IoT technology, this project offers a sustainable and eco-friendly solution for maintaining lawns, promoting energy efficiency, and reducing environmental impact.**

Keywords— ***Dual-axis Solar panel, Grass cutter, Internet of Things (IoT), Wi-Fi controlled, energy efficient, Blynk Cloud.***

I. INTRODUCTION

In recent years, the imperative for renewable, sustainable, and energy-efficient solutions has become increasingly urgent across various industries. This drive toward eco-conscious innovation has spurred the development of novel technologies in diverse fields, including lawn maintenance. Conventional gas-powered grass cutters, while effective in their task, contribute significantly to environmental degradation through emissions of harmful pollutants. As society seeks greener alternatives, there emerges a pressing need for sustainable solutions in lawn care.

This paper addresses this need by introducing a groundbreaking approach to lawn maintenance that integrates solar power and Internet of Things (IoT) technology. The Solar-Powered Grass Cutter represents a paradigm shift in the field, offering efficient grass cutting and a host of environmentally friendly features. By harnessing solar energy and incorporating IoT connectivity, this innovative device promises to revolutionize the way lawns are maintained.

In this introduction, we provide an overview of the motivation driving the development of the Solar-Powered Grass Cutter, its key features, and the potential benefits it offers in terms of sustainability and environmental impact reduction. Additionally, we outline the structure of this paper, highlighting the key sections and insights it will explore in detail. Through this exploration, we aim to shed light on the transformative potential of solar-powered, IoT-enabled solutions in the realm of lawn maintenance.

A. Motivation

The Solar-Powered Grass Cutter project is driven by a commitment to environmental conservation, the advancement of sustainable and renewable energy solutions, and the promotion of technological innovation. With an acute awareness of the escalating environmental challenges posed by conventional lawn maintenance practices, including pollution and resource depletion, this project seeks to pioneer a paradigm shift towards greener alternatives. Harnessing solar energy, not only reduces reliance on finite fossil fuels but also minimizes carbon emissions and noise pollution, thus contributing to a healthier environment. Additionally, through the integration of innovative IoT technology, the project aims to revolutionize lawn care practices, enhancing efficiency and user experience while fostering a culture of sustainable living and technological advancement.

B. Problem Statement

Traditional gas-powered lawnmowers contribute to pollution and resource depletion, posing environmental challenges. In response to the growing demand for sustainable alternatives, there is a need for eco-friendly solutions in lawn maintenance. Additionally, existing equipment lacks efficiency and remote-control capabilities. To address these issues, this paper introduces a Solar-Powered Grass Cutter integrated with IoT technology. This solution aims to reduce environmental impact, promote energy efficiency, and enhance user convenience. Through its development and evaluation, we aim to offer a greener alternative to traditional lawnmowers while advancing sustainable practices in lawn care.

C. Objectives

- ❖ Develop a Solar-Powered Grass Cutter equipped with dual-axis solar panels to efficiently capture solar energy for sustainable operation.
- ❖ Integrate Internet of Things (IoT) technology into the grasscutter to enable remote controlling of grass cutter, enhancing user convenience and efficiency.
- ❖ Promote energy efficiency through the utilization of solar power for lawn maintenance.
- ❖ Reduce environmental impact by replacing traditional gas-powered lawnmowers with an eco-friendly alternative.
- ❖ Contribute to the advancement of sustainable practices in lawn care and encourage broader adoption of eco-friendly technologies.

II. RELATED WORK

M.Asep Rizkiawan et al approached the development of a two-axis sun tracker using Arduino Uno as the main controller. For its implementation, four light-sensitive resistors (LDRs) are used to detect sunlight and maximum light intensity. Two servo motors are used to move the solar panel according to the direction of sunlight detected by the LDRs. Furthermore, an ESP8266 WIFI device is used as an intermediary between the device and the IoT monitoring system [1].

P. Muthukumar et al proposed the development of a dual-axis solar tracking system using IoT to optimize energy output from solar panels. It includes gathering data on the sun's angle of incidence, designing and developing the solar tracker, using a microcontroller to control the panel's position, and monitoring the system's performance through IoT. The developed model aims to address the need for an efficient dual-axis solar tracker system to maximize the performance of a PV panel [2].

Aditi Singh et al presented the grass cutter equipped with UNO, ultrasonic sensor, DC motors, soil moisture sensor module, L293Ds, IR sensor, and Node MCU. Node MCU is used as a secondary microcontroller for fire detection data transmission. The ultrasonic sensor detects obstacles and triggers direction changes based on threshold distance. The developed model with features like obstacle detection and fire extinguishing mechanisms enhances safety. Autonomous operation ensures efficient grass-cutting without human intervention [3].

Y. B. N. V. Bhaskar et al developed the project based on the requirements including Arduino Uno, Node MCU, ultrasonic sensor, motor driver, solar panel, DC motor, battery, and IoT application. The developed project was able to send real-time data to the ThingSpeak cloud and the user was able to monitor and control the system remotely using the IoT application [4].

Huilin Shang et al designed a model that involved experimental measurements to verify the efficiency increase for solar energy with the designed system. A continuous test was conducted for 5 days at the Shanghai Institute of Technology, China. The solar panels were tested outdoors, and data was collected using a multimeter connected to a data logger and computer. The developed solar tracking system showed higher energy output compared to the fixed panel during the daytime. The solar radiation power of both panels increased from morning to noon and decreased in the afternoon. Experimental data confirmed the theoretical predictions of energy collection efficiency [5].

Dr. N. Sambasiva Rao et al proposed a model involving the integration of weed detection technology into a solar-powered grass cutter. This integration includes the use of high-resolution cameras on the grass cutter for real-time weed identification, supported by advanced computer vision algorithms and image processing techniques to accurately [6].

Ragam Prathyusha et al proposed a model where solar panels are arranged to receive high-intensity solar radiation and the conversion of solar energy into electrical energy is done by the panels. Electrical energy is stored in batteries using a solar charger. It incorporates remote control functionality for ease of operation. Utilizes advanced components like the L293D H Bridge IC for efficient motor control. The developed robot effectively removes unwanted plants and grass from crops, reducing manual labor and providing a practical solution for farmers to maintain their fields efficiently [7].

III. METHODOLOGY

1. Data Initial Planning and Research:

During this phase, the project objectives, scope, and requirements are clearly defined. Research is conducted to explore existing automated grass-cutting and weed-removal devices for insights and inspiration. Feasibility studies are undertaken to ensure the technical and economic viability of the project, helping to set realistic goals and expectations.

2. Design

In this phase, the overall structure and component layout of the device is designed, taking into account factors such as durability, functionality, and safety. Suitable materials are selected for construction, and the cutting mechanism is designed for efficiency and safety. Prototypes are developed to test the functionality and make necessary adjustments based on the findings.

3. Solar Energy System Integration:
High-efficiency solar panels capable of dual-axis tracking are selected for maximum energy capture. The solar panel mounting system is designed to allow for dual-axis movement, ensuring optimal sunlight exposure throughout the day. Safety features such as charge controllers and overcharge protection are integrated to regulate the charging of the battery and prevent damage.

4. Wi-Fi Module Integration:
A Wi-Fi module compatible with the device's microcontroller is selected and integrated into the electronic system. Firmware is developed to enable seamless communication between the device and a mobile phone app, allowing for remote control functionality.

5. Data Monitoring:
Data such as battery level, voltage, and voltage will be constantly monitored to evaluate the performance and effectiveness of the system.

6. Testing:
Comprehensive testing is conducted to evaluate the performance of each component and subsystem. Field tests are performed to assess the device's functionality in real-world conditions, collecting data on energy efficiency, and cutting effectiveness. Iterations are made based on test results to improve the design and functionality.

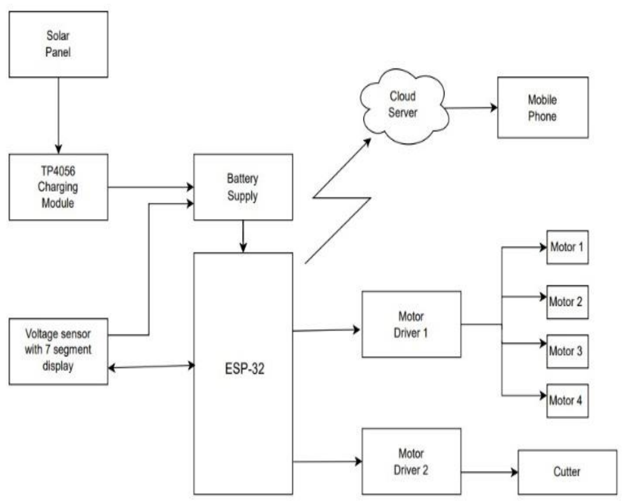

Fig 1: Block Diagram of Solar Powered Grasscutter

IV. IMPLEMENTATION DETAILS

1. Solar Charging Module:
The system includes a dual-axis solar panel capable of efficiently capturing solar energy from various angles. The captured solar energy is converted into electrical energy which is used for powering the grass cutter. A Solar panel of 5V, an Arduino UNO microcontroller, 4 LDR's, TP4056 charging module, 2 Servo motors with 180°, 4 resistors of 10Ω each and a rechargeable battery of 3.7 volts is used in the designing of the Solar Charging Module.

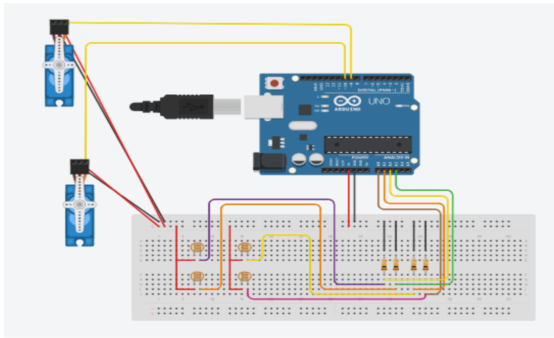

Fig 2: Circuit Diagram of Dual-axis solar panel

2. Wi-Fi Controlled Car
The Wi-Fi controlled car allows users to remotely control the movement of the Wi-Fi controlled car using the Blynk IoT Application. The movement of the car like Forward, Backward, Right and Left can be controlled in the app. The Wi-Fi Controlled is designed using ESP-32 Devkit V1, a L298N Motor Driver to control the wheels, 4 Gear motors of 30 rpm, 3 rechargeable batteries connected in series to generate 12V, Voltage Sensor to monitor the battery level remotely through Blynk app, 4 Wheels of 70mm Dia. x 40mm Width each.

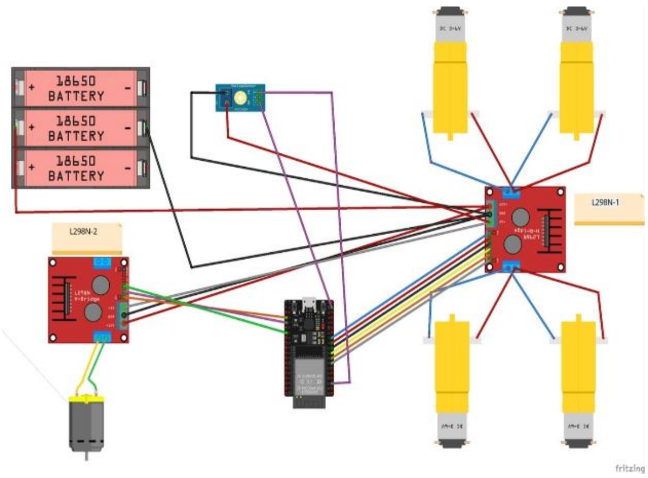

Fig 3: Circuit Diagram of Wi-Fi controlled car with grasscutter

3. Grass cutting Mechanism:
The Grasscutter has a robust cutting mechanism capable of efficiently trimming grass. The Grass cutter is designed using Brushless DC Motor of 3000rpm, 4 blades for grass cutting, an L298N motor driver connected esp32.

4. Ploughing:
The Plougher is used for initial clearing of the land before planting the grass. The mechanism of upward and downward movement of the plough is controlled using a servomotor.

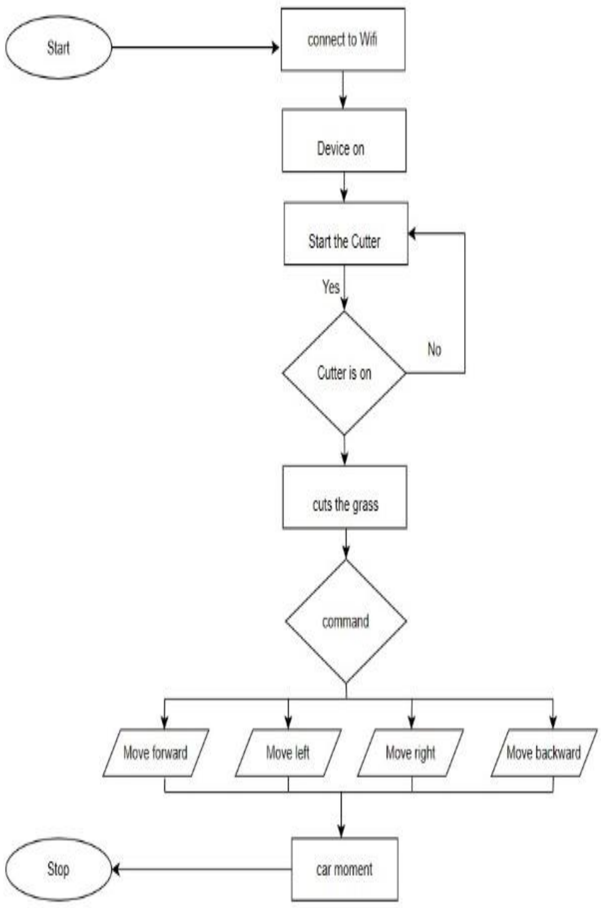

Fig 4: Flow Diagram of Wi-Fi controlled car with grasscutter

V. RESULTS AND DISCUSSIONS

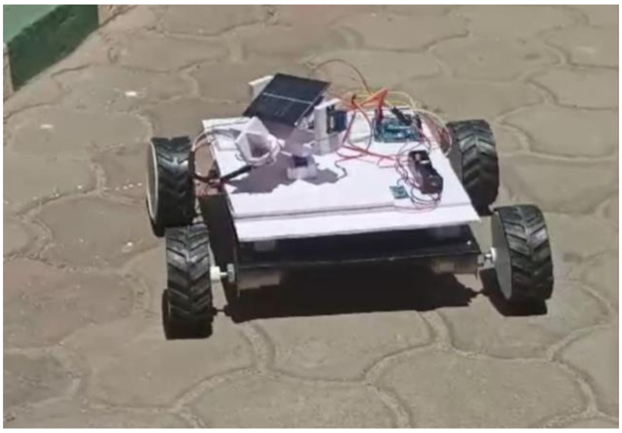

Fig 5: Dual axis solar panel tilting towards maximum intensity sunlight for charging

Figure 5 is the image of the Dual axis solar panel tilting towards maximum intensity sunlight for charging.

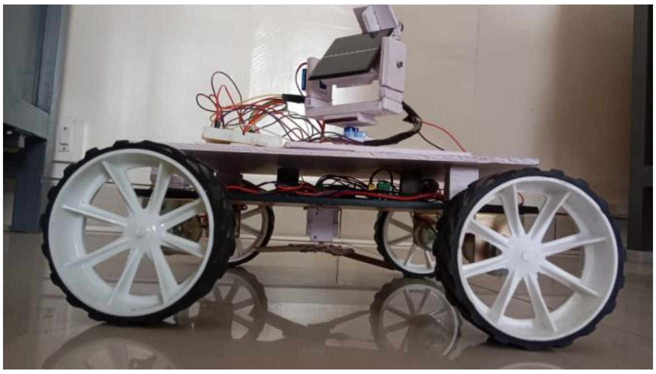

Fig 6: Side view of Grasscutter connected to the Wi-Fi controlled Car

Figure 6 is the side view of the solar-powered Grass Cutter where the cutter is attached to the bottom of the device using a DC motor.

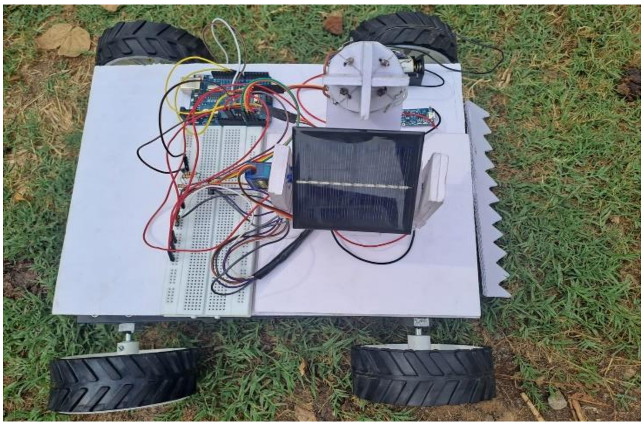

Fig 7: Working of Solar Powered Grasscutter

In Figure 7 the device drives through the field cutting the grass for lawn maintenance. The cutter blade is connected to the DC motor in the middle of the device under it. A dual-axis Solar Panel is mounted on top to capture the Solar Energy in all directions. The energy captured from solar is stored in the battery.

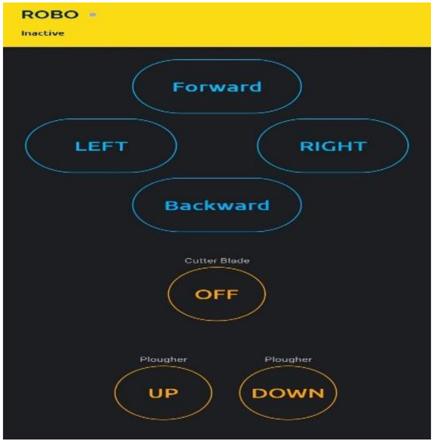

Fig 8: App for Solar-Powered Grass Cutter Control

Figure 8 is the app used to control the Solar-Powered grass cutter where forward, backward, left, and right are the buttons used to control the wheel movements. The cutter blade is controlled using the ON-OFF button and the plougher is controlled using UP and DOWN button. The device's movement is controlled by the user using the Blynk IoT App.

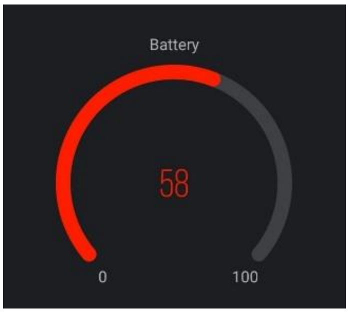

Fig 9: Battery percentage displayed in the App

Figure 9 shows the Battery percentage monitoring of the Solar Powered Grasscutter done in the Blynk app.

VI. CONCLUSION AND FUTURE WORK

In conclusion, the development of a solar-powered grass cutter device integrated with IoT technology presents a promising solution for efficient and sustainable lawn maintenance. Through this project, we have successfully demonstrated the effectiveness of harnessing solar energy to power a grass cutter, thereby reducing the use of fossil fuels and minimizing carbon emissions. Also, there is an additional feature of ploughing which helps in the initial lawn maintenance. The incorporation of IoT capabilities enables remote monitoring and control of the device, enhancing user convenience and optimizing operational efficiency via Wi-Fi communication. By leveraging renewable energy sources and IoT connectivity, our solar-powered grass cutter contributes to eco-friendly practices in lawn care.

Moving forward, further research and development are warranted to enhance the performance and scalability of the device, including improvements in recognizing weeds for weed removal. Additionally, efforts focus on making the technology more accessible and affordable to a wider range of users, thereby encouraging widespread adoption and contributing to the global transition towards sustainable living. In essence, the solar-powered grass cutter device utilizing IoT technology represents a significant step towards greener and smarter landscaping practices, offering both environmental and practical benefits for homeowners, businesses, and communities alike. By embracing innovation and sustainability, we can pave the way towards a brighter and more eco-conscious future.

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