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IoT based intelligent solar power lawn mower

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Abstract

Manual grass cutting requires manpower, consumes time, and often results in uneven grass height. To overcome these challenges, there is a pressing need for a system capable of autonomously cutting grass without human intervention. This research introduces a grass-cutting robot equipped with a solar-charged battery and can be operated using an android phone. The proposed system offers a cost-effective solution compared to existing alternatives, showcasing robustness, durability, and low maintenance requirements. The utilization of solar energy for battery charging makes the system environment friendly and free from pollution.

Subject Classification: *93-XX, 94-XX.*

Keywords: *Android, Bluetooth, Grass cutter, Solar energy.*

1. Introduction

Turn maintenance has been associated with the noise of the gasoline engine and its accompanying emissions. As environmental awareness and

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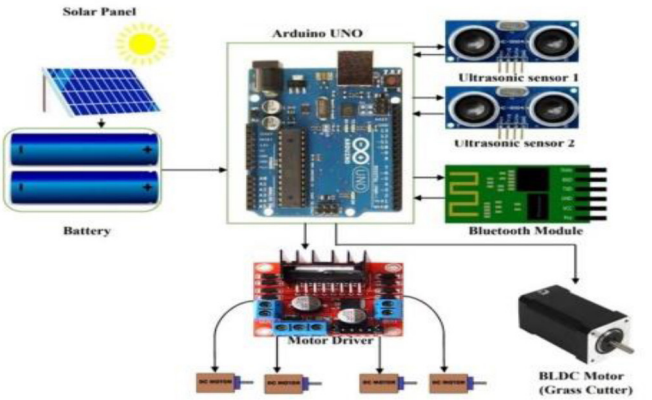


Figure 1

Simplified Bock Diagram of Model

sustainability become more important, so there is need to rethink and replace the tools we use in our daily work. Lawnmowers are often powered by non-renewable resources and cause significant amounts of pollution and carbon emissions. This research papers [1-4] discusses the development of a new solution to solve these environmental problems: An Internet of Things (IoT)-based solar-powered lawn mower with integrated Bluetooth module as shown in Figure 1.

Gas-powered electric heaters are common in communities around the world and have become synonymous with lawn care today. But its dependence on fossil fuels not only causes air pollution and noise, it also causes an international competition to reduce carbon emissions [5]. With sustainability at the forefront of today's agenda, the need for environment friendly alternatives to lawn care has never been greater. The main objective of this study is to conceptualize, design and evaluate a solar powered lawn mower that uses the potential of renewable energy to restore grass in the landscape. By integrating IoT technology, we aim to provide users with cutting-edge technology that not only reduces environmental impact but also has management and unprecedented maintenance capability [6]. Integration of the Bluetooth module improves user interaction by allowing control of the mower's position.

Using solar energy for lawn care is a solution to environmental problems caused by lawns. Solar energy not only provides clean, renewable energy, but also reduces dependence on non-renewable fossil fuels. Integrating solar panels into the design reduces the carbon footprint associated with daily lawn care, ensuring sustainability and environmental

performance. Integration of IoT systems forms the basis of the new lawn mower, which collects real-time data from many sensors. These sensors are integrated in the management of critical parameters such as battery problems and blade operation [7]. The IoT system not only facilitates remote monitoring but also improves the tuning of the mower to keep it running efficiently. A collection of Bluetooth modules offers a new way for users to interact with the mower. Users can control the mower through a dedicated mobile application, providing unprecedented convenience. The mobile app serves as a foundation for users to customize settings, monitor performance metrics, and receive real-time updates, creating a seamless and efficient experience.

This study is important not only in terms of contributing to the maintenance of lawns, but also in the broader context of promoting environmentally friendly technologies. Solar energy research and IoT integration in lawn equipment has advanced future developments in the field, demonstrating the potential for an environmentally friendly alternative to modern technology [8-11].

In the next section we will cover system architecture, sensor integration, mobile application design and solar lawn mower performance evaluation. Results and discussions will show how effective the solutions are in achieving their goals and pave the way for a healthier, safer future.

2. System Architecture

Solar lawn mower consists of solar panel (12V, 25W), charge controller, BLDC (Brushless DC) motor (1000 rpm, 10A), geared DC motor (12V, 80W), Motor driver circuit (L298n), electronic speed controller ESC (30A), lithium ion battery (12v, 2200mAH), Bluetooth module(HC05) and ultrasonic sensors(HC-SR04). Solar panel converts solar energy into electricity and feeds it to the battery. Charge controller controls the charging of the battery from the output of the solar panel. BLDC motor drives the cutting blades and enable efficient and low-maintenance operation. Geared DC motor drives the wheels for mobility and manoeuvrability of the lawn mower. Motor driver circuit controls the speed, direction, and torque of the geared DC motors that drive the wheels. ESC unit adjusts the speed of the BLDC motor efficiently. Lithium ion battery Serves as the primary power source for the solar-powered lawn mower. Bluetooth module enables wireless communication for users to control and monitor via mobile application. Ultrasonic sensors measures distance to detect obstacles and ensure obstacle avoidance during lawn

mowing. Solar lawn mower is also integrated with Arduino UNO, Arduino serves as an open-source embedded system platform in this research, utilizing the ATmega328P microcontroller. The ATmega328P microcontroller, featuring 28 pins, is chosen for its cost-effectiveness and efficiency relative to other microcontrollers. The development and testing of new C++ language code are conducted within the arduino-1.6.7-windows software. Subsequently, after code verification, it can be uploaded to the Arduino platform through a straightforward USB cable connection between the PC and the Arduino kit.

2.1 *Methodology*

The present study employs a 12V, 2200mAH DC battery as the power source for the entire system, with a direct connection to a solar panel for charging. This configuration utilizes solar energy to replenish the battery, ensuring a sustainable power supply. The system is equipped with four DC motors, each linked to one of the four wheels, while the cutting blades are attached at the centre of the system for efficient grass cutting.

For system operation, a connection needs to be established between the system and an Android smartphone. This connection is facilitated through Bluetooth technology. Once successfully connected, users can control the system via a dedicated Android application installed on their smartphone. The application allows users to toggle the grass cutter on and off, providing a convenient means of operation. Furthermore, users can manoeuvre the grass cutter both vertically and horizontally, enhancing its flexibility in navigating the lawn. Ultrasonic sensors are used in front and in the bottom for obstacle detection for safer operation. Simplified block Diagram of complete system is presented in Figure 1 and Figure 4 for Proteus simulation.

3. Bluetooth-Based Mobile Application

The Bluetooth-based mobile application serves as the user interface and control hub for the solar-powered lawn mower. This application is designed to enhance user experience, providing intuitive functionalities for seamless interaction with the mower and real-time monitoring of its performance. The key components and features of the mobile application include:

3.1 *User Interface (UI)*

Dashboard: Presents a comprehensive overview of the lawn mower's speed. Control Buttons: Allows users to initiate or halt the mower's operation, providing convenient control.

3.2 *Remote Control*

Start/Stop Functionality enables users to remotely start or stop the lawn mower, providing flexibility and control from a distance. Directional Controls allows users to adjust the mower's direction through the mobile application, ensuring precise navigation in the lawn. Ultrasonic Sensors enables the lawn mower to detect the obstacle within the range of 2meters and stop the mower from collision as well as it detects obstacles below the mower to stop the blade from damage.

3.3 *MIT Flag Inventor*

MIT App Inventor is an intuitive and visual programming environment designed to enable users, including children, to create fully functional apps for Android phones, iPhones, and Android/iOS tablets. This platform is user-friendly, allowing even those new to App Inventor to have a basic app up and running in under 30 minutes. What sets MIT App Inventor apart is its blocks-based programming tool, streamlining the app development process and enabling the creation of complex, impactful applications in less time compared to traditional programming environments.

The primary goal of the MIT App Inventor is to democratize software development. By providing a platform that is accessible and easy to use, the project aims to empower individuals, particularly young people, to transition from being consumers of technology to creators. This shift encourages a broader and more inclusive participation in software development, fostering innovation and creativity among a diverse range of user.

3.4 *MIT Application Output*

Figure 2 shows the interface of the app. That is designed using MIT Flag Inventor



Figure 2
Bluetooth Connectivity UI

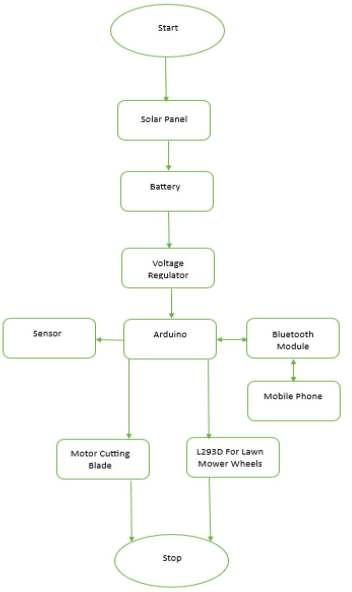


Figure 3
Flow Diagram

4. Simulation and Results

In Figure 3, the power flow is that we receive the power form solar panel. Then The solar panel charges the battery, the charged Battery will act as a primary power supply.

After passing through the voltage regulator the power reaches Ardui UNO which is communicating with ultra-sensors(HCSR04), Bluetooth module(HC05), Motor driver (L298n) and BLDC motor (1000rpm, 10A). The motor Driver is used to give acceleration and direction to the mower. Proteus simulation and hardware implementation are shown in Figure 4 and Figure 5 respectively.

4.1 *Simulation*

The simulation, conducted using Proteus software, demonstrated the functionality of the system has been shown in Figure 4. Specifically, the simulation showcased that when obstacles approached the ultrasonic sensors, the grass cutter halted its movement, exemplifying a safety feature in response to potential obstructions. System hardware is shown in Figure 5.

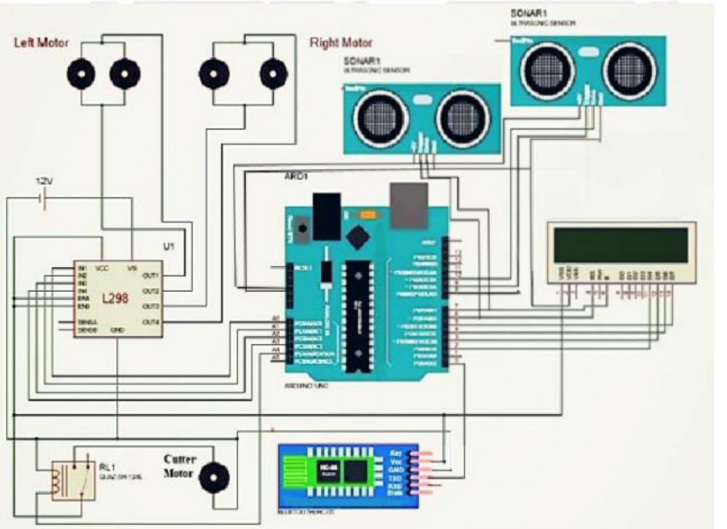


Figure 4

Proteus Simulation of proposed model

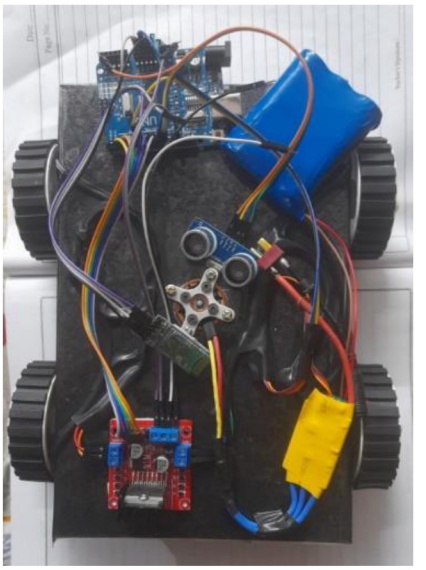


Figure 5

Hardware implementation of proposed system

5. Conclusion

In conclusion, the development and deployment of a solar-powered grass cutter controlled through an Android device signify a notable leap toward sustainable and effective lawn maintenance practices. The incorporation of solar energy not only addresses environmental concerns related to carbon emissions but also ensures energy self-sufficiency and economical operation. The Android-controlled functionality provides users with unparalleled flexibility in shaping their lawns, reducing the reliance on manual labour. The simulation, conducted using Proteus software, effectively demonstrated the system's ability to respond to potential obstacles, highlighting its safety features. This innovation, characterized by its affordability, robust durability, and minimal maintenance needs, emerges as a compelling alternative to traditional grass-cutting systems. As energy assumes a crucial role in our daily lives, the adoption of eco-friendly solutions becomes imperative. The solar-powered grass cutter aligns seamlessly with the global push towards sustainable practices in lawn care, offering an adaptable and environmentally conscious solution for residential, commercial, and public landscapes. With diverse potential applications, ranging from urban landscaping to environmental conservation, this technology signifies a transformative era in automated, eco-friendly grass cutting. Beyond being a technological advancement, the solar-powered grass cutter signifies a conscientious step toward aligning technology with nature, addressing contemporary lawn care needs while prioritizing ecological sustainability.

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