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IOT based solar-powered grass cutter utilizing radiant solar energy

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ABSTRACT:

This research introduces an Internet of Things (IoT)-enabled solar-powered grass cutter designed to automate and optimize lawn maintenance while minimizing environmental impact. Utilizing a photovoltaic solar panel as the primary energy source, the prototype operates independently or through remote control using a mobile interface. The integration of sensors, a microcontroller (NodeMCU), and motor drivers enables real-time obstacle detection, automated navigation, and energy-efficient operation. The machine is suitable for applications in residential gardens, public parks, and commercial landscapes. Simulation and stress analysis demonstrate the mechanical robustness of the design, emphasizing its viability as a green and smart alternative to traditional grass cutters.

Keywords: Node MCU, IoT, grass cutter, Ultrasonic sensor, Solar energy, Fusion 360

Introduction

Traditional grass-cutting machines are generally categorized into two main types: those that use fuel and those that operate electrically. Fuel-powered models typically rely on internal combustion engines that run on gasoline or diesel. Although effective in cutting grass, these machines pose significant environmental risks. The burning of fossil fuels releases harmful pollutants, including carbon dioxide (CO_2), nitrogen oxides (NO_x), and particulate matter, which contribute to air pollution and negatively affect public health. CO_2, in particular, is a leading cause of global warming and climate change. Additionally, fuel-powered cutters generate high noise levels due to engine operation, which can disturb residential areas, wildlife, and cause stress or health issues for users and nearby individuals.

Electric grass cutters present a cleaner alternative, drawing power from the electrical grid or rechargeable batteries.

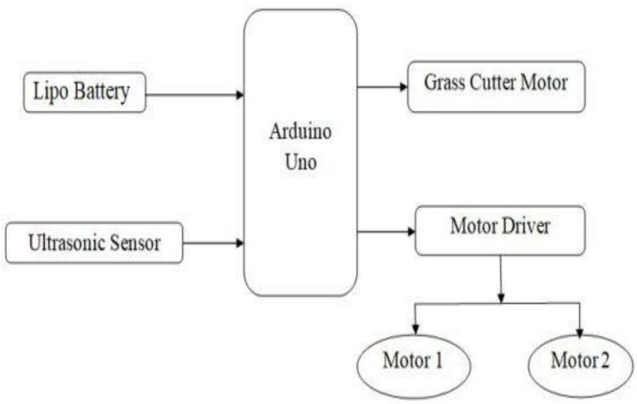

Figure 1. Block diagram of solar grass cutter

To overcome the drawbacks of both fuel-based and traditional electric models, IoT-integrated solar-powered grass cutters have emerged as a smart and eco-friendly innovation. These systems use solar energy to charge batteries, eliminating reliance on fossil fuels and reducing environmental impact. The integration of IoT technology allows for enhanced functionality, such as automated operation, schedule optimization based on weather conditions, and real-time remote control via smart devices. This reduces the need for manual labor and improves safety by enabling monitoring from a distance. The solar-powered nature of these machines ensures quiet, emission-free operation, making them ideal for environmentally sensitive or urban areas.

Literature review

Advanced control strategies, such as nonlinear decoupling methods, have been proposed to enhance the stability and maneuverability of electric vehicles with in-wheel motors. Research has also explored automatic irrigation systems using microcontrollers and soil moisture sensors. Innovations in autonomous robots for cleaning and surface maintenance have shown how smart navigation can be applied to small-scale devices.

In one development, a solar-powered lawnmower robot was designed to be operated via mobile phone, addressing both environmental concerns and labor intensity. Wireless charging technology has also progressed, allowing sensors to recharge when in proximity to mobile energy sources.

As technology evolves, smart systems like solar-powered mowers utilizing IoT platforms are being created to replace manual, fuel-dependent models. These machines are designed for efficiency and autonomy. For example, solar energy has been effectively employed in robotic arms for agricultural harvesting. Fuzzy logic control (FLC) systems are also being used to predict solar charging opportunities based on environmental light conditions.

Other efforts have aimed to automate field cleaning in schools using microcontrollers, Bluetooth, and solar-powered components. With environmental awareness growing, solar energy is gaining importance for its low ecological footprint. Comprehensive studies have reviewed the development of agricultural robots, including those for monitoring crops, livestock, and aquaculture.

Smart farming tools now include automated gantry systems for plant monitoring in greenhouses. These systems rely on off-the-shelf components to allocate more resources to imaging and mapping technologies.

Artificial Intelligence (AI) has enabled the design of lawn mowing robots with high cutting efficiency and minimal human intervention. Software like Autodesk Inventor is used for simulation and CAD design, while microcontroller-based systems manage electrical integration. The IoT facilitates continuous data generation and remote device interaction, which is being leveraged in projects like automated grass cutters.

Battery-powered mowers using lithium-ion cells are becoming more common due to their high energy density. These machines typically feature separate motors for propulsion and cutting.

In agriculture, automation is crucial for increasing productivity. Remote-controlled systems for irrigation and fertilization are being proposed. Fuel efficiency in hybrid electric vehicles has also been improved through mathematical and heuristic strategies.

Innovative communication techniques, such as non-orthogonal multiple access (NOMA), are being explored for connecting IoT devices over long distances. Autonomous systems for obstacle detection and route planning are being applied to small-scale robots using spiral motion algorithms. Furthermore, smart carts with RFID, microcontrollers, and Bluetooth modules are redefining shopping experiences. Overall, fuzzy logic and hybrid approaches are being introduced across energy and agricultural sectors to enhance sustainability and automation.

Methodology

In the proposed design, the NodeMCU serves as the central processing unit, managing and coordinating all operations of the grass cutter system. The energy required for operation is supplied by rechargeable batteries, which are replenished through an attached solar panel. The system's mobility is enabled by DC motors connected to the wheels, and these motors are controlled using a motor driver that manages their speed and direction. Communication between the device and the user is facilitated by the NodeMCU via a mobile application interface. To prevent collisions, an ultrasonic sensor is strategically placed on top of the prototype, enabling it to detect and avoid obstacles in its path. The schematic of the system layout is illustrated in

Figure 2.

The prototype includes the following key components and their specifications:

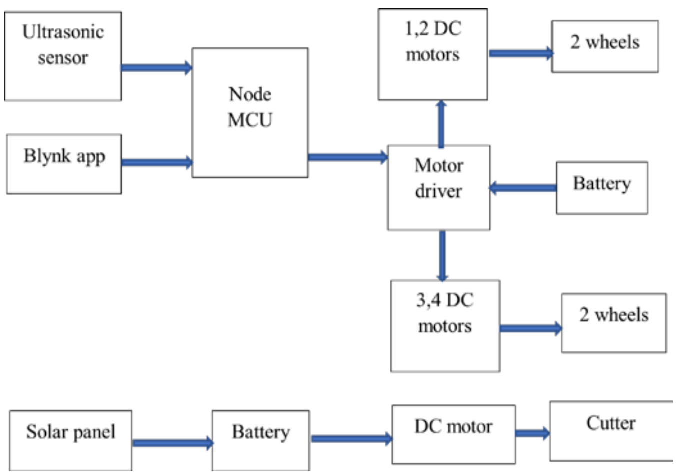

Figure 2. Components of the designed model

- NodeMCU (ESP8266): A cost-effective Wi-Fi-enabled microcontroller developed by Espressif Systems. It can function independently or act as a bridge (UART to Wi-Fi) to connect other controllers to wireless networks.

- L298N Motor Driver: This dual H-bridge motor driver module is designed for driving DC and stepper motors. It incorporates an L298 IC and a 78M05 voltage regulator. Capable of handling up to four DC motors or two motors with direction and speed control, it operates within a voltage range of 5V to 35V and supports currents up to 2A.
- Solar Panel: The 12V 20W solar panel efficiently transforms solar energy into electrical energy. Compact and designed for small-scale applications, it is suitable for charging 12V batteries in standalone systems. With an energy conversion efficiency of approximately 15% to 20%, it performs well even in partial sunlight.
- DC Motors: Operating at 12V, these geared motors provide a torque output of 10 kg-cm and a rotational speed of 1000 RPM. Their side-shaft configuration allows for easy mechanical integration, and their durable construction ensures stable performance in demanding environments.
- Ultrasonic Sensor: This sensor works by emitting high-frequency sound waves and measuring the time taken for the echoes to return from nearby objects. It translates these echoes into electrical signals to calculate distances, allowing the device to detect and avoid obstacles effectively.

Conclusion

In summary, the IoT-enabled solar-powered grass cutter offers a smart and sustainable solution to the environmental issues associated with conventional grass cutting machines. By leveraging solar energy as a clean and renewable power source, combined with IoT-based automation and remote monitoring, the system operates with minimal noise and zero emissions. This makes it an ideal choice for eco-conscious applications in both urban and rural settings.

Key benefits of the developed prototype include:

- Lower operational costs due to improved blade performance and lightweight design
- Elimination of fuel expenses, emissions, and harmful residues through the use of solar power
- Environmental resilience, as the sensors maintain functionality regardless of outdoor conditions
- Stable motor performance with consistent speed even under load
- Continuous battery charging enabled by the solar panel
- Decreased labor demands, as the machine is user-friendly and can be operated by individuals without specialized training

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Conflict of Interest statement

The authors do not have any conflict of interest for this work.

REFERENCES

1. H. Zhang, W. Zhao. Decoupling control of steering and driving system for in-wheel-motor-drive electric vehicle. Mech. Syst. Signal Process. 2018, 101, 389–404.
2. Prasojo, P.T. Nguyen, O. Tanane, N. Shahu. Design of ultrasonic sensor and ultraviolet sensor implemented on a fire fighter robot using AT89S52.
3. J. Robot. Control 2020, 1 (2), 59–63.
4. S. Tokunaga, C. Premachandra, H.W.H. Premachandra, et al. Autonomous spiral motion by a small-type robot on an obstacle-available surface. Micromachines 2021, 12 (4), 375.
5. B. Ibrahim, V. Siva Brahmaiah, P. Sharma. Design of smart autonomous remote monitored solar powered lawnmower robot. Mater. Today Proc. 2020, 28, 2338–2344.
6. B.H. Liu, N.T. Nguyen, V.T. Pham, Y.X. Lin. Novel methods for energy charging and data collection in wireless rechargeable sensor networks. Int.
7. J. Commun. Syst. 2017, 30 (5), 3050.