



Design of smart and self-controlled Solar Grass Cutter with Lawn Coverage

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Abstract: In this paper we design a piece of equipment which is "Variable Head Automatic Solar Grass Cutter with Lawn Coverage". The system is design by some basic components including motor drive circuit, control circuit and solar panel. The overall operation is controlled by an Arduino microcontroller. The proposed system can automatically cut the lawn while adjusting the cutting height according to the surface needs, making it suitable for different types of lawns. The machine's cutting system consists of a DC motor, which drives and controls the rotating edge along a nylon cord. This system enables the machine to cut grass with precision and speed. The basic concern of the machine is the safety of the user. To avoid collision an ultrasonic sensor is installed on the front of the machine, allowing it to detect and avoid obstacles in its path. In this project Solar panels and rechargeable batteries are used that help us to reduce energy consumption and also promote the use of renewable energy sources. This makes our machine eco-friendly and cost-effective. Hence this machine provides an opportunity to promote progress in innovation and maintenance.

Keywords: Solar panel, zigzag movement, DC motor, ultrasonic sensor,

Introduction

The idea of developing a smart solar grass cutter with adjustable head has the potential to significantly alter how we maintain lawns. The design and development of a solar-powered grass cutter was based on the automatic process [1]. The D.C motor, rechargeable battery, solar panel, nylon strings, and micro controller are all parts of the intended solar grass cutter. D.C gear motors provides the necessary torque to drive the nylon strings that will cut the lawn. Through the solar charging controller, the battery is recharged [2-4]. The project offers an eco-friendly and more effective alternative to the conventional technique of lawn maintenance. The traditional tools and equipment's are costly and also a tiresome job for operator, that depends on gas-powered or electric lawn mowers. By the use of renewable energy sources and innovating technology, this project is very useful to address the problem of lawn maintenance. The main purpose of the project is to develop a machine that can cut grass on a lawn consistently and automatically while using solar energy

[5-8]. The conventional machines are exhausting and time-consuming for the person who operate these machines [9-12]. The conventional cutting tools also produce noise and air pollution. The major objective of the project is to create a machine that can navigate a lawn and cut the grass effectively without the assistance of a human using solar power and cutting-edge technologies like sensors and zig-zag algorithm. Since the machine has the adjustable head feature, which makes it easy to adjust to various grass heights [13]. The robotic lawn cutter also needs to distinguish between grass and obstacle while continuously surveying its surroundings. We needed an ultrasonic sensor to tell whether the grass cutter was about to hit something [14-15]. When designing the grass cutter, safety should be primary consideration. By using an autonomous grass cutter, customers won't have to move their own lawns. And it will help to reduce both the noise pollution and bad effect on environment. An autonomous lawn mower will make it easier for the user to cut their yard's grass. While moving, the various sensors are used to detect and avoid objects and people [16-17]. By using this method, automatic grass cutter will cover all the required area of lawn and there is no



need of any person to operate it. The additional thing is that this grass cutter will stop automatically when all required area will be covered. This design includes an Arduino microcontroller, as well as sensors, a solar panel, a battery, an inverter, etc. The major goal of this automatic lawn mower is to allow the user to use variable head of cutter motor to designate the area that needs to be trimmed and the grass height that best suits their needs.

Methodology

First of all, we selected this project due to our deep interest in this field. Besides the rising automation and innovation of technology in all other fields there is also a need to modernize this field now. As we see lawn plays an important part to enhance the beauty of any place or institution, so there is need to do innovation in the lawn maintenance process. The most important thing is that we are using renewable energy sources instead of traditional techniques. In this regard, we can minimize air pollution and noise pollution because our machine will be totally eco-friendly and efficient. Proposed block diagram is shown in fig. 1.

Block diagram

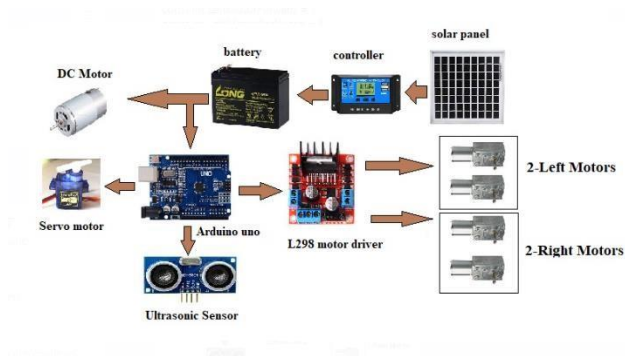


Fig. 1. Block diagram of a machine

Solar grass cutter is an Arduino-based robot and its name is showing that it cuts the grass and covers a lawn. It is implemented on the software to check its working and the power needed to operate it. We can calculate all power. We can observe the battery and as well solar values by in a simulation. I am doing all this programming and simulation in a well-known software proteus.

Simulation working condition

In this simulation, first of all, we installed a lot of software

but could not find all the necessary components. Then we have imported the components one by one. Although it was very difficult to import similar components that we need. Then we uploaded the Arduino programming with so many complications as it was difficult to locate the code file address. After this we made the connections with components to Arduino and various other connections according to the programming which we have done on the Arduino. We connected by following the pins given in the coding and connected all the components as required. We have also connected the solar panel, battery, motors, Arduino and L298 motor driver circuit to run the motors. The simulation model is shown in fig.2. below

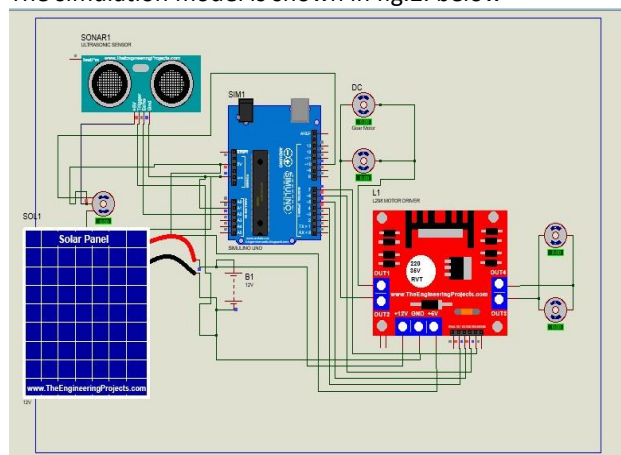


Fig. 2. Simulation Result

Arduino Uno settings for every part of hardware design:

Ultrasonic sensor:

First, this is an ultrasonic sensor which uses sound waves with a frequency above human hearing. It transmits sound waves that are come back after striking an object. In this way, we can estimate the distance between the sensor and the object as shown in fig. 3. Ultrasonic sensors are used in industrial as well as in the medical field for measuring the level of liquid, and detection of objects for safety purposes.

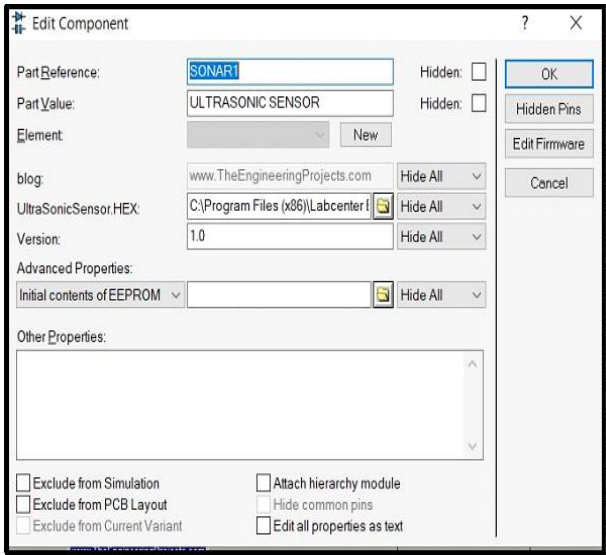


Fig. 3. Parameters of ultrasonic sensor

Arduino Uno:

we need to upload by putting the address of the hex file as shown in fig. 4.

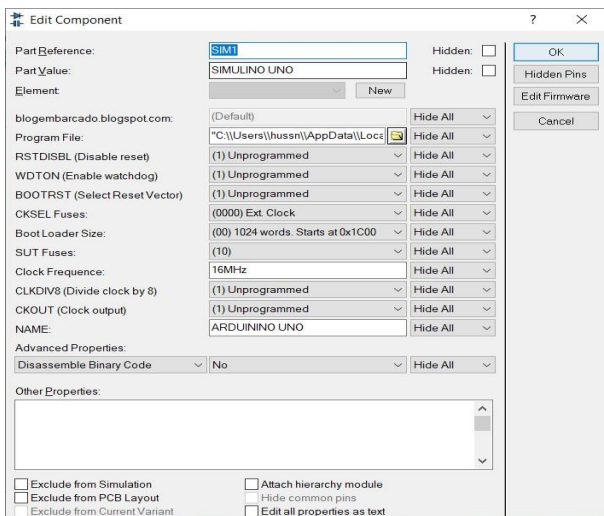


Fig. 4. Arduino

DC gear motors

Parameters of DC gear motor are shown in fig. 5.

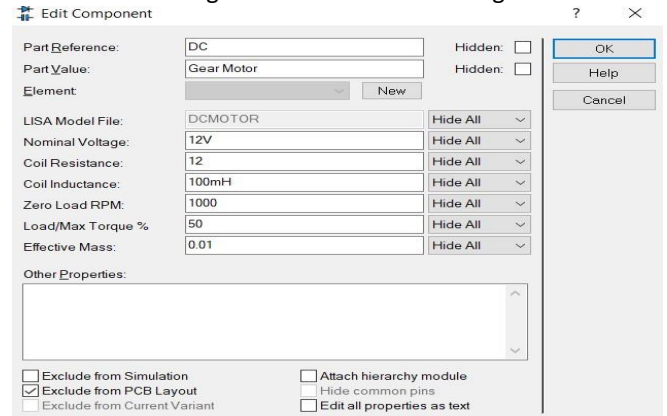


Fig. 5. Parameters of DC Gear Motor

Solar

The solar parameters are shown in fig. 6

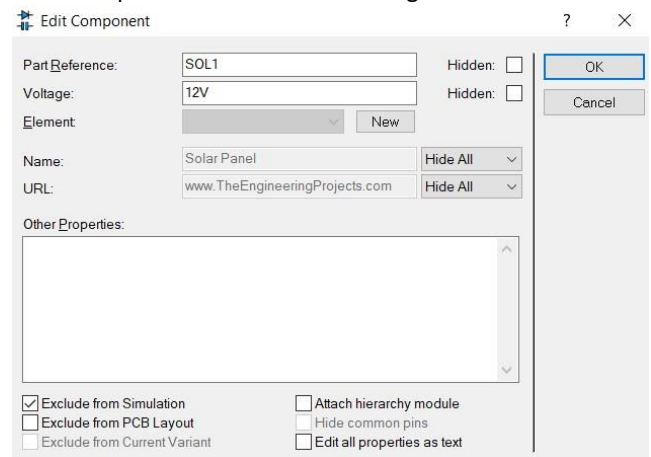


Fig. 6. Parameters of Solar

Hardware Explanation:

The hardware design of an automatic solar grass cutter using lawn coverage would involve several key components and considerations. Here are some points that are included in the design: The grass cutter would require a solar panel to convert sunlight into electrical energy. The size and capacity of the solar panel would depend on the power requirements of the grass cutter. The hardware components are shown in fig. 7.



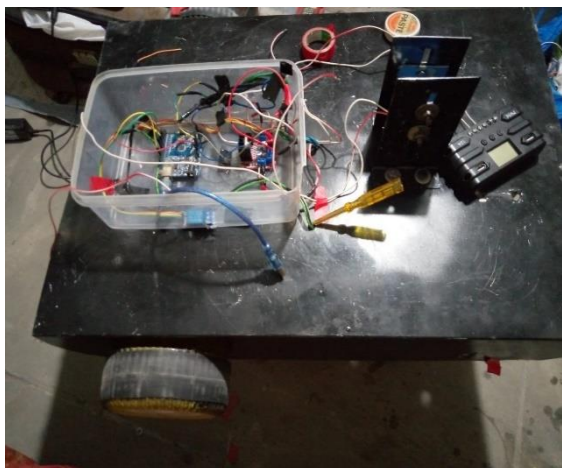


Fig.7. Hardware internal construction

The electrical energy generated by the solar panel would be stored in a battery. The battery should be large enough to provide power to the grass cutter for a sufficient amount of time, even in the cloudy season. An Arduino is working as a brain in our project, and control the working according to the commands that are given by the microprocessor. An Ultrasonic sensor is working as detector for solar grass cutter as shown in fig. 8.

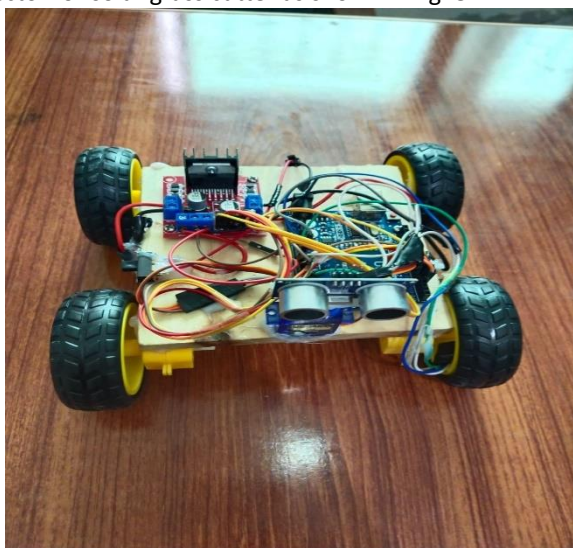


Fig. 8. Hardware internal construction

This sensor measures the distance of grass cutter from the obstacle and send this to Arduino. A l298n motor driver circuit takes command from the Arduino and perform its working according to this. The position of the grass cutter motor is also variable, we can move this motor in upward and down ward. With the help of this movement, we can adjust the Hight of grass according to our desire which is very important as shown in fig. 9.

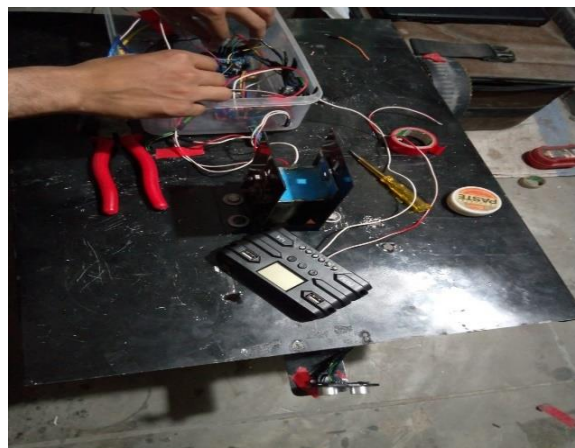


Fig.9. Selection of motor

The main thing in this side is programming of the Arduino according to the working of solar grass cutter. We have programmed this solar grass cutter in such a way that it moves in a zig zag manner so that it will cover all the required area and cut all the grass in an efficient way. In programming we have used the logic of counter as a variable of last turn. Our solar grass cutter moves in forward direction as long as any obstacle not come in front of this as shown in fig. 10.



Fig. 10. Complete Design of Grass Cutter

When obstacle come, it changes its direction according to the requirement. Once it changes its direction either in left or right side then it moves in forward direction. When again it detects obstacle, then it turns in the opposite direction of last turn, means if first it was turn in left side then at next detection it will turn in right side and so on. A thing that we must know the turning of solar grass cutter either in left side or in right side is not 90 degree but it turns at the angle of 180 degree with the extension of forward movement. Side view is shown in fig. 11 below. The figure shows the hardware design of automatic solar grass cutter. This design is very accurate on the basis of its

usage. The rare two wheels of this machine are used to manage the complete movement. The front wheel is placed in such a way that the smooth movement either in right or left side can be easy. The turning mechanism of this machine is totally based on the movement of both side wheels.

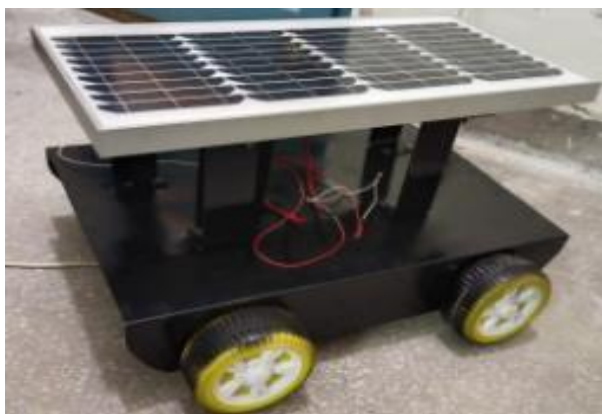


Fig. 11. Side View of Design

When we want to turn this in right side, then movement of left wheel is in forward direction and on same time the right-side wheel moves in backward direction hence the turning of grass cutter in required direction achieve. Similarly turning of grass cutter in left side is also as the motion of right-side wheel in forward direction and left side wheel move in backward direction in same time.

Innovative aspects of solar-powered lawn mower in comparison to existing Lawn Mower

In the ever-evolving panorama of sustainable era, the emergence of solar-powered garden mowers marks a sizable stride toward green garden care solutions. This article wants to delineate the groundbreaking capabilities of this revolutionary era in assessment to conventional gas-powered mowers, dropping slight on its technological breakthroughs, common typical overall performance advantages, and environmental impact. sun-powered lawn mowers harness the inexhaustible strength of the solar to pressure their operations. The integration of superior photovoltaic cells guarantees green conversion of sun strength into power, permitting extended and sustainable operation without compromising performance

Table 1 Comparison of modern solar lawn mower with existing technology

Aspects	Solar Powered Lawn Mower	Traditional Lawn Mower
Power Source	Solar energy	Gasoline, electricity,

		manual push
Technology	It is fully automatic Using different sensor and algorithms.	Manually Operated not use such kind of features which make it easier.
Performance	This covers all area desired to cut even in the absence of supervisor.	Need a human to operate it in some kind of lawn mowers
Environmental Impact	Zero emissions, eco-friendly due to	Pollutants (gasoline mowers), varying eco-friendliness for electric mowers
Maintenance	Low maintenance, minimal moving parts	Regular maintenance required, including oil changes, spark plug replacement, etc.
Mobility	Moves independently within defined area	Requires manual pushing or driving
Convenience	Can operate without user supervision	Requires user presence and manual operation

By eschewing fossil fuels, those mowers mitigate greenhouse fuel line emissions, contributing to weather extrude mitigation efforts. Moreover, the removal of dangerous exhaust emissions related to fuel line-powered mowers interprets into advanced air high-satisfactory and more suitable public fitness outcomes. Additionally, the discount in noise pollutants fosters a tranquil outside environment, reaping benefits each customer and surrounding communities.

Mower safety features and mechanism using ultrasonic sensor

At the core of the safety system of the grass cutter are ultrasonic sensors strategically placed to detect obstacles and maneuver through various terrains accurately and



dependably. These sensors utilize sound wave technology to help the grass cutter perceive its surroundings and autonomously adjust its path, reducing the risk of collisions and improving safety during operation. Additionally, the inclusion of redundant sensor systems strengthens the grass cutter's safety measures, guaranteeing continuous obstacle detection and proactive avoidance of hazards in dynamic environments.

The usage of Nylon string in place of metal blade in order to cut the grass also add user safety. The safety strategy of the grass cutter goes beyond hardware solutions to include intelligent algorithms.



Fig 12 Actual design of using nylon strings

Design efficiency and performance

From actual design as shown in figures above we can calculate performance capacity and efficiency.

Battery Capacity

As we have used total 3 motors. 1st for left side wheel, 2nd for right side wheel and 3rd for main cutter motor.

Wheel Motors Rating (On Load) = 12V & 0.5 A

Main Cutter Motor Rating (On Load) = 12V & 1,5A

$$\text{Battery Capacity (In Ampere – Hours)} = \frac{\text{Battery Capacity (in Ampere)}}{\text{Motor Capacity (in Ampere)}}$$

$$\text{Battery Capacity} = \frac{7AH}{2.5A} = 2.8 \text{ Hours} \quad (1)$$

Calculations for Charging Current:

$$\text{Charging Current} = \frac{\text{Solar Panel Power}}{\text{Battery Voltage}}$$

$$\begin{aligned} \text{Charging Current} &= \frac{35 \text{ W}}{12V} \\ &= 2.92A \end{aligned} \quad (2)$$

Calculations for Charging Time:

Battery Capacity is 7Ah and Calculated charging current is 2.92 A, let's assume 80% Charging Efficiency.

$$\begin{aligned} \text{Charging Time} &= \frac{\text{Battery Capacity}}{\text{Charging Current} \times \text{Charging Efficiency}} \end{aligned}$$

$$\text{Charging Time} = \frac{7Ah}{2.92 \text{ A} \times 80\%} = 2.99 \text{ Hours} \quad (3)$$

So approximately 3 Hours are required for a 35 W Solar Panel to charge a battery of 7Ah.

Efficiency.

$$\text{Efficiency} = \frac{\text{Power of Grass Cutter}}{\text{Power of Solar Panel}} \times 100\% \quad (4)$$

We will assume some efficiency losses, Let's Assume Solar or Battery Gives 80% efficiency to run the lawn mower.

So,

$$\text{Efficiency} = \frac{30 \text{ Watts}}{35 \text{ Watta}} \times 0.80 \times 100\%$$

$$\text{Efficiency} = 0.8571 \times 0.80 \times 100\%$$

$$\text{Efficiency} = 68.57 \%$$

Based on the above calculations, the solar grass cutter's efficiency would be around 68.57%. Keep in mind that this is a estimate, and actual efficiency may differ depending on real-world factors like changes in the amount of sunshine and system efficiency losses.

A 12V, 7Ah battery is consequently deemed suitable, affording an operational window of approximately 2.8 hours. Charging this battery through a 35W solar panel entails a duration of around 3 hours, with an assumed 80% charging efficiency. The overall system efficiency is then approximated at 68.57%, factoring in anticipated

losses stemming from both the solar panel and the battery.

Impact of Solar-Powered Lawn Mower on the Environment and Sustainable Development

By utilizing solar energy, these innovative devices offer a cleaner, more efficient option compared to traditional gasoline or electric lawn mowers.

Decreased Energy Usage

Solar-powered lawn mowers function solely on solar energy, thereby decreasing reliance on non-renewable energy sources like fossil fuels. Traditional lawn mowers powered by gasoline engines release harmful pollutants into the air, contributing to air pollution and climate change. Conversely, solar-powered lawn mowers emit no emissions while operating, lessening environmental damage and promoting a healthier ecosystem.

Pollution Mitigation

Conventional lawn mowers with gasoline engines are known for noise pollution and emissions of harmful gases like carbon monoxide and nitrogen oxides. Solar-powered lawn mowers operate quietly and release no pollutants, making them ideal for residential areas where noise and air pollution are significant concerns.

Advancement of Sustainable Development

Embracing solar-powered lawn mowers aligns with sustainable development principles by encouraging the efficient utilization of renewable resources and reducing environmental impact. These lawn mowers provide a sustainable approach to lawn care, diminishing reliance on limited resources and fostering environmental responsibility.

Resource Preservation

Solar-powered lawn mowers require minimal external resources due to their utilization of solar energy to power their cutting mechanisms.

Community and Policy Considerations

The widespread adoption of solar-powered lawn mowers in communities can positively impact public health, environmental quality, and overall community well-being. Policy measures incentivizing solar-powered lawn mower use, such as tax benefits or rebates, can encourage individuals and businesses to make environmentally

conscious decisions.

Conclusion:

Our Automatic Solar Grass Cutter project is completed successfully by reviving the literature survey. In order to satisfy all conditions, the components were selected based on design requirements and as well as additional factors. Depending on the requirements, a fully automatic solar grass cutter design and construction could vary according to need of electrical engineering, and technical knowledge and Coding skills may be needed for the project. The end result is an effective tool which can cut grass on itself. There are many benefits to using a self-powered solar grass cutter, including improved sustainability, environmentally friendly, and less cost. It can be a useful tool when managing and designing or caring for grassy areas. The best location for a solar panel is one that allows it to absorb the most solar energy. Nonskilled people can also handle it with ease. It is very accurate since it detects the obstruction and changes the direction. Solar based grass cutter comparatively better than the traditional cutters, such gas-powered cutters.

Future work

In future, a lot of work can be done on it as it is a world of AI. So, it can be used in future for better operation. AI is the most used technology nowadays. With the aid of using that era, the sensor can regulate itself robotically and exchange the placement of the sensor in step with the peak of the grass. This AI can make the grass cutter more functional and efficient. The grass cutter that is based on AI will change its direction by itself scanning the things which will come its way and that makes it more prominent.

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