DESIGN AND IMPLEMENTATION OF SOLAR GRASS CUTTER

By

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Date Received: 28/08/2021 *Date Revised: 16/09/2021* *Date Accepted: 16/10/2021*

ABSTRACT

This paper proposes a lawnmower which operates on solar power, eliminating the use of internal combustible engines that uses fossil fuel. This new design has no emission and hence there is no pollution. A microcontroller is used in this work to control the entire operating process of the lawnmower or the grass cutter. An ultrasonic sensor is used to detect obstacles; DC motors are used for the robot chassis and cutting blades. All the electromechanical devices used in this cutter are powered by solar panels placed on trucks and trailers. The key objective of this design is to keep the environment clean with reducing noise pollution and clean air.

Keywords: ESP32 Microcontroller, Bluetooth, Sensors, DC Motors, Lawnmower, Green Energy.

INTRODUCTION

Pollution is a big issue in the modern world. Fossil fueled lawn mowers pollute the environment because they emit undesirable gases. Solar energy can be used to power the new motors that has been using IC engines. Traditionally, lawn mowers have been clumsy machines that require a great deal of muscle and energy to operate. In addition, manpower is necessary to operate them. Traditional grass cutters should be replaced by efficient, power-saving, and smart lawn cutters as technology improves. The proposed lawnmower is solar powered and robotic that has the ability to avoid obstacles and mow grass with minimal human intervention. As a result, traditional grass cutters will be replaced with daily-use robots capable of cutting grass on the lawn without the need for human interaction. For assistance and other obstacle recognition, the system will include some automation.

Battery will be the main source of power with facility to charge it using solar panel. The electric lawn mowers with power cable is inconvenient to use. As a result, it is more cost-effective to utilise a solar-powered lawn cutter that is both smart and efficient (Baingane et al., 2018; Yadav et al., 2017).

The solar powered lawnmower is based on the same principle as in the conventional lawn mowers, the only difference is the energy source used. So, automatic grass cutter using the rechargeable battery is economical. Users can trim the grass of the desired area using this automatic grass cutter with a remote wireless control. The primary goal of this grass mower is to reduce the amount of work required to cut the grass and also to cut the grass in a specific area, according to the needs of the user (Patil & Patil, 2017).

1. Related Work

The studies by Aponte-Roa et al. (2019) and Paala et al. (2019) used ultrasonic sensor to detect obstruction by object or human or animal potential to damage the lawnmower through programmed microprocessors.

Habib et al. (2019) and Khodke et al. (2018) designed automatic lawnmowers and implemented solar energy as its primary source. The proposed grass cutter is lightweight and portable. It has two major parts: one is a motor-powered base and the other is cutting blades with motor. Its default mode is automatic, though it can be operated manually whenecessary. It can detect the position of grass by a colour sensor through specified band of green colour signal and is able to move automatically towards the grass by its motorized controlled base. As soon as the motor driven cutting blade comes close to the grass, it starts cutting and continue until all grasses around it is being cut down. The prototype of the grass cutter is tested and the machine operated successfully. Two degree-of-freedom PID controllers were used to control the motor speed of the prototype.

Sultana et al. (2020) designed a solar powered lawnmower that overcomes obstacles and operated using hand gestures. A video camera is mounted on the highest point of the vehicle which translates hand gestures to operate the machine. The system uses 6 V batteries to drive both the motors, one for vehicle movement and the other for cutting grass. The system uses solar panels to charge the battery. The grass cutter and vehicle motors are interfaced with micro-controllers programmed to control the motors for movement and cutting purpose. It is also interfaced with ultrasonic sensor to track the object of hindrance.

2. Objectives

- To study previously available lawnmowers, both commercial and research prototype.
- To determine the specific sensors and technical parameters of the hardwares needed for the project.
- To design a block diagram for the proposed grass cutter.
- To design the prototype solar grass cutter hardware and calibrate the sensors.
- To train the software for the given dataset to make the grass cutter automatic.
- To test and validate the solar grass cutter responses against the trained dataset and test dataset.

3. Methodology

Understand the technologies applied by various researchers and investigate the advantages and disadvantages in each design.

- The technical specifications and data regarding the types of sensors used in the solar lawnmowers will be extracted from the available literature and hardware manuals.
- Based on the sensors and the hardware chosen, we create a block diagram for the proposed lawnmower. The block diagram provides a quick, visually clear view of the work.
- Appropriately selected sensors, batteries, gyroscope sensors and used cutters blades will be installed. The microprocessors will be mounted on the circuit board. The design of the solar lawnmower will be refined based on the accuracy of the measured data.
- The finalized solar grass cutter hardware will be assembled and write necessary software for automating it. The software will be tested to have the grass cutter work automatically.
- The finalized hardware will be operated by different users. Initial calibrations will be performed and the operation of the grass cutter and the processing hardware will be observed. The performance of the cutter for different situations, and the accuracy of calculations for obstacles and the height of the grass will be recorded, for different sets of training, testing. Before operating the machine, validation of datasets, from both the available dataset and from newly generated dataset would be done.

The performance of the designed hardware and the software will be determined, and conclusions will be drawn based on the validation studies done by Hariya et al. (2017) and Wasif (2011).

4. Design and Implementation

The block diagram of the solar grass cutter is shown in Figure 1. An ESP32 microcontroller, solar panel, DC motors, cutting blades, various sensors, and a solar charging system are all part of the design. By assembling these components, we can create a robotic lawnmower that can be operated manually or automatically, depending on the user preference. The eye of the proposed

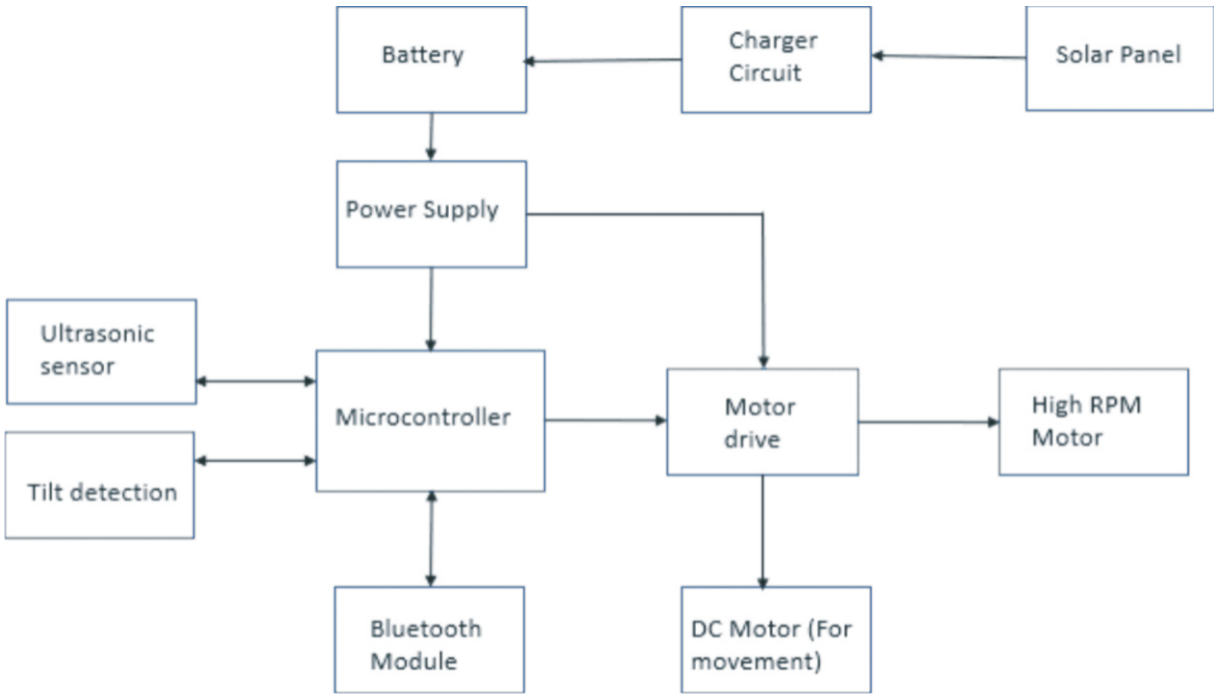

Figure 1. Block Diagram of Solar Grass Cutter

lawnmower is the ultrasonic sensor, which prevents colliding with any object of hindrance in its path.

One of the important factors when building this robotic lawnmower is the cutting blade is safety. We developed a capacitive touch sensor that stops the mower is lifted up or touched hard surface as we did not want the motor to dry run or damage the blade. The surface or floor is detected using an infrared sensor. The location of this sensor is critical to the overall efficiency of the design. The solar panels were supposed to be mounted horizontally on the robot to get maximum exposure of the sunlight. To protect the robot from hitting any hindrance, an ultrasonic sensor will be put right in front of the robot.

Using the Arduino controller app and the software code, the sensors were tested by holding an object in front of the prototype. The sensor's response was noticed when the object was moved to the right, left, forward and backward, and the circuit was controlled through the app. The procedure is repeated and observed if the reaction was similar to the previous phase. Based on the functioning of the component, the program code was rewritten and executed (Dilip et al., 2017; Manimegalai et al., 2018).

The flowchart in Figure 2 shows that the overall process is done in a simple form.

- Start the solar lawnmower system, as this will initialize the sensors and the microcontroller.
- Once the microcontroller is initialized, it checks if the system is in manual or automatic mode.
- If the system is in manual mode, the system follows the instructions given to the microcontroller.
- If the system is in automatic mode, the device moves forward and checks if there are any obstacles. If any obstacles detected, then the system pauses for some time and then changes its direction.
- And if there are no obstacles detected, the system moves forward cutting the grass until it finds any other obstacle or until the system is switched off.

5. Results and Discussion

- All the components required for the project are as shown in Figure 3. The components were tested individually using a multimeter to get the output in range.
- Sensors, motors and microcontroller are components

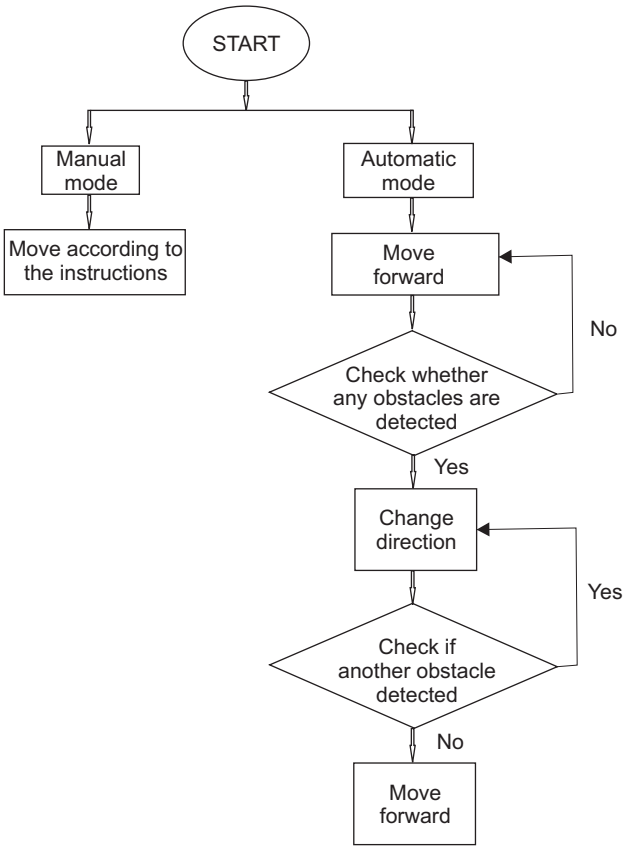

Figure 2. Flowchart of Design

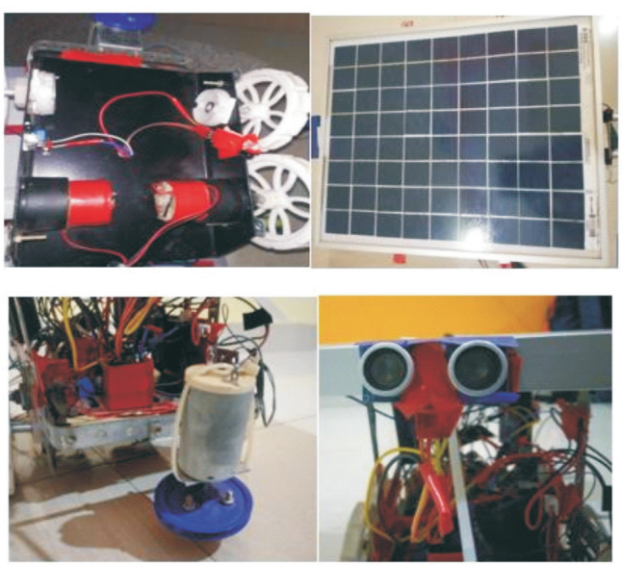

Figure 3. Front and Side View of Project

that have been connected and tested after the developed software code has been implemented, and the response has been verified. At this stage, the

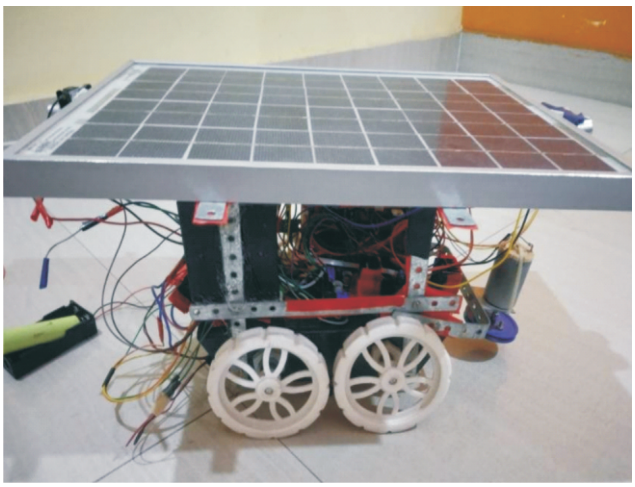

Figure 4. An Implemented Model of Solar lawnmower

entire circuit has been connected to the equipment in which the motors, drives, wheels and other components are assembled, and is shown in Figure 4.

Conclusion

The design of the robotic solar lawnmower and implementation are completed and tested, and the results are satisfactory. It will be simpler for those who are going to take the project and modify it further. This system is capable of recharging the batteries while the solar powered lawnmower is in motion. The renewable energy has been chosen because of the high cost of commercial electricity. All project objectives and proposed requirements have been achieved.

This prototype is using green energy and it senses the obstruction and adjusts the course or stops operating according to the instructions.

Future Work

The robot, in its current state, is capable of fulfilling its purpose with 100 percent precision. However, as technological trends change, new capabilities can be added with increasing component feasibility.

The robot could be made capable of managing complicated boundary formations with more precision using Geo-Fencing technology.

The robot can effectively use the proposed method of messaging via SMS from the user's mobile phone using the GSM module. More sophisticated algorithm designs can

improve boundary-domain computations, and estimates of the required time and energy can be displayed.

The robot can be taught to trim nearby lawns in a single session by using satellite tracking to automatically move to the next lawn.

The robot can alert the user when the blades need to be replaced.

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