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# Arduino Based Smart Solar Mower

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**ABSTRACT**

**This study recommends an Arduino-based smart solar grass cutter to increase user productivity and accessibility. This paper presents the Smart Solar Grass Cutter's algorithm, scope, aims, applications and benefits. Grass Cutter industry heavily relies on manually operated grass cutters. However, in addition to using a significant amount of energy and contributing to air pollution, manually operated grass cutters also produce a significant amount of noise and vibration. Arduino based smart solar grass cutter is an intelligent automated grass cutter with ultrasonic sensors for obstacle detection.**

***Keywords*--** Arduino-Based, Ultrasonic Sensor, Obstacle Detection

## I. INTRODUCTION

Amid a time when environmental consciousness and technology are combining, consumers are searching for methods to lessen their personal carbon footprints. Human activity is the source of pollution, which is evident in our daily lives and particularly in our houses [1]. Government and industry partners are supporting green technology initiatives. A modern design that addresses an antiquated practice will benefit the environment and consumer. A mower is a device, used in residential environments that has several parts, including motor, rotor, and blades. Its purpose is to cut grass to a predetermined height, which can be adjusted based upon the specifications of blades. The electric-powered lawn cutter, which is made up from revolving cutters, first appeared in 19th century. In 1830, Edwin Beard Budding created the first lawn type cutter. It was based upon local cloth mill's basic concept and was used for fabric trimming. The same concept for mowing the grass was implemented using a cast iron cutting wheel, which was fixed to a shaft. By 1832, Ransoms of Ipswich, the largest lawn mower manufacturer today, began producing Budding's lawn mower. Thomas Green created a brand-new type of chain-driven lawn mower known as a "silensmessor" due to its low noise level.

Workers who take care of lawns have begun using standard grass cutters on a large scale lately. But in addition to using a lot of energy and polluting the air, manually operated lawn cutters also produce a lot of noise and vibration, which is directly harmful to workers' health. A typical lawn cutter produces a lot of vibration and noise. This work presents an intelligent and automated solar lawn cutter to prevent those issues. Both solar energy and an electrical supply can power this device. Its three primary systems—the smart control system, the solar system, and the grass cutter—are intelligently regulated, due to which it has been named as "smart solar grass cutter." The primary power source for this mower is based upon solar energy.

An innovative approach for an antiquated practice benefits the environment and the consumer. The consumer won't have to worry about cutting their lawns as solar-powered autonomous grass cutter reduces noise and environmental pollution. This design is intended to serve as a green substitute for the widely used, but

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environmentally dangerous, fuel-powered grass cutter. Through this mower, the consumer requires working less in their daily lives and contribute more to the environment. The goal is to continue working till an appropriate design can be put into practice and, in the end, be found to be accurate.

Using solar energy to power an electric motor, which turns a blade to cut grass is its applications. It is clarified that the smart solar grass cutter is an automated device, designed for cutting grass. Through the use of a solar panel and a battery to store the voltage, the source is powered by solar energy. Two design elements of the automatic lawn cutting machine are the motor speed control and solar source. This work aims to create a solar-powered grass cutter that uses less energy and manpower. In this work, a microcontroller is used to regulate the grass cutter's numerous functions.

## II. SYSTEM ARCHITECTURE

The Smart Solar grass cutter comprises two hardware as well as software implementation. The hardware component includes solar panel, DC motor, blade, batteries, Arduino UNO Board and various other components. The software component includes programming based on Arduino.

It is an automated grass cutting machine powered by solar energy and it is capable to operate without any human interaction. This system uses 12-volt batteries supply for the vehicle motors as well as grass cutter motor. A solar panel is used for charging purpose of the battery, but in case of cloudy season, a charged battery can be used. The grass cutter motor and the vehicle motors are connected with 4 channel relay, which is interfaced to Arduino uno microcontroller, which controls all the movements of motor. As manual grass cutters require physical exertion from the operator, which can be tiring, especially for larger areas or thick grass. Additionally, some manual grass cutters may have limited or no height adjustment options, making it challenging to achieve the desired grass height. Manual grass cutters are typically less manoeuvrable than powered cutters, especially in tight spaces or areas with obstacles.

**Figure 1:** Schematic of manual grass cutter

## III. PROPOSED SYSTEM METHODOLOGY

### *A. Design of Smart Solar Grass Cutter*

The hardware implementation requires with the help of mild steel, the wheel is placed on the downside of the hardware. The solar panel is placed on the above side where solar energy is converted into electrical energy and stored in battery through the solar charge controller [2]. Cutting blade, which cuts the grass is connected on the shaft of the motor and the shaft of other dc motor is connected to the 4 wheels for the movement of the vehicle. Because of the continuous rising in the price of fuel and the effect of release of gases from the burnt fuel coming from the machine into the surrounding, it is required to make ample use of solar energy from the sun.

### *B. Methodology*

A 10-watt solar panel is used to charge the rechargeable battery. The solar panel provides a maximum voltage of 18 V and a current of 580 mA. Basically, it creates a charging circuit between the solar panel and the battery. The charging circuit has a voltage regulator that regulates the voltage to 15V, a transistor that amplifies the circuit's maximum current, and a diode. The entire circuit runs on a 12-volt battery. The 8051 microcontroller receives input from the ultrasonic sensor. When an interruption or obstacle occurs, the ultrasonic sensor detects the obstacle and provides feedback to the microcontroller. It then rotates left or right according to the microcontroller's program. It waits for a delay and senses again, and the same procedure repeats. If there is no detection within the ultrasonic range, it keeps going until a detection is found. The device is driven by two DC motors with a rotation of 100 rpm. The motors are driven by using motor driver (L293D). It is also known as H-Bridge. The main purpose of using a motor driver is that the DC motor requires a minimum voltage of 9V as input. However, since the microcontroller only provides an output voltage of 5V, it requires 9 to 12V to drive the motor. Therefore, a motor driver is used which requires 5V as input and provides 12V to the motor. The L293D motor driver drives only two motors that can move in either direction. Grass cutting blades are used to cut grass. In order to cut any type of grass, it requires a high-speed motor so a 1400 rpm motor for the cutting blade is used. The motor is powered directly by a rechargeable 12V battery. DPDT switches are used for individual device and cutting blade movements.

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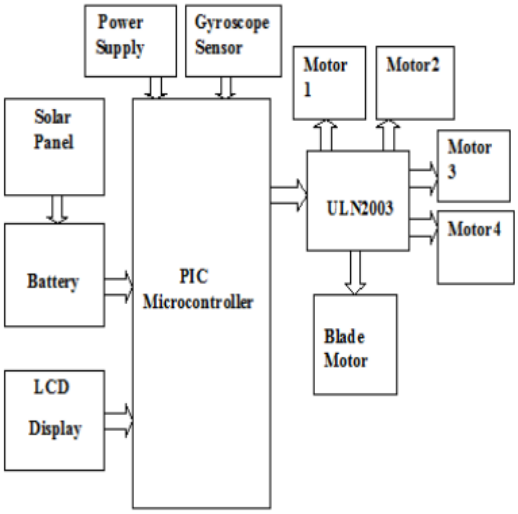


**Figure 2:** Block Diagram of Smart Solar Mower

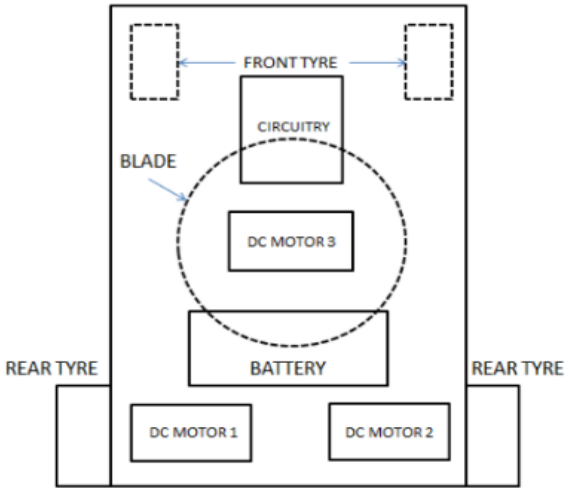


**Figure 3:** Experimental diagram of Mower

## IV. COMPONENTS

The circuit diagram of the proposed system is shown in Fig.4. Various components, which are used to implement this work are presented here.

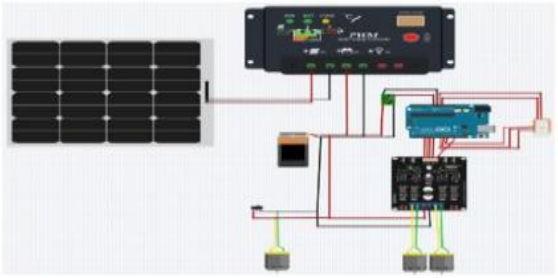

**Figure 4:** Circuit diagram of the prototype

***1) Solar Panel:*** A solar panel is a set of solar photovoltaic module electrically connected. The source used here is driven from solar energy using solar panel which receives energy and converts it into electric energy. Solar panel generates energy upto 12V. The solar panel is used to capture the solar radiation to convert into electric energy. For the designed system 12V solar panel is used. The photo voltaic effect can be observed in nature in a variety of materials, with semiconductors demonstrating the best performance. When photons from the sun are absorbed in a semiconductor, it creates free electrons with higher energies [6]. However, there must be an electric field to induce these higher energy electrons to flow out of the semi-conductor to do useful work. A solar cell consists of a layer of p-type silicon placed next to a layer of n-type silicon. When sunlight strikes a solar cell, electrons in the silicon are ejected, which results in the formation of "holes"—the vacancies left behind by the escaping electrons. If this happens in the electric field, the field will move electrons to the n-type layer and holes to the p-type layer. If the n-type and p-type layers are connected with a metallic wire, the electrons will travel from the n-type layer to the p-type layer by crossing the depletion zone. Following which the electrons go through the external wire back of the n-type layer, creating a flow of electricity.

**Figure 5:** Solar Panel

***2) Rechargeable Battery:*** To store the electric energy produced by the solar panel, the designed system consists of 12V, 7Ah rechargeable battery, which works around 6 hours. The rechargeable battery is a critical component of a solar-powered grass cutter, storing energy collected from solar panels to power the cutting mechanism. It features high-capacity lithium-ion cells for long-lasting performance and efficient energy storage. Rapid charging capability ensures quick replenishment of power, while

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intelligent charging management extends battery lifespan by preventing overcharging and overheating. An integrated battery status indicator allows users to monitor remaining power, ensuring uninterrupted grass cutting sessions. This device is provided with battery backup which is very useful in times of less solar power production. This battery is adequate for providing power to grass cutter and can serve as a savior in need.


**Figure 6:** Rechargeable battery

***3) Arduino Uno:*** The Arduino Uno is the main control unit of the system responsible for data acquisition, processing, and decision-making. It interfaces with sensors, collects data, and sends alerts to the user interface module. Arduino Uno is used due to its versatility, ease of programming, and compatibility with various sensors. The Arduino Uno is an open-source microcontroller board, based on the Microchip ATmega328P microcontroller (MCU) and developed by Arduino.cc and initially released in 2010 [4]. It provides the platform for interfacing components with each other. The board has sets of digital and analog input/output (I/O) pins that can be connected to various expansion cards (shields) and other circuits. The board has 14 digital I/O pins (six PWM outputs), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment) via USB Type-B cable. It can be powered by a USB cable or an external 9-volt battery, although it accepts voltages between 7 and 20 volts. It is also similar to Arduino Nano and Leonardo.


**Figure 7:** Arduino UNO ATmega328P

***4) DC relay:*** A relay is an electromechanical component, which acts as a switch. The relay coil is supplied with direct current, which opens or closes the contact switch. Single-channel 5V relay modules generally include a coil and two contacts, such as: Normally open (NO) and Normally closed (NC) [5]. 5V DC relay is a commonly used automatic switch in automatic control circuits, which controls large currents through small current signals. The input voltage of the relay signal can be between 0 and 5V. The function of the DC relay is to disconnect the circuit of the DC motor, when the ultrasonic sensor detects an obstacle on the track. After the sensor detects the obstacle, it uses the PNP transistor to send a signal to the DC relay, triggering the DC motor circuit to rotate the vehicle.

**Figure 8:** DC Relay

***5) Ultrasonic Sensor -*** Ultrasonic sensor is an electronic device which calculates the distance between the target and the sensor by emission of ultrasonic sound waves. It mainly consists of two components named as transmitter and receiver. Using the piezoelectric crystals, the transmitter generates sound waves and from there it travels to the target and gets back after striking the target, which is then received by the receiver component.

To know the distance between the target and the sensor, the sensor calculates the amount of time required for sound emission to travel from transmitter to receiver. The calculation is done as represented by equation [1]:

$$D = 1/2\ T * C \quad \ldots [1]$$

Where 'T' corresponds to time measured in seconds 'C' corresponds to sound speed = 343 measured in mts/sec [6]

So, for the obstacle detection by using ultrasonic sensor, the distance between the device and the sensor remains constant, which includes time period of ultrasonic wave returning back to the receiver. However, when there is any obstacle on the way, the returning time of ultrasonic wave exceeds the given limit, which indicates the increased distance between obstacle and sensor. This

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indication of the increased distance represents an obstacle on the way. An essential part of the ultrasonic sensor is the update rate or sampling frequency of an ultrasonic sensor. It determines how often it takes distance measurements. Higher update rates allow for faster response times and more accurate tracking of moving objects.

**Figure 9:** Ultrasonic sensor

***6) DC Gear Motor*** - A DC motor is an electrical machine which uses electricity and produces mechanical power. Normally, the output of the motor is the rotary motion of the shaft. The mechanism of a DC motor is like a wire-twisted rod placed between two north and south pole magnets. The stretched wire is energized, resulting in a rotary motion which results in rotary output. DC motor has been used to move the vehicle in forward direction for the cutting of grass. For supplying the power to motor, it uses a separate battery of 9 volts other than the battery, which is being used for supplying power to the other components.

**Figure 10:** DC Gear Motor

## V. RESULTS

The aim of this work is to use renewable energy sources such as solar energy to operate a grass cutter equipped with various accessories to cut and collect grass from lawns. The battery-powered DC motor maintains a charge through the solar panel and is equipped with a spiral mowing blade. The entire structure is supported by a frame made of metal rollers. Solar panels are attached to the structure and charge by transferring charge through a circuit to the battery, when the system is not operating. Solar grass cutters can be used in both durations i.e. day as well as night. The device's battery backup lasts 2 hours. Here the design has a solar panel, DC motors, battery, and microcontroller. The components are incorporated into a microcontroller. The ultrasonic sensor transmits the signal to detect the objects. If any echo signal is received that information goes to the microcontroller that controls the movement of the DC motors. In the case of no object detected by the sensors, the grass cutter moves until it finds the object in front. When it finds an obstacle, the object changes the path based on the preferences. The cutter motor is connected to the battery and the microcontroller and it works uninterruptedly to cut the grass consistently. Meanwhile, the battery gets charged using the solar panel.

Fig.11. shows the model of the hardware implementation of Arduino based Smart Solar Mower. All these hardware have been interfaced with each other through the Arduino and working as per the requirement.

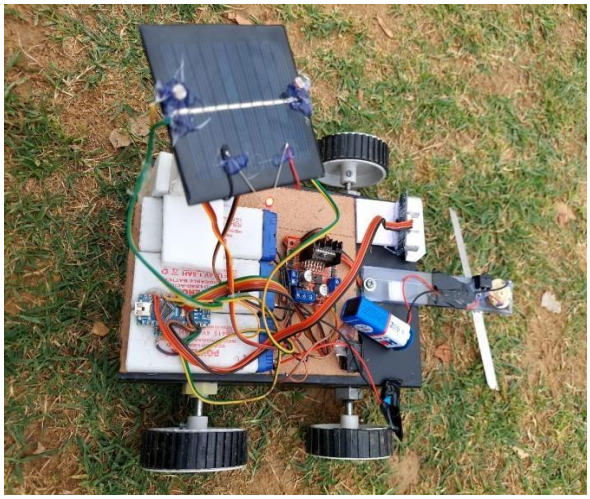

**Figure 11:** Working Model

## VI. CONCLUSION

This work is more suitable for the common person as it provides more benefits. This provides humans with more physical activity and is easier to manage. The system is capable of charging the battery while the solar lawn mower is running. Night operation is also possible as these batteries can be charged during the day. The equipment features a combination of technologies that help reduce manpower and maximize work efficiency. The device is proven to replace gasoline-powered lawn grass cutters. To enhance the beauty of home lawn and garden, a smart solar lawn grass cutter is the best option. Humans

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can easily maintain their gardens. Today, there are a variety of options, from the simplest push lawn mowers to the most advanced solar powered grass cutters.

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