A Project Stage-II Report

on

SMART SOLAR GRASS CUTTER WITH LAWN COVERAGE

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(An Autonomous Institute, Affiliated to SPPU, Pune)

CERTIFICATE

This is to certify that **Mr.Mayur D Patil, Mr.Yash P Sonawane, Mr.Pranit S Kukade, Mr.Mayur S Patil**, has successfully completed the Project Phase-I report entitled **"Smart Solar Grass Cutter With Lawn Coverage",** under the supervision of **"Dr.Dipak S Patil"** in the partial fulfillment of Bachelor of Technology in Mechanical Engineering Department under Savitribai Phule Pune University(SPPU).

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Place:

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Abstract

In today's world, Automation is a very important part of invention. Presently, manually handled devices are commonly used for cutting the grass over the lawn. Because of this, there is pollution and loss of energy. The old grass cutters need to be replaced by automated one where system will work for guidance and obstacle detection using battery as a power source. A solar panel will be attached on the top of the robot this will reduce the problem of more power consumption.

These days we are facing the problems like pollutions, power cut problem etc. In order to overcome these problems, we have thought about the device, which can be performing its functions without causing any of these problems. So we have thought of doing the project on cutting grass, this uses the renewable source of energy for its operation like solar energy. This project aims at developing a portable solar operated grass cutting device, as there is power shortage. So we have decided to make a solar energy operated device. Solar panel is connected to the battery. Then by connecting inverter to battery DC current is converted to AC current. This motor is connected to blade shaft by the help of belt drive. This will rotate the blade in high speed, cut the grass. This device will help in building of eco- friendly system. Current technology commonly used for cutting the grass is by the manually handled device. In this project we used novel technology. So in this project we are trying to make a daily purpose cutter which is able to cut the grasses in Lawn. The system will have some automation work for guidance and other obstacle detection and the power source that is battery and a solar panel will be attached on the top of the cutter because of this reduces the power problem. This report describes the different features and technologies present in Automated Solar Grass Cutter and different technologies able to cut the grass in lawn using ultra sensors for obstacle detection.

Keywords:

Solar panel, DC motor, Battery, Control unit, Cutter.

Acknowledgement

We take opportunity to express us deep sense of gratitude and respect to our guide **Dr. D S Patil** . It was great pleasure for us to have worked under his valuable and endless guidance, technical assistance and constant encouragement, which inspired us. We thank him for the confidence he showed and developed in us. Also, we would like to thanks to our other teaching department and our respected HOD **Dr. Adik Yadao** for encouraging us and providing us this golden opportunity. Lastly, we would like to thanks all the people who had helped us in this research directly and indirectly.

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Index

Chapter 1

1.1 Introduction

Intelligent robots are vision, all intelligent robots work precisely, using multiple degree of coordinate motion and does something like a human, they mimic expected human response, they learn from humans making mistakes. Over the years there have been numerous developments in grass cutter technology. Nowadays pollution is a major concern in all parts of the environment. In order to make our environment attractive we are polluting it by gas powered and fuel based lawn mowers. By using the programmed grass cutter user can cut the grass of required area by giving input. The main objective of this grass cutter is that grass in lawn must be trimmed with less effort. The sensors are the eyes of this grass cutter. The other objective is that the automatic grass cutter has to distinguish between grass and concrete while monitoring its surroundings continuously. We will use an ultrasonic sensor to detect if the grass cutter was heading towards an object. And also automatically changes its direction if any obstacle or particle is in the moving path. The information about the surrounding will be given by the ultrasonic sensor to cutter. We will also use accelerometer sensor in order to stop the cutter motor when the cutter will be tilted at a particular angle. In order to make the robot to operate manually the Bluetooth module is used. A solar panel is a set of solar photovoltaic modules electrically connected and mounted on a supporting structure. A photovoltaic element is a packaged, connected assembly of solar cells. The solar panel can be used as a component of a larger photovoltaic system to generate and supply electricity in commercial and residential applications. Sun is not available for twenty hours, so it is necessary to store some energy. A fabrication or the body part material will use in this project is also of less weight as a result the weight of the cutter is being reduced as compared to the other available cutter in market. The material will use is a steel sheet which is light in weight and also very cost efficient as compared other sheet metals The main object of this solar power grass cutter is using renewable energy source instead of fuel based energy sources. Using the solar based energy sources is easier to use, and more advantageous as comparing

other energy sources. To make life easier and decreasing the need of man power. Reduce the pollution in the environment. By considering eight to ten papers related to the solar grass cutter project we will make various changes in order to reduce the overall defect which was occurred by the project developed by the other members. Also the main motive of our project is to work on only renewable energy resources and also to make the solar grass cutter very cost effective. While designing the hardware model many consideration have been done in this project such as to make the cutter as possible as light in weight so it may be easy to handle for this reason instead of using a metallic sheet as a base material a steel sheet of a better quality is used as base material as a result the fifty percent of total weight is reduced there. Also while using the wheel regular plastic or fiber wheel are used so it may be easy to move from one place to another and also the weight would become lower. This selection of all the components and all the materials is done on the basis of the old project so the new prototype which we are going to design would be of approximately less errors. For our understanding less us consider one example of selection of battery. While considering the battery there were many options but we went with the lithium ion Battery which was quite costly as compared with other batteries but the operational features where excellent. The efficiency and the life span of the battery are very great as compared to other batteries.

1.2 Background Study

A lawn mower is a machine that uses one or more revolving blades to cut a lawn to an even height. The blades may be powered either by hand; pushing the mower forward to operate the mechanical blade(s), or may have an electric motor or an internal combustion engine to spin their blades. There are several types of mowers, each suited to a particular scale and purpose. The smallest types are pushed by a human user and are suitable for small residential lawns and gardens. Riding mowers are larger than push mowers and are suitable for large lawns. The largest multi-gang mowers are mounted to tractors and are designed for large expanses of grass such as golf courses and municipal parks. But with advancement in technology and things being converted to mobile and automatic these days, transition from traditional hand-guided or ride-on mowers to automatic electric mowers is beginning to take place. In 2012, the growth of robotic lawn mower sales was 15 times that of the traditional

styles. It is predicted that if this growth continues at this rate, automatic lawn mowers may even surpass the sales of traditional lawn mowers in some places.

Automatic lawn mower is a machine that cut grass automatically. It can be stated as a machine or robot that helps people to do cutting grass work. The automatic lawn mower will do the cutting grass task with a preset setting by the user. Unlike other robotic lawn mowers on the market, this design requires no perimeter wires to maintain the robot within the lawn. Through an array of sensors, this robot will not only stay on the lawn, it will avoid and detect objects and humans.

The concept of lawn mower started during the 19th century whereby the design of grass cutter pulls by an animal such as cow or buffalo. This animal will pull the grass cutter and the grass cutter will does its work cutting the grass along the way the animal walk. Due to animal cannot work for a very long period, human start to reduce the usage of animal and building a machine. So various types of lawn mower have been built over the course of time. Mostly theses have been manually operated but corresponding to the advancing of technology, latest lawn mowers work automatically. Sensor such as rain sensor, light sensor, ultrasonic sensor and infrared sensor has widely been used nowadays to enable the lawn mower to be more intelligent and work efficiently.

1.3 Problem Statement

In the world today where technology is merging with environmental awareness, most people are looking for ways to contribute to the relief of their own carbon foot prints .Pollution is manmade, which can be seen in the day to day activities of man. In this part of the world, the most common types of lawn mowers are powered by gasoline engines which are hazardous to the environment thereby leading to global warming and depletion of the ozone layer.

Gasoline powered mowers create noise due to the loud engine noise, and air pollution due to the combustion in the engine. Thus, gasoline powered lawn mower contributes to both air and noise pollution. Hence, alternatives to the use of non-renewable energy and polluting fossil fuels needs to be taken into consideration.

1.4 Justification

The smart solar grass cutter with lawn coverage is set to eliminate both noise and

environmental pollution to the barest minimum. The design can be seen as an alternate option to popular and environmentally hazardous gas powered lawn mower Solar lawn cutter is advantageous over gasoline powered cutter because its eliminates environmental pollution which is responsible for the emission of gases that results to global warming on the earth surface. Also, with the rate at which petroleum products are increasing day by day, the use of solar energy can be seen as a reasonable practice to the use of renewable energy sources to operate lawn cutter by eliminating the use gasoline fuels which gasoline engines solely depends on.

1.5 Objectives

The objective of this project is to design and fabricate a smart solar grass cutter with lawn coverage which would be powered by solar energy in addition to the common gasoline engine.

The specific objectives are as follows:

1. To study the design parameter of a smart solar grass cutter with lawn coverage
2. Fabrication of the smart solar grass cutter with lawn coverage
3. Testing of the smart solar grass cutter with lawn coverage.
4. To analyze the smart solar grass cutter with lawn coverage and compare its performance with gasoline operated mowers.

Chapter 2

Literature Review

2.1 Literature Summary

1. Design and Implementation of Autonomous Lawn Mower Robot Controller

This paper basically focuses on designing an automated lawn mower controller which can use to mower the grass at lawns and playgroundsome sensor such as sonar sensor which use to detect obstacles, encoder to calculate the distance the lawn mower travel together with the GPS system.

2. Modified Lawn Mower Search Pattern for Areas Comprised of Weighted Regions

This paper discuses on the way the lawn mower move while it work. It used weightage spot or region to determine the correct way of path. With this technique, the lawn mower can find the most important place to cut the grass depending on the amount of weight comprised in order to cover the maximum area and also to minimize the time usage. The region with the most weight will be allocated first followed by the second weight and so on. This is some sort of guided path system whereby it move according to the weight given. With this technique, is able to achieve a good result on area coverage.

3. Design and Modeling a Prototype of a Robotic Lawn Mower

This paper discuss on how to develop a robotic lawn mower with several functions. It objective is to build a lawn mower that do not go out of workspace, do not leave any uncut area, able to avoid collision and the most important that is the robot must be cheap and affordable to everyone. Basically it used PIC microcontroller to perform the lawn mower working process or to run the lawn mower.

4. Survey of Robotic Lawn Mowers

This paper discusses different types of Robotic Lawn Mowers present in the market at present. It discusses different companies and their products and compares them with others.

5. A Fully Automated Lawn Cutter using Solar Panel

The solar lawn cutter is a fully automated grass cutter powered by solar energy that also avoids obstacles and is capable of fully automated grass cutting without the need of any human intervention.

6. A Review of Fully Automated Grass Cutter Using Solar Power

The fully automated solar grass cutter is a completely automatic grass cutting robotic automobile powered by solar electricity that still avoids barriers by using ultrasonic sensor and it is successful for automatic grass cutting without the want of any human interaction.

7. Fabrication of Solar Grass Cutter

The project aims to fabricate a grass cutting machine system which runs with the help of

motor by using the solar energy.

Chapter 3

Methodology

3.1 Methodology

To design a Smart Solar Grass Cutter, some parameters need to be considered such as the components to be used in the project, the position of the components, the structure of the main body, the advantages and disadvantages of the design and the safety factors. The Smart Solar Grass Cutter is able to operate autonomously or non-autonomously. Other than that, the important factor is the efficiency. The materials and components selections including the positions are crucial to achieve a better efficiency. This Smart Solar Grass Cutter is a simple design which is optimizing the usage of materials. The overall dimensions are depending on the size or the dimensions of the solar panel. Three motors are used for rear tires and the blade. The height of the roof is depending on the height of the battery. The rubber rotating wheel is used as the front tires as it will automatically change the direction depending on the rear tires. One motor is implemented for each rear tire. The design is cost effective and compatible to the main objectives. Starting from the hand sketch, the prototypeis designed in multidimensional using ANSYS software. Dimensions of the design are very important and need to be accurate and precise to enhance the safety factor.

Arduino microcontroller known as the brain of the prototype and PV panels are the main power supply. The PV panel supplied the absorbed energy to the battery through the solar charge controller. The solar charge controller protected the battery from overcharge as well as to maintain the battery performance. During autonomous mode, the ultrasonic sensor was detecting the obstacle. The sensor transfers the information to the microcontroller regarding the detected obstacle then the microcontroller will act, and the grass cutter will change the direction. If non-autonomous mode is used, Bluetooth module will be used to connect the Smart Solar Grass Cutter with the smartphone. The grass cutter will be controlled by using the smartphone and the direction is depending on the requirement. The microcontroller will be programmed to ensure both motors at the rear wheels will be having the same speed when it is required. If the grass cutter is needed to move to the right direction, the left motor will be having a higher speed compared to the right motor and vice versa. From the hand

sketching and digital design of Smart Solar Grass Cutter was created. The Arduino Board, Bluetooth module and other electrical components are included in circuitry. Two DC motors were used for rear wheels and the third motor was used for the blades.The front wheels are made of rotating rubber tires located below the main body. The selection of the used materials and components are very important to produce a reliable and effective design of smart solar grass cutter.

3.2 System Block Diagram

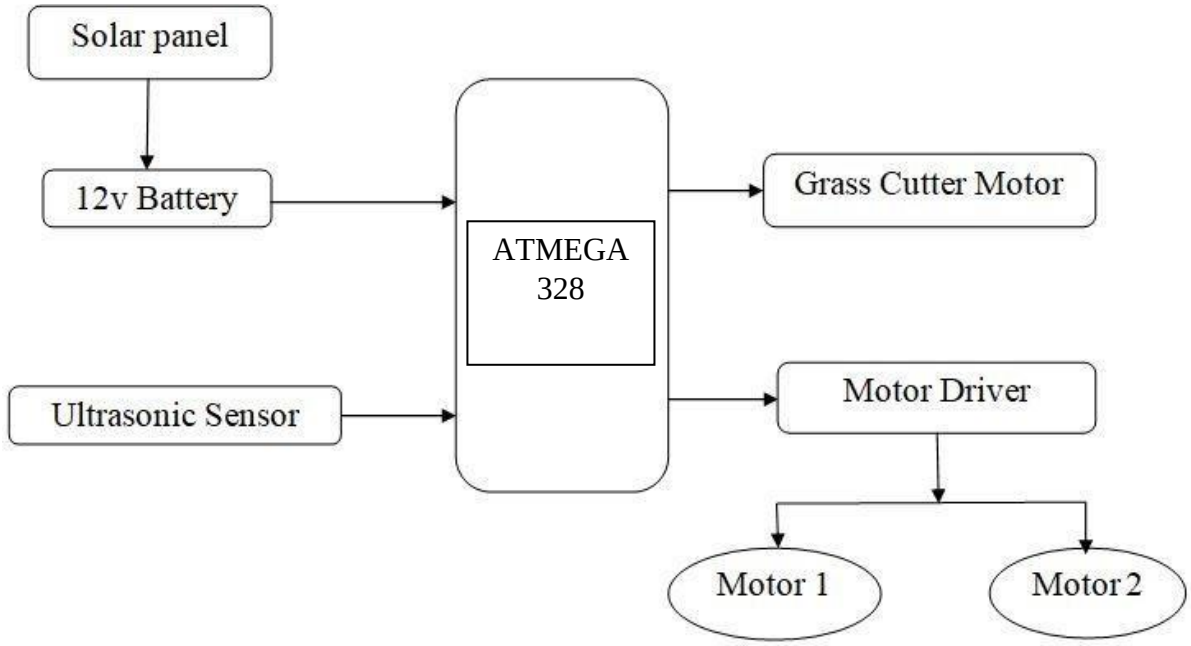

Fig.01 Block Diagram of System

In this proposed system we have used the atmega328 AVR microcontroller, four DC motor and driver circuits. In this project the system is been totally operated by solar energy. The main aim of solar based grass cutter is to cut the grass in which farmer take too much hard working so we can reduce all that. In above block diagram there is one ultrasonic sensor which we have used for obstacle sensing when obstacle is detected the robot is stop and vice versa. Microcontroller continuously check the output of ultrasonic sensor and gives signal to the motor driver circuit which drives the motors.

Chapter 4

COMPONENTS

4.1 AVR (ATMEGA 328)

1) The high-performance Atmel 8-bit AVR RISC-based microcontroller combines 32KB ISP flash memory with read-while-write capabilities, IKB EEPROM, 2KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts , serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, 6-channel 10-bit A/D converter (8-channels in TQFP and QFN/MLF packages), programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.8-5.5 volts.

2) By executing powerful instructions in a single clock cycle, the device achieves throughputs approaching I MIPS per MHz, balancing power consumption and processing spe

ed.

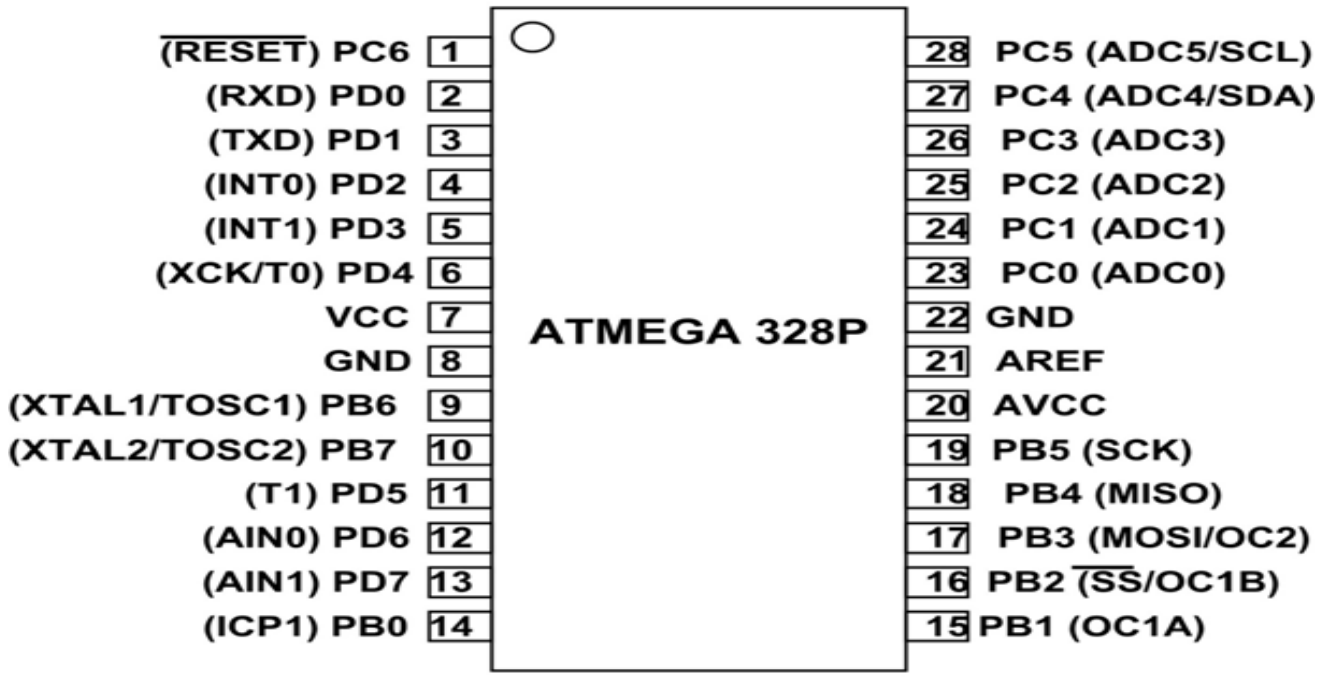

Fig.02 Pin Diagram of ATMEGA 328

Parameter	Value
CPU type	8-bit AVR
Performance	20 MIPS at 20 MHz
Flash memory	32 kB
SRAM	2 kB
EEPROM	1 kB
Pin count	28-pin PDIP, MLF, 32-pin TQFP, MLF
Maximum operating frequency	20 MHz
Number of touch channels	16
Hardware QTouch Acquisition	No
Maximum I/O pins	26
External interrupts	2
USB Interface	No
USB Speed	No

Table 01. Key Parameters of ATMEGA 328

4.2 BC547-Diode

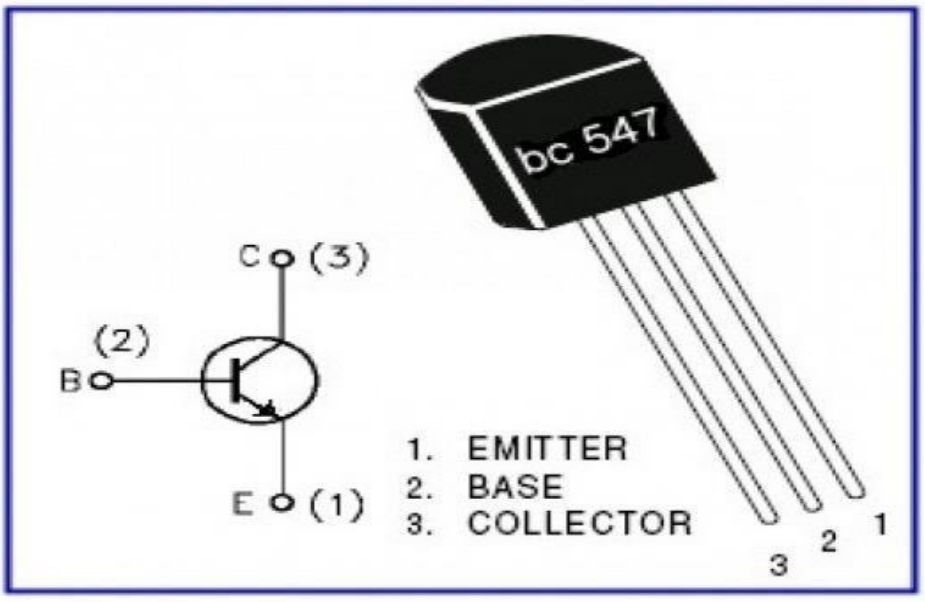

Fig.03 Diagram of BC547 Pin Out

1. The BC547 transistor is an NPN Epitaxial Silicon Transistor.
2. The BC547 transistor is a general-purpose transistor in small plastic packages.

3. It is used in general-purpose switching and amplification BC847/BC547 series 45 V, 100 mA NPN general-purpose transistors.
4. Whenever base is high, then current starts flowing through base and emitter and after that only current will pass from collector to emitter

4.3 LED

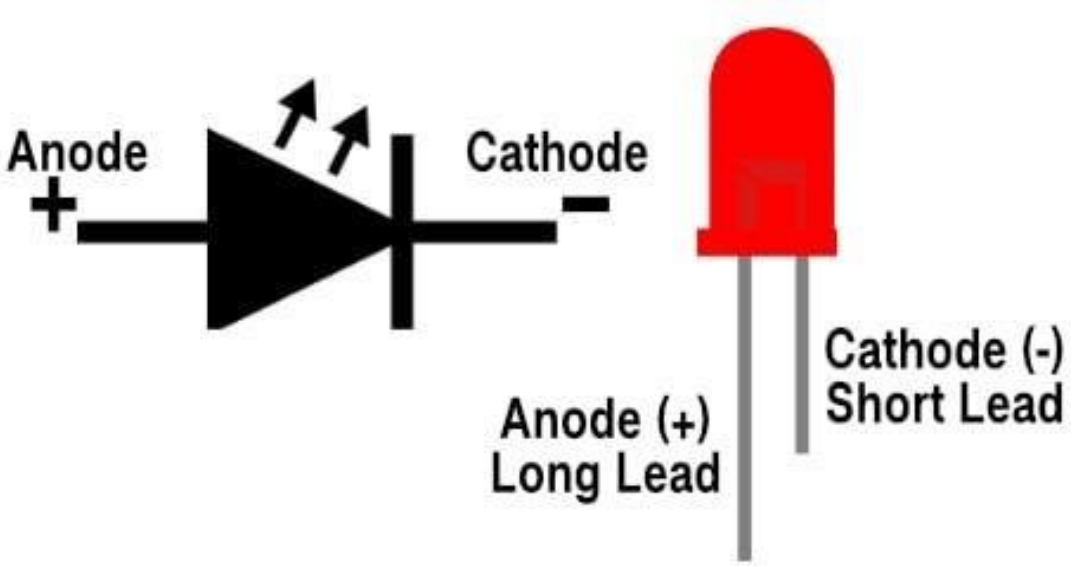

Fig.04 Diagram of LED

LEDs are semiconductor devices are made out of silicon. When current passes through the LED, it emits photons as a byproduct. Normal light bulbs produce light by heating a metal filament until its white hot. LEDs present many advantages over traditional light sources including lower energy consumption, longer lifetime, improved robustness, smaller size and faster switching

4.4 Solar panel:

A Solar panel was designed to absorb the solar rays, which provides energy source for generating electricity. The working principle of the solar panel is, when the photovoltaic cells absorb solar radiation, photovoltaic effect leads to the production of the electromotive force at the ends of the cells, which then generates electricity. This electricity produced is called direct current (DC). The panel having the size of 18 cell no. was selected to meet the

design requirements. The solar panel has been placed above the chassis with an inclination of 450, so that panel will extract maximum energy from solar rays.

Fig.05 Solar Panel

Type of solar panel	Poly crystalline
Operating voltage	12V
Operating current	0.6A
No. of panel cells	18

Table 02. Specifications Of Solar Panel

4.5 Motor driver:

L298N dual H- bridge motor driver was used, which control's the speed and direction of vehicle. The module can drive the DC motor whose voltage in between 5V to 35V, with a peak current up to 2A. Motor driver connects the Dc motor (wheels), to the micro controller. It controls the wheel motion as per the program fed to the microcontroller.

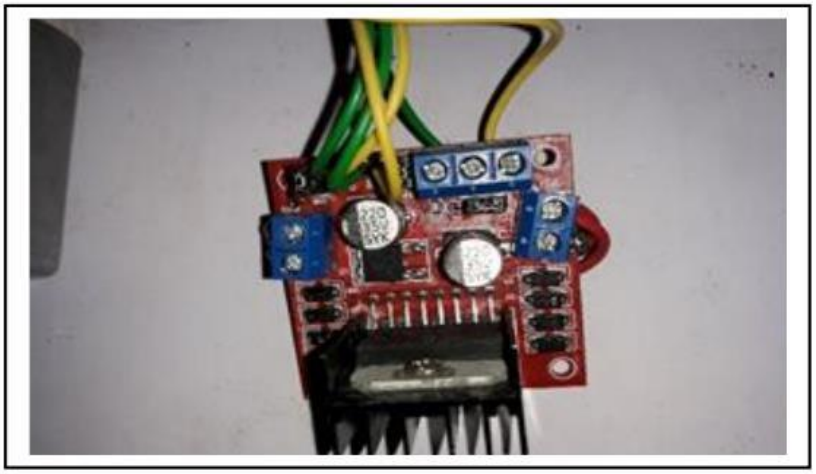

Fig.06 L298N motor driver

4.6 DC Gear Motor (Wheels):

It is generally a DC motor with a gearbox attached to it, which were used for the wheel rotation. DC motor used with 30 rpm, which helps the wheel to rotate slowly, so that it covers the area of the grass to be cut. Four DC gear motors were used for four wheels. The DC motors shaft of 5mm with 3mm drilled hole, then shaft was inserted into the holes made in a chassis and fixed with the help of threads. Shaft were designed to withstand the weight of the chassis.

Fig.07 Specification of DC Gear motor for wheels

RPM	30
Operating voltage	12V DC
Gear box used	Attached plastic(spur)gear box
Shaft diameter	6MM
Torque	2 Kg-cm
No-load current	60mA (max)
Load current	300mA (max)

Table 03. Specifications Of DC Gear Motor

4.7 Solar Charge Controllers:

Solar Charge Controller is an electronic device that manages the power going into the battery bank from the solar array. It ensures that the deep cycle batteries are not overcharged during the day and that the power doesn't run back to the solar panels overnight and drain the batteries. Some charge controllers are available with additional capabilities, like lighting and load control, but managing the power is its primary job. A PWM solar charge controller stands for "Pulse Width Modulation". These operate by making a connection directly from the solar array to the battery bank. A 12V solar panel can charge a 12V battery.

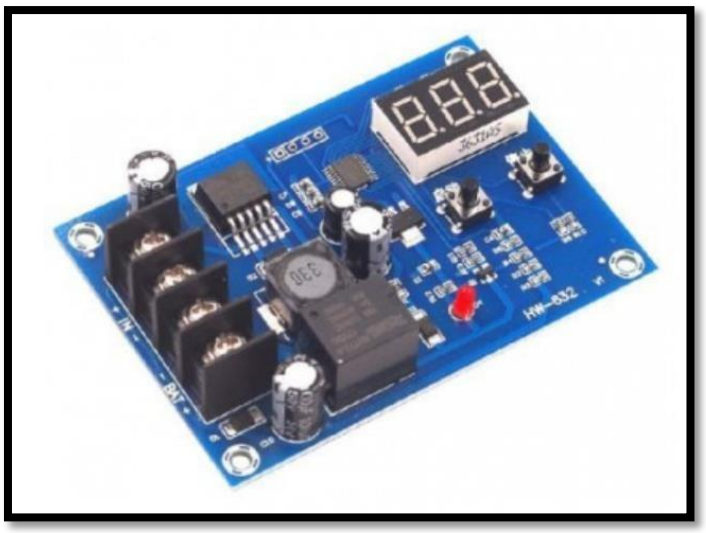

Fig.08 Solar Charge Controllers

4.8 DC Motor (Blade):

DC motor was connected to the blade and placed in front of the vehicle. For the grass to be cut efficiently blade has to rotate at very high speed for this purpose DC motor of 500 rpm was selected. DC motor takes the power from the battery. The control of the DC motor has been provided by separate switch.

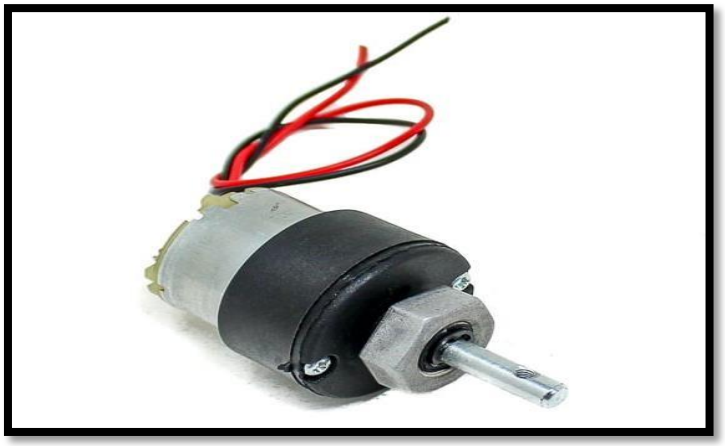

Fig.09 DC Motor

4.9 Battery:

Battery 12v, 8000mAh A lithium-ion battery or Li-ion battery (abbreviated as LIB) is a type of rechargeable battery. Lithium ion batteries are commonly used for portable electronics and electric vehicles and are growing in popularity for military and aerospace application. A 12v, 8000mAh battery is used serve the need of this project.

Fig,10 Battery

Specifications:

- Built-in ON/OFF switch to save power usage
- Super storage capacity
- Over-charge/discharge protection
- With working indicator * Suitable for all 12V DC devices
- Size: (L)12cm x(W)6.2 cm x(H)1.9cm * DC input: 12.6V
- DC output: DC12.6V~10.8v
- Capacity: 8000mah

4.10 Ultra Sonic Sensor:

HC-SR04 Ultrasonic range sensors were used, the principle behind this sensor is that, it uses sonar to determine the distance to an object and it offers the excellent non-contact range detection with high accuracy and stable readings. The sensor was connected to the micro controller. Operating Voltage 5V Input Voltage 7-12V Flash memory 32 KB Frequency 16MHz DC current on I/O pins 40mA DC current on 3.3v pin 50mA Ultrasonic sensor was selected, because of its suitability for outdoor application, since intensity of the sunlight does not affect the sensor, it sends the sound waves unlike the light waves in case of Infrared (IR) sensor.

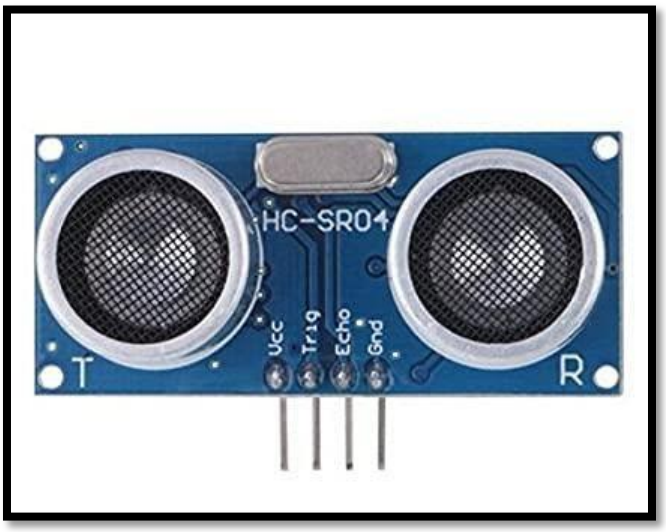

Fig.11 Ultra Sonic Sensor

4.11 Cutting Blade:

A blade is that portion of a tool, weapon, or machine with an edge that is designed to cut and/or puncture, stab, slash, chop, slice, thrust, or scrape surfaces or materials. The blade is seldom sharp enough to give a neat cutting. The blade simply tears the grass resulting in brown tips. However, the horizontal blades are easy to remove and sharpen or replace. Existing engine trimmers suffer from high initial cost, high levels of engine noise, high fuel consumption rates and high operator's fatigue in long-run. Mower blades are the cutting components of lawn mowers. They are usually made of sturdy metals as they must be able to withstand high-speed contact with a variety of objects in addition to grass. The materials used (as well as size, thickness, and design of the blades) vary by manufacturer. A blade may be made from a flaking stone, such as flint, metal (usually steel), ceramic, or other material. Here we used two blades i.e. fixed blade and sliding blade.

Fig.12 Cutting Blade

4.12 Frame:

The frame of the Lawn mower will be made of grey cast iron and will be welded at the joints. Grey cast iron is the alloy of iron and composes of 2-4% carbon with the presence of silicon and manganese. Grey cast iron used in the frame is of grade ASTM A48 CLASS 20. It is more effective because it can be easily machined and manufactured and it is easily available. MIG welding will be preferred for joining all the joints of the Lawn Mower.

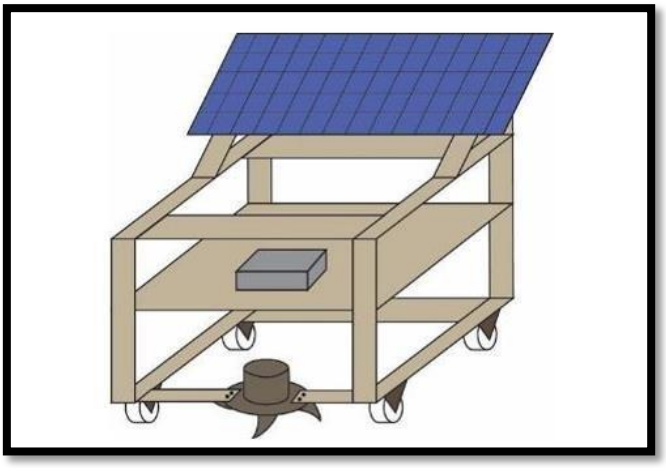

Fig.13 Frame

4.13 HC-06 Bluetooth module:

HC-06 is a Bluetooth module designed for establishing short range wireless data communication (<100 meters). It is very easy to interface and communicate. It can be interfaced with almost all microcontrollers or processors as it uses UART interface.

This module has the ability to transmit files at speed up to 2.1Mbps and works on Bluetooth 2.0 communication protocol. Unlike the HC-05 Bluetooth module, this module can only act as a slave device.

Operating Voltage: 3.3V - 6V

Operating Frequency range: 2.402 GHz - 2.480 GHz

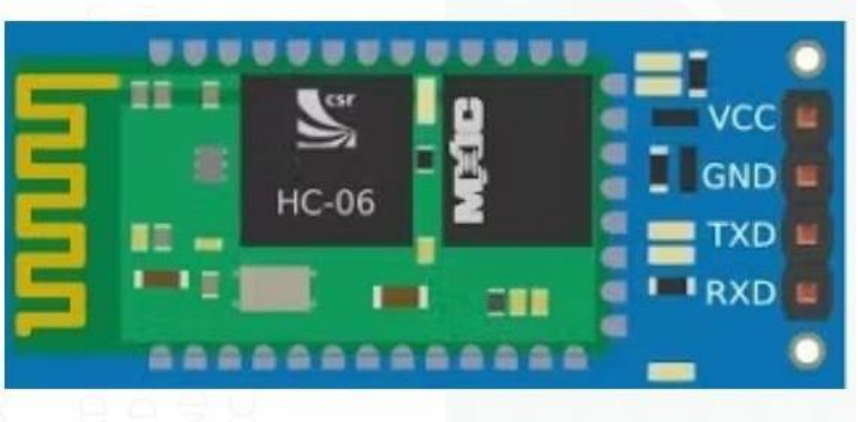

Fig.14 HC-06 Bluetooth Module

Pinout:

RXD: Serial Data Receive Pin. Used for serial input. 3.3V logic

TXD: Serial Data Transmit Pin. Used for serial output. 3.3V logic

GND: Ground

VCC: +5V

Chapter 5

5.1 Designing

To design a Smart Solar Grass Cutter, some parameters need to be considered such as the components to be used in the project, the position of the components, the structure of the main body, the advantages and disadvantages of the design and the safety factors. The Smart Solar Grass Cutter is able to operate autonomously or non-autonomously. Other than that, the important factor is the efficiency. The materials and components selections including the positions are crucial to achieve a better efficiency. This Smart Solar Grass Cutter is a simple design which is optimizing the usage of materials. The overall dimensions are depending on the size or the dimensions of the solar panel. Three motors are used for rear tires and the blade. The height of the roof is depending on the height of the battery. The rubber rotating wheel is used as the front tires as it will automatically change the direction depending on the rear tires. One motor is implemented for each rear tire. The design is cost effective and compatible to the main objectives. Starting from the hand sketch, the prototypeis designed in multidimensional using SolidWorks software. Dimensions of the design are very important and need to be accurate and precise to enhance the safety factor.

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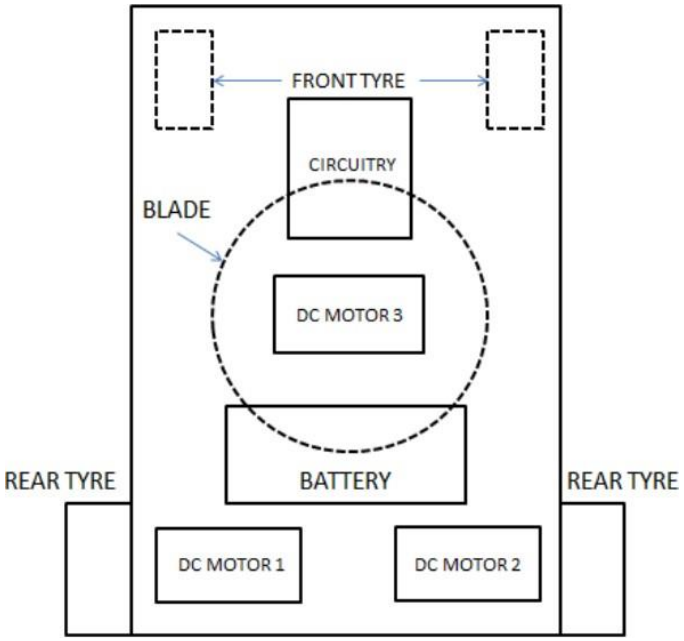

Fig.15 Design of System

Design Calculation In the numerical simulation, a model was implanted with unlimited variations to produce complex scenarios. These capabilities allow the analysis and understanding the interaction of each element in the system. Firstly, the design of the model must be developed. The model represents the system itself, whereas the simulation represents the operation of the system over time. To conduct a simulation and fabrication, a design calculation is introduced and applied. The dimension of the blade is important as the calculation of weight required the volume .The volume can be obtained from the multiplication of the length, width and the thickness of the blade.

$$W = mg \qquad \text{.....(1)}$$

The weight calculation of the blade is important to calculate the blade power. The blade power can be obtained by multiplication of the torque and angular velocity. The weight of the blade is used to calculate the torque. The calculation of the blade power is important to

check the power consumption and the motor selection. The power of the motor was selected to be higher than the blade power to ensure that the motor is able to rotate the used blades.

$$P = T\omega = Fdx\frac{2\pi \times N}{60} \quad \text{....(2)}$$

the calculated weight and power of the blade are 0.7N and 9.33W respectively. These values are used to calculate the total power consumption. is used to calculate the value of the power consumption by both rear motors and the supplied power by the solar panel as well as the rechargeable battery.

$$P = IV \quad \text{.....(3)}$$

A single motor of the rear wheel is having 12V of rated voltage and 1.2A of rated current. the power consumption of one motor is 14.4W. Therefore, the total power consumption is 28.8W for both rear wheels. However, the designed model is not using motors and blade. Therefore, an estimation of power consumption for one motor is 10W. As a result, the total power consumption of the whole system is 55.8W. Theoretically, the total possible operation duration is calculated based on the values obtained A battery is taking up to 8.43 hours to be fully recharged. In this model, the battery used is 12V and 7Ah, thus the battery is able to supply 84Wh to the proposed prototype.

$$\eta = \frac{P_{out}}{P_{in}} \quad \text{.....(4)}$$

However, the most important part of any design and development of a project is the system efficiency. The efficiency is required to prove the reliability of the systems. To sum up, it is important to show the improvement of new prototype compared to the previous studies. In the efficiency calculation, it is necessary to calculate the used power and supplied power by the system.

Chapter 6

Expected Result

6.1 There are many desirable properties in this device some of which are listed as –

- **Should be capable of cutting the grass properly:** The device should be able to cut the grass properly as it the primary requirement of the machine. The grass should be cut uniformly and cuts should be clean.
- **Should operate automatically:** As the name suggests, the device should be able to operate automatically. It shall use the sensors and microcontroller to formulate its path and its required work.
- **Should be lightweight:** It should be light in weight due to energy consumption issues. Lighter is the device, lesser will be the energy required to run it and hence more will be its efficiency.
- **Should work effectively in sensing the obstacles:** As the device is required to run without a human operator, it must be capable of sensing and avoiding the obstacles in its path.

6.2 Advantages

- It reduces human effort.
- It has simpler design than most commercial mowers.
- This type of mower is cheaper than commercial mowers.
- It has wider range more than conventional mechanical mowers due to absence of main supply wire.
- It aids elderly users or those with disabilities who are unable to fulfill this task themselves.

Conclusion

A workable smart solar grass cutter prototype is focusing on the renewable energy as the primary sources of energy has been successfully fabricated with high working efficiency. Therefore, it can be concluded that the developed design of the proposed Smart Solar Grass Cutter has achieved the main objectives and it can be further developed by industry. Smart Solar Grass Cutter is able to reduce the air pollution and also it is a user-friendly device. The grass cutter is suitable to be used for small application due to the shortest operating time, but it is not suitable for tall height grasses. For future work, there are few recommendations can be made to develop a better device. Instead of using polycrystalline solar panel, it is better to used mono- crystalline solar panel due to the high efficiency. The motor for the blade should have both high speed and torque. Higher capacity of rechargeable battery can lead to more operating time. Lastly, few types of blade to be considered to cut different types of grasses.

References

1. A Fully Automated Lawn Cutter using Solar Panel(Ramya. P , Yogesh Sharma , Kondeti Veerendra) International Journal of Engineering Science and Computing .
2. A Review of Fully Automated Grass Cutter Using Solar Power(Shubham R. Khillare , Deepak P. More, Bhagyashri A. Ghoti , Shaileja S. Thorat) International Journal of Research in Engineering, Science and Management.
3. Fabrication of Solar Grass Cutter (Pankaj Malviya, Nukul Patil, Raja Prajapat, Vaibhav Mandloi, Dr. Pradeep Kumar Patil.) International Journal of Scientific Research in Science, Engineering and Technology IJSRSET.
4. Automatic Solar Grass Cutter (Mallikarjun Mudda, VishwaTeja , Srujan Kumar , Praveen Kumar.) International Journal for Research in Applied Science & Engineering Technology (IJRASET).
5. M. Wasif (2011). Design and Implementation of Autonomous Lawn-Mower Robot Controller. 2011 7th International Conference. 5-6 September. Emerging Technologies (ICET), 1-5.
6. J. S. Campbell, and J. Morton. (2005). Design and Implementation of a Control Algorithm for an Autonomous Lawn Mower. Circuits and Systems. 7–10 August. Midwest Symposium, 456-459.
7. Ousingsawat, J. and M.G. Earl. Modified Lawn-Mower Search Pattern for Areas Comprised of Weighted Regions. American Control Conference. 9-13 July. 918- 923.
8. Mohammad Baloch, T. and K. Timothy Thien Ching. (2008). Design and modelling a prototype of a robotic lawn mower. Information Technology,. International Symposium. 25-28 August. 1-5.
9. Hicks, R.B. and Hall, E. A Survey of Robot Lawn Mowers. SPIE Intelligent Robotics and Computer Vision Confrence.
10. Srishti Jain, Amar Khalore, Shashikant Patil. Self-Efficient and Sustainable Solar Powered Robotic Lawn Mower in International Journal of Trend in Research and Development(IJTRD). Vol.2(6), December 2015.

11. Bidgar Pravin Dilip, Nikhil Bapu Pagar, Vickey S. Ugale, Sandip Wani, Prof. Sharmila M. Design and Implementation of Automatic Solar Grass Cutter in International Journal of Advanced Research in Electrical(IJARE). Vol.6, April 2017.
12. Ms. Bhagyashri R. Patil, Mr. Sagar S. Patil. Solar Based Grass Cutting in International Journal of Electrical and Electronics Engineers (IJEEE). January-June 2017. e-ISSN: 2395-0056 p-ISSN: 2395-0072