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MICROCONTROLLER BASED SOLAR GRASS CUTTER

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ABSTRACT

The project describes a grass cutter, which is operated on solar power & is controlled through microcontroller. This project is mainly reduces the manpower and usage of electricity. Maximum power point tracking technique is used to improve the efficiency of the solar panel. The DC to DC buck boost converter helps to step up the DC voltage from the photovoltaic panel and store the DC voltage in a battery. It is an automated system for the purpose of grass cutting. The source is derived from the solar energy by using photovoltaic panels. The DC-DC converter is used to convert the low level DC voltage into the high level DC voltage. High level DC voltage is required to operate the whole system. Automation is achieved by using sensors and microcontrollers. Wheels and cutting operations are operated using dc motors. DC battery is utilized for powering and standby mode operation of the system.

Keywords: Microcontroller, MSGC, Solar Energy, Renewable energy.

1. INTRODUCTION

The standard of living is of a common man is increasing day by day. To make the campus beautiful, maintaining gardens & lawns has become common in most of the houses & companies. It also helps to keep the environment fresh and reduces the pollution. Grass cutters have become very essential to maintain the gardens and yards. In order to prepare beautiful gardens and playgrounds manual grass cutting doesn't give satisfied results. It may be due to the lack of accuracy and improper cutting. Hence automated devices can be the better choice for grass cutting operation. Grass cutter, which has been developed in this work, is a fully automated robotic vehicle without any human intervention, which uses solar energy to operate. The main advantage of this vehicle is, it detects obstacles and takes the deviation with the help of ultrasonic range sensors and microcontrollers.

The working process of the grass cutter consists of a motor, which provides high rotational speed to the blades. Due to the high speed of blades the grass gets trimmed by shearing action. In the present scenario manually handled devices are used for trimming the grass, which needs an operator to move the vehicle manually. By using microcontroller based solar grass cutter (MSGC) the labor cost, maintenance cost can be eliminated to a certain extent compared to manually operated machine.

Based on a literature survey, it is found that, currently almost all the grass cutter devices work with conventional fuel and electricity, which causes pollution. In order to overcome these issues, a fully automated solar grass cutter has been developed, which supports the green technology initiative, by reducing the pollution. FAGC uses solar energy to run the motor and cutter, by using solar energy. The machine is an example of importance & growing need of renewable energy. Considering environmental awareness, MSGC is more efficient and eco-friendly which overcomes the drawbacks of fuel-based grass. The MSGC machine was designed by considering important aspects such as efficiency, accuracy, eco-friendly, durability and low cost.

The major components of fully automated solar grass cutter model are solar panel, batteries, microcontroller, sensors, motor driver, DC motors and cutter. The abundant solar energy is collected, with the help of a solar panel which is used as a source of energy. The batteries are used to store the electrical energy produced by the solar panel. Microcontroller is used to store the program code which controls the direction of the model motion. Ultrasonic sensor is used to detect the obstacles in the path of the vehicle and sends the signal to micro-controllers, then microcontroller send the signals to motor driver so that wheels would take the deviations, which helps in avoiding the damage to the vehicle. Two types of DC motors are used based on the requirement of rotational speed. Two DC motors with 100 rpm are used to move the vehicle and DC motor with 3000 rpm is used for the cutter blade rotation. The cutter blade of the prototype can be adjusted based on the height of the grass that needs to be removed. The minimum height of grass can be cut with this prototype is 10 mm and maximum height up to 75mm.

2. OBJECTIVES

Grass cutting is necessary because uniformity in growth of grass is needed in maintaining a beautiful yard and this can be achieved by various techniques. In today's world automation is an important part of innovation. Presently, manually handled devices are commonly used for cutting the grass, but it will be time consuming and results in loss of energy. In a present scenario, we all know that pollution is a major issue in the universe. So usage of gas powered lawn mover, results in emission of gases and it is responsible for environmental air pollution. In order to overcome these disadvantages, an idea of a fully automated solar grass cutter is suggested, which will produce no harmful gasses to the environment and it will be efficient.

3. BLOCK DIAGRAM

Block diagram of microcontroller based solar grass cutter is shown in fig. 3.

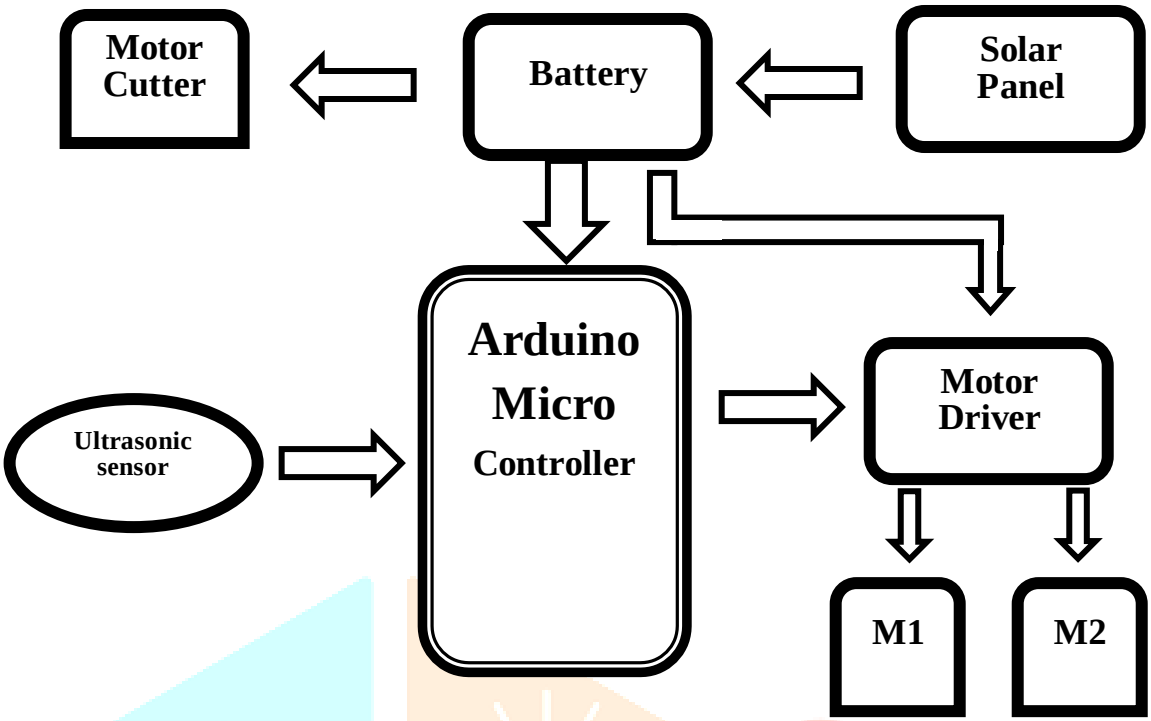

Fig. 3: Block Diagram of Microcontroller Based Solar Grass Cutter

It consists of following blocks.

3.1 Arduino Microcontroller
3.2 Ultrasonic sensor
3.3 Motor Driver circuit
3.4 Motors
3.5 Solar Panel and Battery
3.6 Cutter

3.1 Arduino Microcontroller

Arduino microcontroller used is an open-source microcontroller board based on the microchip ATmega328P microcontroller and developed by Arduino.cc. The board consists of digital and analog input / output pins that can be interfaced to several expansion boards and other circuits. The embedded C program is fed to a microcontroller to control the movement of the vehicle. The diagram of arduino microcontroller is shown in fig. 3.1.

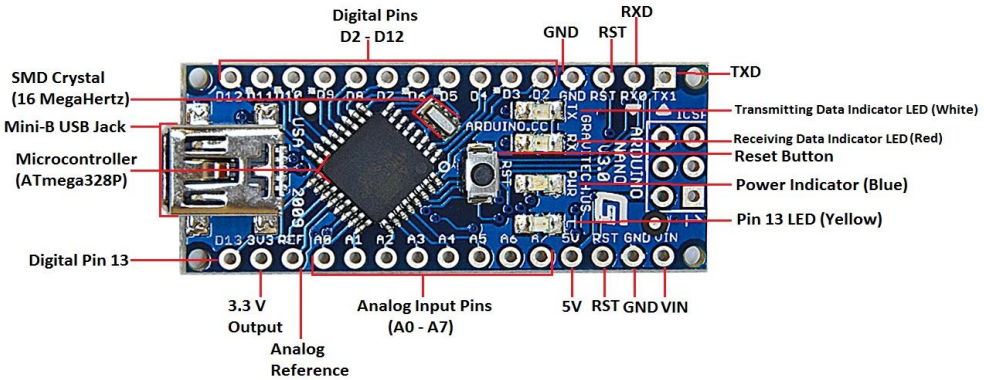

Fig. 3.1: Arduino Microcontroller

Table 3.1: Specification of Microcontroller

Operating Voltage	5V
Input Voltage	7-12V
Flash memory	32KB
Frequency	16MHz
DC current on I/O pins	40mA
DC current on 3.3v pin	50mA

3.2 Ultrasonic Sensor

HC-SR04 ultrasonic range sensors are 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 is connected to the microcontroller.

Generally, ultrasonic sensor ranging distance is from 4cm to 400cm, but in our project programming is done like that, if any object is at distance of 20cm it stop cutter motor and start taking 180⁰ turn and start cutting grass in another lane. Ultrasonic sensor is fitted in front of the solar grass cutter.

Ultrasonic sensor is 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. The diagram of ultrasonic sensor is shown in fig. 3.2.

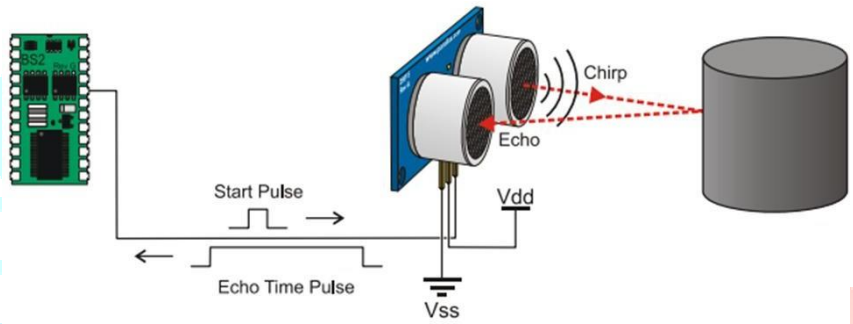

Fig. 3.2: Ultrasonic Sensor

Table 3.2: Specification of sensor

Power supply	5V DC
Quiescent current	< 2mA
Effectual angle	< 15⁰
Ranging distance	2cm-500cm
Resolution	0.3cm

3.3 Motor Driver Circuit

A L293D dual H- bridge motor driver is used, which controls the speed and direction of the vehicle. The module can drive the DC motor whose voltage is between 5V to 35V, with a peak current up to 2A. Motor driver connects the Dc motor (wheels) to the microcontroller. It controls the wheel motion as per the program fed to the microcontroller. The diagram of DC Motor Driver is shown in fig. 3.3.

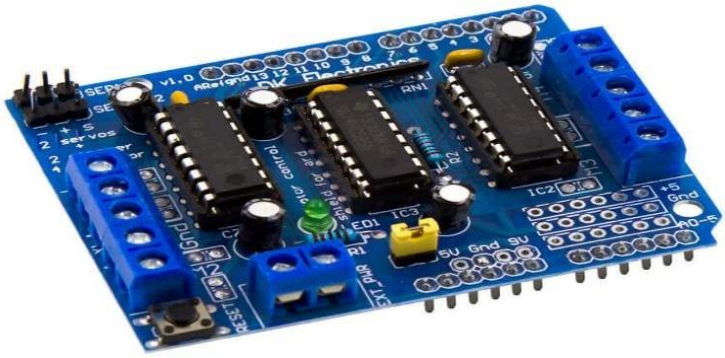

Fig. 3.3: DC Motor Driver circuit

3.4 DC Gear Motor (Wheels)

It is generally a DC motor with a gear box attached to it, which is used for the wheel rotation. DC motor with 100 rpm is used, which rotate wheels slowly to cover the area of the grass to be cut. Two DC gear motors are used for 2 two wheels of back side and front two wheel are free wheel.

Table 3.4 : Specification of DC Gear motor for wheels

RPM	100
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).

3.5(a) Solar Panel

A solar panel is designed to absorb the solar rays, which provides an 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 36 cells is selected to meet the design requirements. The solar panel has been placed above the chassis with an inclination of 45^0, so that panel will extract maximum energy from solar rays. The diagram of solar panel is shown in fig. 3.5.

Fig. 3.5(a): Solar Panel

Table 3.5(a): Specification of solar panel

Brand	**Innova**
Type of solar panel	Poly crystalline
Operating voltage	12V
Operating current	0.6A
No. of panel cells	36

3.5(b): Battery

Lead acid batteries are selected, because of its light weight, resistance to corrosion, low cost, recharge ability and the discharge rate is low as compared to other batteries. We are using one batteries of 12 voltages which is connected in series which has weight of 800g. The batteries are charged by the solar panel. It powers other electrical components in the project. The diagram of battery is shown in fig. 3.5(b)

Fig. 3.5(b): Battery

Table 3.5(b): Specification of Battery

Operating voltage	6V

Capacity	5Ah
Initial current	1.5A
Cycle use	(7.35-7.50)V
Stand by use	(6.75-6.9)V

3.6: DC Motor (Cutter)

The DC motor is connected to the cutter and placed in front of the vehicle for the grass to be cut efficiently. The cutter has to rotate at very high speed for this purpose a DC motor of 3000 rpm is selected. The DC motor takes the power from the battery. The control of the DC motor has been provided by a separate switch.

Table 3.6: Specification of DC Gear motor for cutter

RPM	3000
Operating voltage	12V
Body diameter	28mm
Shaft diameter	2mm
Torque	0.3kg-cm

4. WORKING PRINCIPLE

The fig. 3 shows the block diagram of microcontroller based solar grass cutter. First, solar panels will receive the sun rays, which produce electricity due to photovoltaic effects. This produced electricity gets stored in the batteries whit the help of solar charger.

The power from the battery is given to the microcontroller (Arduino) which controls the functioning of the device in order to operate it automatically. The machine uses an ultrasonic range sensor, which detects the obstacles within the range of 20cm and protects the vehicle against damage. When obstacle is detected a by ultrasonic sensor, a signal to the microcontroller is send which in response will send the signal to the motor driver to take deviation.

The machine is fed with a program (in Embedded C). Initially vehicle moves in a straight path, as the fence is detected vehicle will take 180^{0}rotation on the right and again it takes the straight path and move in another line so that all area of the lawn gets covered.

Two DC gear motors are used which are connected to the two wheels of the vehicle, one at back side on the left and other one on right side, which helps in rotation of the wheels and gear motors are driven by the motor driver, which is connected to the microcontroller. The DC motor connected to the cutter, is placed on the front side of the vehicle and helps in rotation of the cutter. The motor is fixed to the cutter, which is mounted on an adjustable plate such that the cutter height can be adjusted from 10mm to 70mm from the ground level. Cutter is designed in such a way that it cuts the grass efficiently. Two switches are used; one switch for the on/off of the solar grass cutter and another switch for modes switching. The MSGC machine was designed by considering important aspects such as efficiency, accuracy, eco-friendly, durable and low cost.

5. APPLICATIONS

- Home Gardens
- College Grounds
- Function Halls
- Farms
- Playgrounds
- Lawns etc

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6. ADVANTAGES AND DISADVANTAGES

6.1 Advantages

- This solar grass cutter minimizes the efforts of human being.
- It saves human time.
- It saves electricity and money.
- Uses advanced technology.
- Less maintenance
- Cost effective & durable
- Eco friendly
- Pollution free
- Portable
- No long wires connected

6.2 Disadvantages

- Must be used properly during rainy seasons.
- Should be handled carefully.

7. RESULT AND CONCLUSION

Reviving all the literature surveys and by knowing our needs, a suitable design of solar grass cutter is made. The components we chose are based on the design requirement and considering few of the other parameters in order to meet all the constraints. Based on the revived prototype model of the hardware and software system along with the ultrasonic sensor were demonstrated and required output was obtained. The cutter is designed in such a way that it can cut the grass efficiently and also height from the ground level can be adjusted from 2mm to 70mm. A panel is placed in a position where it can obtain maximum energy of the sunlight. So among eco-friendly grass cutter this device is the efficient one.

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