Design and Fabrication of Solar Powered Guided Grass Cutting and Pesticide Spraying Machine

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Abstract - *The solar powered grass cutting and pesticide spraying machine is a guided vehicle. The main purpose of this design and manufacturing is to eliminate the need for a traditional grass cutter, which pollutes the environment. The goal is to design and build a mechanical machine that can cut grass and spray pesticides in the most efficient way possible. The operation of this project is dependent on non-conventional energy sources like solar power transmission. The design is simple and easy to use because it is controlled via smartphones.*

***Key Words*: Solar Powered, Grass Cutting, Pesticide Spraying, Guided, Smartphone**

1. INTRODUCTION

Solar energy is one of the most widely used renewable energy sources in India. A solar powered grass cutter is one that uses solar energy to power an electric motor, which then moves a blade to cut grass. This concept is a safer alternative to using a gas-powered grass cutter. The user can save money by employing a solar powered grass cutter with a rechargeable battery. It is used for pesticide spraying in lawns with the integration of a water pump and a water tank connected to the battery. By using the keypad on the mobile phone, the user can cut the grass and spray the pesticide within the set area with this guided grass cutter and pesticide spraying machine. The blade height can also be modified to change the height of grass cutting. The primary purpose of this machine is to make mowing the lawn more convenient. The purpose of this project is to develop a solar-powered lawn cutter and pesticide spraying machine that can be modified to cut grass at three (3) different heights based on the operator's preference. The machine is also aimed at reducing air and noise pollution as it has no internal combustion engine thus making it a pollution free machine. Finally, to develop a machine that does not rely on fuel or electricity, but rather utilizes solar energy.

1.1 Objectives

To develop guided grass cutting and pesticide spraying vehicle powered by solar energy using Arduino Uno microcontroller.

Adjustment of height of grass cutter as per the user requirement.

The project is powered by solar energy hence the consumption of fossil fuel is reduced.

To reduce human efforts by using solar powered grass cutter.

1.2 Methodology

We are developing a prototype of the solar powered guided grass cutter and pesticide spraying machine. The methodologies of these attachments are explained in few sub- headings.

•   Components of Solar Grass Cutter and Pesticide Spraying Machine

•   Working of Solar Grass Cutter

The main components of the solar powered grass cutter are:

•   Software
•   Hardware

Software used:

1. Arduino IDE
2. C Language

Hardware used:

1.   Solar Panel:

A solar panel is a collection of photovoltaic cells mounted on a framework. Solar panels use sunlight as a source of energy to generate direct current power. In our project we have used 20W, 12V solar panel which is used to charge the battery. A photovoltaic module is a solar cell assembly that has been packaged and connected together. The photovoltaic effect is used in photovoltaic modules to generate electricity from the Sun's light energy.

Fig -1: Solar Panel

2. Battery:

A battery is an electrochemical device that may be charged and discharged as needed with an electric current. Small electric devices such as cell phones, remote controls, and flashlights are typically powered by batteries. In the past, the term "battery" was used to refer to the combination of two or more electrochemical cells. We have used 12V, 12Ah battery in our project to carry out the operations such as to power the Arduino Uno, the DC motors etc.

Fig -2: Battery

3. DC Motor:

A DC motor, also known as a direct current motor, is an electrical machine that converts electrical energy into mechanical energy by creating a direct current magnetic field. Based on following calculations the motors are being selected.

Technical specification

I.   Operating voltage- 12V
Rpm- 7000 rpm

This High Torque DC motor is used for rotating grass cutter blades.

Fig -3a: DC Motor

II.   Operating voltage- 12V
Rpm- 45 rpm

This DC motor is used for rotating wheels.

Fig -3b: DC Motor

4. Arduino UNO:

The Arduino board comprises a number of controllers and microprocessors. The Arduino Uno is a microcontroller board that uses the ATmega328P microcontroller. There are 14 digital input/output pins, 6 analogue inputs, a 16 MHz ceramic resonator, a USB connector, a power jack, an ICSP header, and a reset button on this board. The hardware is a programmable circuit board and the software we use is called the "Arduino Integrated Development Environment".

Fig -4: Arduino Uno

5. L293D Motor Driver:

The motor driver is a device that connects the Arduino to the motors. A motor driver is a type of integrated circuit chip that controls motors. The L293D is a 16-pin IC with eight pins dedicated to operating a motor on each side. In our project we have connected two DC motors to motor driver for rotating rear wheels.
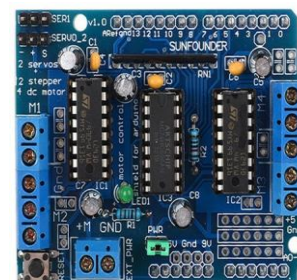

Fig -5: L293D Motor Driver

6. Relay:

A relay is an automatic switch that is typically used to regulate a high-current utilizing a low-current signal in an automatic control circuit. In simple words a relay is a switch that is operated by electricity. The relay signal's input voltage varies from 0 to 5V. We have used 2 channels, 5V relay in our project. We have connected two DC motors which are used for rotating grass cutter blades and water pump to relay. And relay is connected to Arduino Uno.

Fig -6: Relay

7. Water Pump:

A water pump is a device that increases the pressure of water so that it can be moved from one location to another in order to supply water. In our project we have used 12V, 110 PSI water pump as a pesticide sprayer. A water tank is used for storing pesticide.

Fig -7: Water Pump

8. Bluetooth Module:

The HC-05 Bluetooth Module is a basic Bluetooth Serial Port Protocol module that lets you build a transparent wireless serial connection. It interfaces with a controller or PC via serial transmission, making it simple to connect. We have used the Bluetooth module to connect the mobile phone so that we can give command through keypad.

Fig -8: HC-05 Bluetooth Module

9. UPVC Pipes:

Unplasticized Polyvinyl Chloride (UPVC) pipes are built of a low-maintenance, low-cost material that is widely used. Because of their excellent tensile and impact strength, UPVC pipes are a long-term solution. They are flexible and bend well, making them suitable for handling during construction of our model.
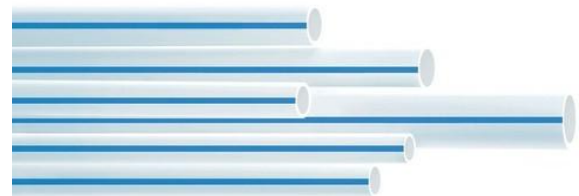

Fig -9: U PVC Pipes

10. Blades:

Blades are used for cutting the grass. 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. Due to its S shape the area of contact between grass and blade is more, hence the grass is mowed effectively. We have used two grass cutting blades which are 15 cm each.

Fig -10: Blades

2. BLOCK DIAGRAM:
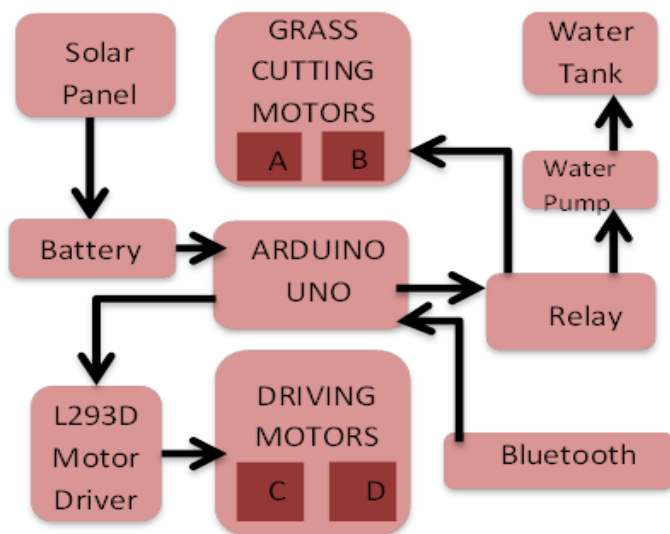
3. WORKING OF SOLAR POWERED GRASS CUTTER AND PESTICIDE SPRAYING MACHINE

When it comes to the operation of a solar powered grass cutter, the panels are positioned at a 45-degree angle so that high-intensity solar radiation from the sun can be quickly accepted.

Solar panels convert the sun's energy into electricity. Batteries are now used to store this electrical energy.

Through connecting wires, the motor is connected to the batteries. We used four motors in total.

The machine is driven by two motors.

Grass cutting is done with two motors (a, b) to which blades are attached. The power from these motors is transmitted to the blade, which rotates at a high speed and cuts the grass.

There is also a provision for height adjustment of cutter blades at three different levels above ground level, namely at 3 cm, 4.5 cm, and 6 cm.

The motor driver connects the two motors (c, d) that are attached to the wheels. Its movements are well coordinated due to the assistance of the motor driver.

The motors are connected to an Arduino Uno, which regulates their direction of movement.

The relay, which is interfaced with Arduino Uno, is attached to the two grass cutting motors that are connected in series, as well as the water pump.

The Arduino Uno has been pre-programmed to send signals through Bluetooth transceiver, allowing it to be easily detected by mobile phones.

The connecting pins connect the Arduino, motor controller, and relay to the Bluetooth transceiver, allowing data to be sent to the configured device.

The Bluetooth transceiver transmits the incoming RF, completing the setup by sending waves to the specified device while also trimming the grass.

Connection pins, often known as jump pins, are used to transport data from one component to the next. Using application software loaded on the phone, one may control the phone's functionalities from a specific range.
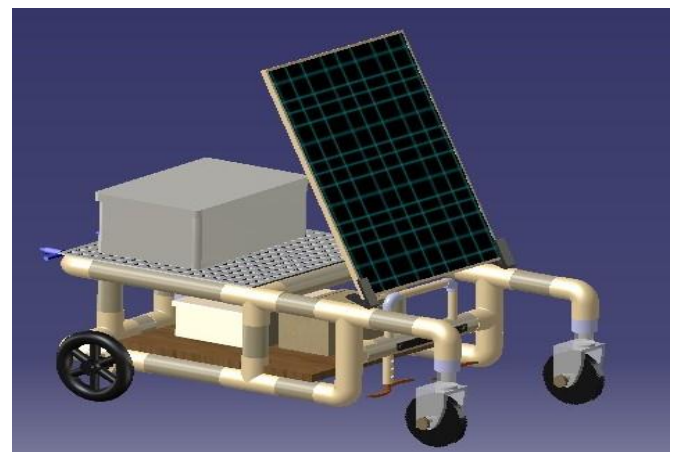

Fig -11: CATIA Model

Fig -12: Final Assembly

4. CALCULATIONS

TORQUE CALCULATION FOR WHEEL MOTOR

Rating of the Battery: 12 Volt, 12 Ah

Power produced: 12 X 12 = 144 Wh

Speed of the motor: 45 rpm

Torque of motor:

$P = [2\pi NT]/60$

$144 = [(2\pi) \times 45 \times T]/60$

$T = 30.557$ Nm

For 2 wheels, $T = 15.2788$ Nm

Hence the efficient torque is produced than the rated torque of the motor.

TORQUE CALCULATION FOR CUTTER BLADES

Rating of the battery: 12 Volt, 12 Ah

Power of the battery: 144 Wh

Speed of the Motor: 7000rpm

Torque produced:

$P = [2\pi NT]/60$

$144 = [(2\pi) \times 7000 \times T]/60$

$T = 0.19644$ Nm

$T = T_1 = T_2$

Hence the efficient torque is produced than the rated torque of the motor.

FORCE PRODUCED IN CUTTER BLADES

As we all know that,

Torque = Force x Radius

$0.19644 = \text{Force} \times 0.01$

Force = $[0.19644]/0.01 = 19.644$ N

Hence a force of 19.644 N is produced in the cutter blade which is sufficient enough to cut the grass.

CHARGING TIME FOR BATTERY

Solar Panel:

20 watts, 12 volts

Power = Volt x Current

20 = 12 x Current

Current (I) = 1.6667 A

Charging Time = 12 Ah / 1.6667 = 7.2

Charging Time = 7 Hours 12 Minutes

BATTERY LIFE

$$\text{Battery Life} = \frac{Battery\ Capacity \times 60 \times Power}{Current \times Voltage}$$

$$\text{Battery Life} = \frac{12 \times 60 \times 144}{1.667 \times 12}$$

Battery Life = 5182.9634 sec

Battery Life = 1 Hour 26 Minutes

5. PROPOSED WORK

Solar Powered Grass Cutter and Pesticide Spraying machine is powered by solar energy that is capable of grass cutting and pesticide spraying which reduces human effort.

The system uses 12V battery to power the vehicle movement motors as well as the grass cutter motor and water pump.

The Blade is kept at the Angle of 90 Degree for flexible operation.

We use a solar panel to charge the battery so that there is no need of charging it externally.

The vehicle motors are interfaced to Arduino Uno through motor driver that controls the working of the motors.

The grass cutter motors and water pump are interfaced to Arduino Uno through relay which will perform grass cutting and spraying of pesticide.

6. ADVANTAGES

There is no need to use any fuel.

It is small in size and lightweight.

The operating principle is simple and easy.

This machine can also be operated by a non-skilled individual.

There is no pollution.

7. CONCLUSIONS

Our project entitled, Design and Fabrication of Solar Powered Guided Grass Cutting and Pesticide Spraying Machine, has been completed successfully, and the results achieved are satisfactory. We were able to successfully carry out height adjustment feature according to which the user can adjust the height of cutter blades as per his/her requirement. We provided provision for three height adjustments of cutter blades which the user have to do manually. The adjustments were at 3 cm, 4.5 cm and 6 cm above the ground level. Our project is more suitable for the common man since it offers numerous advantages, including

no fuel costs, no pollution, and no fuel residue, reduced wear and tear due to fewer moving parts, and the ability to run on solar energy.

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