Experimental Investigation On Automated Solar Grass Cutter Robot

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A Graduation Exercise Submitted to the Department of Mechanical Engineering in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Mechanical Engineering

DEPARTMENT OF MECHANICAL ENGINEERING

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DHAKA, BANGLADESH

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DECLARATION

We hereby declare that this thesis is our own work and to the best of our knowledge it contains no materials previously published or written by another person, or have been accepted for the award of any other degree or diploma at Sonargaon University or any other educational institution. We also declare that the intellectual content of this thesis is the product of our own work and any contribution made to the research by others, with whom I have worked at Sonargaon University or elsewhere, is explicitly acknowledged.

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CERTIFICATION OF APPROVAL

The thesis title "Experimental Investigation On Automated Solar Grass Cutter Robot and Its Future Prospective" submitted by Md. Abdulla (BME2001020023), Md. Sajal Hossain (BME2001020325), Md. Abu Bakkar Siddik (BME2001020601), Ariq Mahmud (BME2001020612) and Md. Rubel Rana (BME2001020667) has been accepted as satisfactory partial fulfillment of the requirement for the degree of bachelor of science in mechanical engineering on 25 August 2023.

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LIST OF ABBREVIATIONS

SU	Sonargaon University
AC	Alternating Current
DC	Direct Current
IC	Integrated Circuit
IR	Insulation Resistance
RPM	Revolution Per Minute
MC	Micro Controller
CPU	Central Processing Unit
LED	Light Emitting Diode
BMS	Battery Management System
CC	Constant Current

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ABSTRACT

These days the computerization assumes vital part in the field of creations and furthermore mechanization is becoming quickly. Previously, the grass cutter was dealt with physically that is by human contact and furthermore, they require fuel or energy for working, due to this there is parcel of loss of fuel and energy and it causes contamination as fuel is utilized for running the machine. Solar energy is a best free wellspring of the energy; we are likewise running out of energizes. the traditional grass cutter is expensive and its support cost is extremely high. In this way, we need to supplant the ordinary grass cutter to the solar force based grass cutter to stay away from the above downsides. This model is prudent as contrast with the traditional one. The fundamental witticism of this system is to make a grass cutter that sudden spikes in demand for solar force energy, hence to save the electrical energy and to decrease the human interface. In this undertaking we use microcontroller for controlling the activities of a grass cutter, the grass cutter has given Ultrasonic sensor for detecting obstacle in front of it, an edge for cutting the grass, and DC motors for the wheels of the Robot. It is completely app based and sustainable power based venture. Grass cutter works consequently in this manner it doesn't need any talented individual to do the task.

CHAPTER 1

INTRODUCTION

1.1 OVER VIEW OF THE PROJECT

Nowadays, pollution is the major issue in the universe. In case of Gas powered lawn mowers due to emission of gases it is responsible for pollution. From time immemorial, the sun has been the major source of energy for life on earth. We can use the solar energy for giving power to the new high tech robotic grass cutters. Traditionally, lawn mowers are often clunky pieces of machinery that involves a lot of strength and energy to use. Man power is also required to look after them. As technology is improving day by day these traditional grass cutters should be replaced by the efficient, power saving and smart ones.

Automated Solar Grass Cutter is a fully automated grass cutting robotic vehicle powered by solar energy that also avoids obstacles and is capable of cutting grass without the need of any direct human interaction. One of main feathers of this system is that to control using by smartphone on app based control facility. So the traditional grass cutters are to be replaced by daily purpose robot which will be capable of cutting the grass in lawn without human intervention. The system will have some automation work for assistance and other obstacle recognition. The system will have a power source that is battery and a solar panel will be attached on the top of the robot. Cutting grass cannot be effortlessly accomplished by elderly, younger, grass cutter moving with engine which creates noise pollution due to the loud engine, and local air pollution due to the combustion in the engine. Along with motor powered grass cutter, electric grass cutters are also risky and cannot be easily used by all. Also, if the electric grass cutter is corded, moving could demonstrate to be challenging and unsafe.

So it is more efficient to use a solar power grass cutter which will be smart and which consumes less power. The trial product will be charged from sun by using solar panels. The design of solar powered agricultural equipment (e.g. grass cutter) will include direct current (D.C) motor, a rechargeable battery, solar panel, a stainless steel blade and control switch. The remote will permit the user to control the speed and direction of the grass cutter. The automatic grass cutting machine is going to perform the grass cutting operation by its own which means no manpower is mandatory. This will be better because man power is not essential in managing cutter on those hot or cold days, where you will prefer not to be out due to difficult weather.

1.2 BACK GROUND OF THE PROJECT

The first grass cutter was invented by Edwin Beard Buddingin in 1830, who was an engineer from England. Then in United States of America, gas powered grass cutter were first design in 1914 by “Ideal Power Mower Co. of Lancing, based on patent by Ransom E. Olds. Ideal power mover also designs the world’s first able to move without external population (self-propelled), riding tractor in 1922, known as the “Triplex” Te roller grass cutter has changed very little from around 1930. Now a day, we have seen the various type of grass cutter machine based on their engine, fuel as well as structural position. Regarding the above issue So, we are basically try to modify as well as upgraded this grass cutter in the area of power, controlling system and power analysis. we use solar based energy as main source, which is easy to use, it is more advantageous as compare to other energy as gas based source of power, petrol or diesel based energy source. At the same time, we have made alternative source of power by charging system in case of emergency condition, which made it more reliable in application ground.

1.3 OBJECTIVE

The objectives of the project are:

- To reduce the human efforts by using fully automatic solar grass cutter.
- The project is powered by solar energy hence the consumption of fossil fuel is reduced.
- It is an eco-friendly, No pollution, less economical, Efficient, Unmanned vehicle.
- Whole object will be controlled through Wi-Fi module.
- Without using any external power supply the machine is going to perform its own operation.
- Using solar energy (renewable source), the battery will charge automatically.

In the long term the objective of this project is to try new feathers and assemble a smart vehicle powered by solar energy, which will be huge potential for like Bangladesh as an agricultural based economy to apply at field for removing or cutting the unnecessary grass to prepare field for proper fertile condition as well as gain maximum economic benefit for farmer.

1.4 STRUCTURE OF THE THESIS

The background, methodology and outcomes of the present research has been detailed in five chapters, *Chapter 1* being a general introduction along with specific objectives and scope. The rest of the chapters are organized as follows:

Chapter 2: This chapter consists of literature review of automated solar grass cutting and This chapter is ended up by re-counting with a chapter summary

Chapter 3: This chapter is described by the benefits as well as challenges regarding this project in the field of construction as well as long term planning.

Chapter 4: This chapter introduce the hardware and methodology regarding this project which discuss about the hardware specification except solar panel as well as their utilization on the basis of their capacity.

Chapter 5: The chapter is discussed about power system management where include BMS and other relevant topic.

Chapter 6: The chapter is discussed one of main component of this project is solar panel as well as the power analysis for this project.

CHAPTER 2

LITERATURE SURVEY

2.1 LITERATURE SURVEY

This study offers a solar-powered app-based controlling robotic vehicle that is self-sufficient, with the goal of allowing individuals to eliminate grass with minimal effort. Unlike other grass cutter, this robotic vehicle is capable of operate by using solar power to rotate vehicle wheel and cutting blade. To operates its operation, this system uses 6V batteries to power the vehicle movement motors as well as the grass cutter motor. The grass cutter and vehicle motors are interfaced to an 8051 family microcontroller that controls the working of all the motors. We have use an android based app to send the instruction as per physical working environments. By using this command, we can make forward, backward, left rotate and right rotate of this vehicle to get high performance.

So, the literature survey exploring the fundamental concepts and execution of using solar power at agricultural or field level by replacing the old tradition like burning fossil fuel. It necessary to construct an environment friendly grass cutter in consideration of reliability in application. So it is highly suitable for our country specially at agricultural area where, we have already uses solar energy in large scale like solar powered pump.

CHAPTER 3

BENEFITS & CHALLENGES

3.1 BENEFITS

The benefits of this project is written as below:

- It is environment friendly, which usage solar energy.
- This device doesn't emit carbon dioxide.
- Low maintenance cost which is sign of cost effective.
- This device can have operated by using app based controlling system.
- Its output benefit is comparatively large than other type of grass cutter.
- Long life of this project.
- Relatively compact size and portable.
- Easy to move from one place to another place.
- Operating principle is simple.

3.2 CHALLENGES

There are number of challenges to prepare this project which can be identified into two stage (i) construction stage, (ii) after construction stage:

(i) construction stage:

Frame

- Frame design, analysis, and fabrication

Powertrain

- Powertrain design
- Motor research, selection and purchase

Parametric analysis of required power

- Control research, design, and purchase

Battery research, selection, and purchase

- Management of battery life and safety
- Solar energy charging capability Steering.

DC motor, research and selection

- Controlling of motor and capacity of motor.
- Motor research and selection.

<u>(ii) after construction stage</u>:

<u>Controlling:</u>

- To control accurately, which require experience manpower.
- Extreme weather or large obstacle may harm this vehicle.
- Large time required to remove the grass.

3.3 CHAPTAR SUMMERY

We have discussed and various type of benefit and challenges during and after construction of this project, where we get more benefit in terms of investment. To discuss it briefly, we are going to show a table where we show difference between conventional grass cutter and solar grass cutter.

SL No.	Conventional grass cutter	Solar grass cutter
1	Works on non-renewable fuel sources	Works on renewable fuel resources
2	Emission of gases leads to air pollution	Emission is not present thereby no pollution
3	Engine sound creates noise pollution	Comparatively less sound is generated
4	Periodic maintenance is required of fuel engine	Environmental friendly & low maintenance
5	Power consumption is more	Power consumption is less

Table-4.1: difference between conventional and solar grass cutter.

CHAPTER 4

HARDWARE AND METHODOLOGY

4.1.1 ARDUINO UNO

Arduino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. You can tinker with your Uno without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again. "Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform; for an extensive list of current, past or outdated boards see the Arduino index of boards.

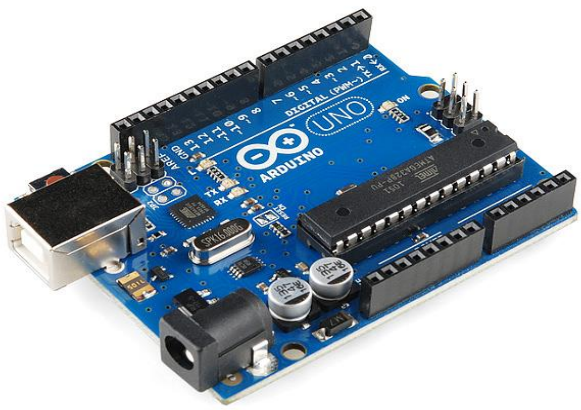


Figure-4.1: Arduino R3

4.1.2 TECHNICAL SPECIFICATION OF MICROCONTROLLER

SL No.	Name	Specification
1	Microcontroller	ATmega328P
2	Operating voltage	5v
3	Input voltage (recommended)	7-12V
4	Digital I/O pin	14 (in which 6 provide PWM output)
5	PMW digital I/O pin	6
6	Analog input pin	6
7	DC current per I/O pin	2 mA
8	DC current for 3.3v pin	50 mA
9	Flash memory	32kb (ATmega328P) of which 0.5KB use for bootloader
10	SRAM	2 KB (ATmega328P)
11	EEPROM	1 KB (ATmega328P)
12	Clock speed	16 MHz
13	LED_BUILTIN	13
14	Length	68.6 mm
15	Width	53.4 mm
16	Weight	25 g

Table-4.2: ARDUINO pin attribute

4.1.3 PROGRAMING

The Arduino Uno can be programmed with the (Arduino Software (IDE)). Select "Arduino Uno from the Tools > Board menu (according to the microcontroller on your board). For details, see the reference and tutorials. The ATmega328 on the Arduino Uno comes preprogramed with a boot loader that allows you to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol (reference, C header files). You can also bypass the boot loader and program the microcontroller through the ICSP (In-Circuit Serial Programming) header using Arduino ISP or similar; see these instructions for details. The ATmega16U2 (or 8U2 in the rev1 and rev2 boards) firmware source code is available in the Arduino repository. The ATmega16U2/8U2 is loaded with a DFU boot loader, which can be activated by:

- On Rev1 boards: connecting the solder jumper on the back of the board (near the map of Italy) and then resetting the 8U2.
- On Rev2 or later boards: there is a resistor that pulling the 8U2/16U2 HWB line to ground, making it easier to put into DFU mode.

You can then use Atmel's FLIP software (Windows) or the DFU programmer (Mac OS X and Linux) to load a new firmware. Or you can use the ISP header with an external programmer (overwriting the DFU boot loader). See this user-contributed tutorial for more information.

4.1.4 POWER OF ARDUINO

The Arduino Uno board can be powered via the USB connection or with an external over supply. The power source is selected automatically. External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the GND and Vin pin headers of the POWER connector.

The board can operate on an external supply from 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may become stable. If using more than 12V, the voltage regulator may overheat and damage the board. The commended range is 7 to 12 volts.

The power pins are as follows:

- Vin. The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- 5V. This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 12V), the USB connector (5V), or the VIN pin of the board (7-12V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage your board. We don't advise it.
- 3V3. A 3.3-volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- GND. Ground pins.
- IOREF. This pin on the Arduino board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin voltage and select the appropriate power source or enable voltage translators on the outputs to work with the 5V or 3.3V.

4.1.5 MEMORY

The ATmega328 has 32 KB (with 0.5 KB occupied by the boot loader). It also has 2 KB of SRAM and 1 KB of EEPROM (which can be read and written with the EEPROM library).

4.1.6 COMMUNICATON

The Arduino Uno has a number of facilities for communicating with a computer, another Arduino board, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An Tmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The 16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a .inf file is required. The Arduino Software (IDE) includes a serial monitor which allows simple textual data to be sent to and from the board. The RX and TX LEDs on the board will flash when data is being transmitted

via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1).
A Software Serial library allows serial communication on any of the Uno's digital pins. The ATmega328 also supports I2C (TWI) and SPI communication. The Arduino Software (IDE) includes a Wire library to simplify use of the I2C bus; see the documentation for details. For SPI communication, use the SPI library.

Automatic (Software) Reset
Rather than requiring a physical press of the reset button before an upload, the Arduino Uno board is designed in a way that allows it to be reset by software running on a connected computer. One of the hardware flow control lines (DTR) of the ATmega8U2/16U2 is connected to the reset line of the ATmega328 via a 100 Nano farad capacitor. When this line is asserted (taken low), the reset line drops long enough to reset the chip. The Arduino Software (IDE) uses this capability to allow you to upload code by simply pressing the upload button in the interface toolbar. This means that the boot loader can have a shorter timeout, as the lowering of DTR can be well-coordinated with the start of the upload.

This setup has other implications. When the Uno is connected to either a computer running Mac OS X or Linux, it resets each time a connection is made to it from software (via USB). For the following half-second or so, the boot loader is running on the Uno. While it is programmed to ignore malformed data (i.e. anything besides an upload of new code), it will intercept the first few bytes of data sent to the board after a connection is opened. If a sketch running on the board receives one-time configuration or other data when it first starts, make sure that the software with which it communicates waits a second after opening the connection and before sending this data.

The Uno board contains a trace that can be cut to disable the auto-reset. The pads on either side of the trace can be soldered together to re-enable it. It's labelled "RESET-EN". You may also be able to disable the auto-reset by connecting a 110-ohm resistor from 5V to the reset line; see this forum thread for details.

4.2 BLUETOOTH MODULE (HC 05)

HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. Serial port Bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband. It uses CSR Blue core 04-External single chip Bluetooth system with CMOS technology and with AFH (Adaptive Frequency Hopping Feature). It has the footprint as small as 12.7mmx27mm. Hope it will simplify your overall design/development cycle.

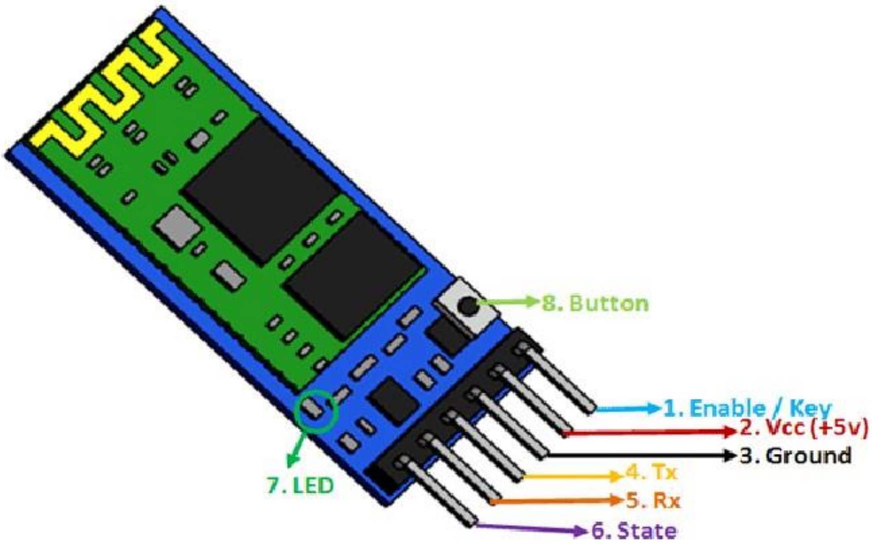


Fig-4.2: Bluetooth module HC 05

4.2.1 HC-05 PINOUT CONFIGURATION

The pinout configuration of HC-05, which we have shown as in the table below:

Pin Number	Pin Name	Description
1	Enable / Key	This pin is used to toggle between Data Mode (set low) and AT command mode (set high). By default it is in Data mode
2	Vcc	Powers the module. Connect to +5V Supply voltage
3	Ground	Ground pin of module, connect to system ground.
4	TX – Transmitter	Transmits Serial Data. Everything received via Bluetooth will be given out by this pin as serial data.
5	RX – Receiver	Receive Serial Data. Every serial data given to this pin will be broadcasted via Bluetooth
6	State	The state pin is connected to on board LED, it can be used as a feedback to check if Bluetooth is working properly.
7	LED	Indicates the status of Module ➢ Blink once in 2 sec: Module has entered Command Mode ➢ Repeated Blinking: Waiting for connection in Data Mode ➢ Blink twice in 1 sec: Connection successful in Data Mode
8	Button	Used to control the Key/Enable pin to toggle between Data and command Mode

Table-4.3: Pin out of HC 05 Module.

4.2.2 TECHNICA SPECIFICATION OF HC-05

The technical specification of Bluetooth Module HC-05 has shown below step by step:

- Serial Bluetooth module for Arduino and other microcontrollers.
- Operating Voltage: 4V to 6V (Typically +5V).
- Operating Current: 30mA.
- Works with Serial communication (USART) and TTL compatible.
- Follows IEEE 802.15.1 standardized protocol.
- Uses Frequency-Hopping Spread spectrum (FHSS)
- Can operate in Master, Slave or Master/Slave mode
- Can be easily interfaced with Laptop or Mobile phones with Bluetooth
- Supported baud rate: 9600,19200,38400,57600,115200,230400,460800.

4.2.3 L298N MOTOR DRIVE CHIP

At the center of the module is a big, black chip with a chunky heat sink – the L298N. The L298N chip contains two standard H-bridges capable of driving a pair of DC motors, making it ideal for building a two-wheeled robotic platform. The L298N motor driver has a supply range of 5V to 35V and is capable of 2A continuous current per channel, so it works very well with most of our DC motors.

4.2.4 TECHNICAL SPECIFICATION OF L298N

Motor output voltage	5V – 35V
Motor output voltage (Recommended) Logic input voltage	7V – 12V
Continuous current per channel	2A
Max Power Dissipation	25W

Table-4.4: Technical Specification of Motor Drive Module.

4.2.5 L298N MOTOR DRIVER MODULE PINOUT:

The L298N module has 11 pins that allow it to communicate with the outside world. The pinout is as follows:

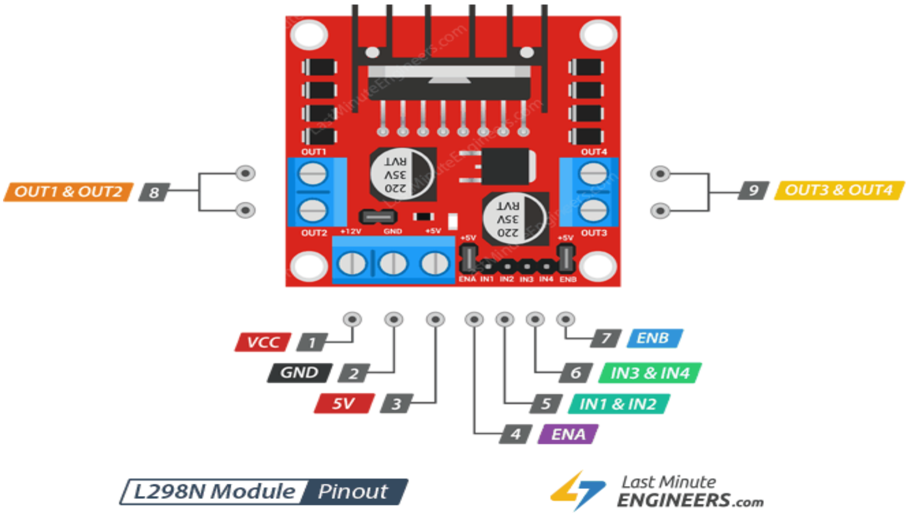


Fig-4.3: L298n Motor Driver Pinout

4.2.6 MOTOR DRIVER MODULE TO AN ARDUINO

Now that we know everything about the module, we can start hooking it up to our Arduino! Let's begin by connecting the motor power supply. In our experiment, we are using DC gearbox motors, also called "TT" motors, which are often found in two-wheel-drive robots. They are rated for 3 to 12V. We will therefore connect an external 12V power source to the VS terminal. Because L298N has a voltage drop of about 2V, the motors will receive 10V and spin at a slightly lower RPM. But that's okay.

Next, we need to supply 5V to the logic circuitry of the L298N. We'll use the on-board 5V regulator to draw 5V from the motor power supply, so keep the 5V-EN jumper in place.

Now connect the L298N module's Input and Enable pins (ENA, IN1, IN2, IN3, IN4 and ENB) to the six Arduino digital output pins (9, 8, 7, 5, 4 and 3). Note that both Arduino output pins 9 and 3 are PWM-enabled

Finally, wire one motor to terminal A (OUT1 and OUT2) and the other to terminal B (OUT3 and OUT4). You can swap out your motor's connections. There is technically no right or wrong way

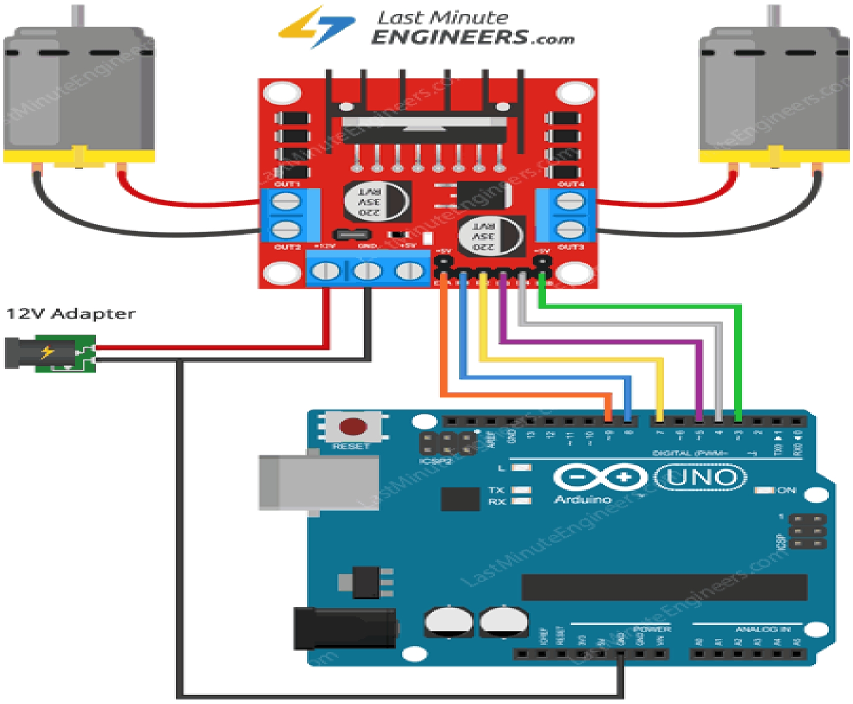


Fig-4.4: L298n Interface with Arduino.

4.2.7 ARDUNIO EXAMPLE CODE

The sketch below will show you how to control the speed and spinning direction of a DC motor using the L298N Motor Driver and can serve as the basis for more practical experiments and projects.

```
int enA = 9;
int in1 = 8;
int in2 = 7;
// Motor B connections
int enB = 3;
int in3 = 5;
int in4 = 4;
void setup() {
// Set all the motor control pins to outputs
pinMode(enA, OUTPUT);
pinMode(enB, OUTPUT);
pinMode(in1, OUTPUT);
pinMode(in2, OUTPUT);
pinMode(in3, OUTPUT);
pinMode(in4, OUTPUT);
// Turn off motors - Initial state
digitalWrite(in1, LOW);
digitalWrite(in2, LOW);
digitalWrite(in3, LOW);
```

```
digitalWrite(in4, LOW);
}
void loop() {
directionControl();
delay(1000);
speedControl();
delay(1000);
}
// This function lets you control spinning direction of motors
void directionControl() {
// Set motors to maximum speed
// For PWM maximum possible values are 0 to 255
analogWrite(enA, 255);
analogWrite(enB, 255);
// Turn on motor A & B
digitalWrite(in1, HIGH);
digitalWrite(in2, LOW);
digitalWrite(in3, HIGH);
digitalWrite(in4, LOW);
delay(2000);
// Now change motor directions
digitalWrite(in1, LOW);
digitalWrite(in2, HIGH);
digitalWrite(in3, LOW);
digitalWrite(in4, HIGH);
delay(2000);
// Turn off motors
digitalWrite(in1, LOW);
digitalWrite(in2, LOW);
digitalWrite(in3, LOW);
digitalWrite(in4, LOW);
}
// This function lets you control speed of the motors
void speedControl() {
// Turn on motors
digitalWrite(in1, LOW);
digitalWrite(in2, HIGH);
digitalWrite(in3, LOW);
digitalWrite(in4, HIGH);
// Accelerate from zero to maximum speed
for (int i = 0; i < 256; i++) {
analogWrite(enA, i);
analogWrite(enB, i);
delay(20);
}
// Decelerate from maximum speed to zero
for (int i = 255; i >= 0; --i) {
analogWrite(enA, i);
analogWrite(enB, i);
delay(20);
```

```
}
// Now turn off motors
digitalWrite(in1, LOW);
digitalWrite(in2, LOW);
digitalWrite(in3, LOW);
digitalWrite(in4, LOW);
}
```

4.2.8 GEAR MOTOR

A gear motor is an all-in-one combination of a motor and gearbox. The addition of a gear head to a motor reduces the speed while increasing the torque output. The most important parameters in regards to gear motors are speed (rpm), torque (lb-in) and efficiency (%). In order to select the most suitable gear motor for your application you must first compute the load, speed and torque requirements for your application. ISL Products offers a variety of Spur Gear Motors, Planetary Gear Motors and Worm Gear Motors to meet all application requirements. Most of our DC motors can be complemented with one of our unique gearheads, providing you with a highly efficient gear motor solution. Inlet and outlet pressure are measured by the analogue pressure gauge. It measured pressure by height of the water. The range of the suction pressure is 0 to 5 m of water in the anticlockwise direction and the outlet pressure range is 0 to 25 m of water in the clockwise direction.

Fig-4.5: DC Gear Motor with Wheel

4.2.9 GRASS CUTTER BLADE:

Actually it one of front line parts of this vehicle which play one of main role to cut grass by using its rotational speed which it obtains from motor and also its shape which helps it cutting grass smoothly.

Fig-4.6: Grass Cutter Blade

CHAPTER 5

POWER SYSTEM MANAGEMENT

5.1 POWER SYSTEM MANAGEMENT

The most important thing in an electric vehicle is its battery power. If it stays on, the rest will work normally. Otherwise, you are facing various problems. The most important aspect of this project is the power management system. Because here we have used a battery pack which will provide 12 volts. Normally a lithium ion battery is 3.7 volts. But if sufficiently charged it can be up to 4.1 volts. So the battery pack we have made consists of 3 batteries.

Because 12-volt charge is enough for the solar powered electric car we are going to make. It is going to be a demo car that can be charged by solar and direct electricity simultaneously. Because of which we need to keep a close eye on battery management. So that we don't have to face any kind of problem while charging the vehicle.

5.1.1 BATTERY MANAGEMENT SYSTEM (BMS)

A battery management system is any electronic system that manages a rechargeable battery, such as by protecting the battery from operating outside its safe operating area, monitoring its state, calculating secondary data, reporting that data, controlling its environment, authenticating it and / or balancing it.

5.1.2 PROTECTION

A BMS may protect its battery by preventing it from operating outside its safe operating area, such as:

- Over-charging
- Over-discharging
- Over-current during charging
- Over-current during discharge
- Over-temperature
- Charging while under low temperature
- Ground fault or leakage current detection (system monitoring that the high voltage battery is electrically disconnected from any conductive object touchable to use like vehicle body)

5.1.3 BALANCING

Distributed Battery Management system
In order to maximize the battery's capacity, and to prevent localized under-charging or over-charging, the BMS may actively ensure that all the cells that compose the battery are kept at the same voltage or State of Charge, through balancing. The BMS can balance the cells by:

- Wasting energy from the most charged cells by connecting them to a load (such as through passive regulators)
- Shuffling energy from the most charged cells to the least charged cells (balancers)
- Reducing the charging current to a sufficiently low level that will not damage fully charged cells, while less charged cells may continue to charge (does not apply to Lithium chemistry cells

CHAPTER 6

SOLAR PANEL AND POWER ANALYSIS

6.1 SOLAR PANELS

A solar cell panel, solar electric panel, photo-voltaic (PV) module, PV panel or solar panel is an assembly of photovoltaic solar cells mounted in a (usually rectangular) frame, and a neatly organised collection of PV panels is called a photovoltaic system or solar array. Solar panels capture sunlight as a source of radiant energy, which is converted into electric energy in the form of direct current (DC) electricity. Arrays of a photovoltaic system can be used to generate solar electricity that supplies electrical equipment directly, or feeds power back into an alternate current (AC) grid via an inverter system.

When the sun shines onto a solar panel, energy from the sunlight is absorbed by the PV cells in the panel. This energy creates electrical charges that move in response to an internal electrical field in the cell, causing electricity to flow.

6.1.1 SOLAR PANEL TYPES BY EFFICIENCY

Among all panel types, crystalline solar panels have the highest efficiency.

- Monocrystalline panels have an efficiency rating over 20%.
- PERC panels add an extra 5% efficiency thanks to their passivation layer.
- Polycrystalline panels hover somewhere between 15-17%.

In contrast, thin-film panels are usually 2-3% less efficient than crystalline silicon. On average:

- CIGS panels have an efficiency range of 13-15%.
- CdTe ranges between 9-11%.
- a-Si have the lowest efficiency at 6-8%.

So, we have shown different types of solar panel on basis of their efficacy in the table below:

Panel type Efficiency	Panel type Efficiency
PERC Highest	PERC Highest (5% more than monocrystalline)
Monocrystalline	Monocrystalline 20% and up
Polycrystalline	Polycrystalline 15-17%
Copper indium gallium selenide (CIGS)	Copper indium gallium selenide (CIGS) 13-15%
Cadmium telluride (CdTe)	Cadmium telluride (CdTe) 9-11%
Amorphous silicon (a-Si)	Amorphous silicon (a-Si) 6-8%

Table-6.1: Efficiency of different type of solar panel.

6.1.2 SOLAR PANEL TYPES BY COST

Monocrystalline panels (or modules as they are technically known) carry a hefty price tag, due to its energy-intensive and inefficient manufacturing process with only a 50% yield for every silicon crystal. Polycrystalline modules are cheaper because they make use of the crystal fragments leftover from monocrystalline production, which results in a simpler manufacturing process and lower production costs. Among thin-film solar panels, CIGS is the most expensive, followed by Cadet and amorphous silicon. Apart from the lower acquisition cost, thin-film modules can be easier to install thanks to their lighter weight and flexibility, which lowers the cost of labor. While the total cost of residential systems has declined by more than 65% over the last decade, the soft cost of a system has actually risen from 58% of total system cost in 2014 to 65% in 2020. For more information about soft costs, check out our article on the soft costs in the solar industry, and what’s being done to reduce them. The basic construction of an analog tachometer includes a mechanical or electronic sensor that detects the rotational motion of the object being monitored. This sensor generates a signal that is proportional to the speed of the object. In the case of an engine, for example, the sensor may be connected to the ignition system or directly to the crankshaft. The generated signal is then sent to the tachometer, where it is processed and converted into a corresponding display on the gauge. The gauge typically consists of a circular dial or scale with markings representing the RPM range. A needle or pointer is attached to a pivot and moves across the scale in response to the input signal.

Panel (Module) type	Average Cost per Watt
PERC	\$0.32-\$0.65
Monocrystalline	\$1 – \$1.50
Polycrystalline	\$0.70 – \$1
Copper indium gallium selenide (CIGS)	\$0.60 – \$0.70
Cadmium telluride (CdTe)	(CdTe) \$0.50 – \$0.60
Amorphous silicon (a-Si)	(a-Si) \$0.43 – \$0.50)

Table-6.2: Different Type of Solar Panel Cost.

Note that these figures don’t include the cost of installation and labor. With labor and other overhead factors, the total can rise to \$2.50 to \$3.50 per watt.

6.2 POWER ANALYSIS:

In power analysis we are going to evaluate motor, solar power production, power repaired to operate the vehicle etc step by step.

<u>Selection of electric motor:</u>

i) 30 RPM DC motor SPEED =30
ii) RPM VOLTAGE = 12VOLT
iii) WATTS = 18WATT

BATTERY CALCULATION

The shaft is made of MS and its allowable shear stress= 42MPa

Torque = 3.14 x fs x d ^{3} / 16 5.72 x 10^3 = 3.14 x 42 x d ^{3} / 16D = 8.85 mm

The nearest standard size is d =9 mm.

6.2.1 ELECTRICAL (ELECTRIC) POWER EQUATION:

Power P = I × V Where V = 12 W = 18I=18/12=1.5

A H.P = .02414

6.2.2 SOLAR POWER CALCULATION:

VOLT = 12V

W = V X I 5 = 12 X I I = 5/12 I = 420maWATT = 5W

i) BAH /CI = 8 ah/420ma = 19hrs

ii) To find the Current Watt = 18w

iii) Volt = 12v Current=?

P= V x I 18 =12 x I I = 18/12 = 1.5

iv) AMPS battery usage with 1.5 AMPSBAH /I 8/1.5 = 5.3hrs

6.2.3 MOTOR SPEED CALCULATION

Speed (km/hr)	Speed (rpm)	Torque (nm)
10	208.97	3.58
20	417.94	1.79
30	626.91	1.19

Table-6.3: Motor Output Torque with Speed

<u>Calculations for obtaining speed and torque</u>:

Speed in rpm= (speed in km/hr*1000)/ (2*pi* radius*60)

Torque = power/ (speed in rpm)

So, we are showing the torque speed comparison in the bellows figure:

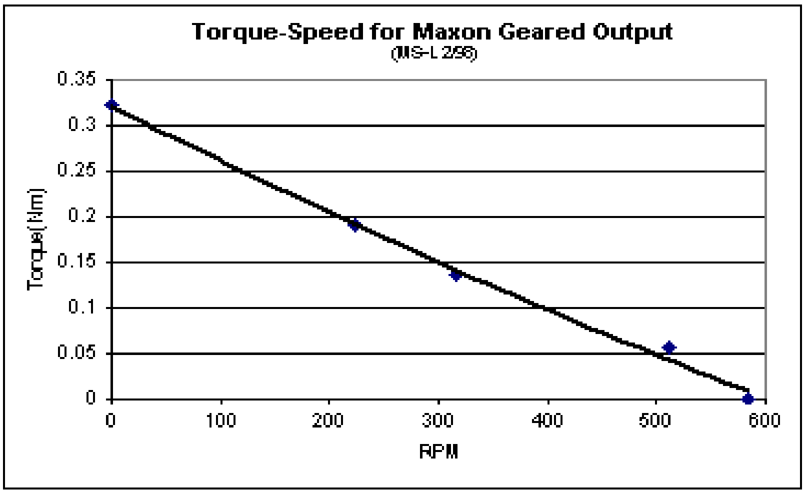


Fig-6.4: Torque-Speed Comparison

6.2.4 DATA COLLECTION

Sample plot	Average height of grass before moving (mm)	Average height of grass after moving (mm)	Expected height of grass after moving (mm)
Elephant grass	224	90	100
Stubborn grass	234	92	100
Spare grass	111	70	80
Carpet grass	70.5	56.5	50

Table-6.5: Data Collection

6.2.6 FLOW CHART

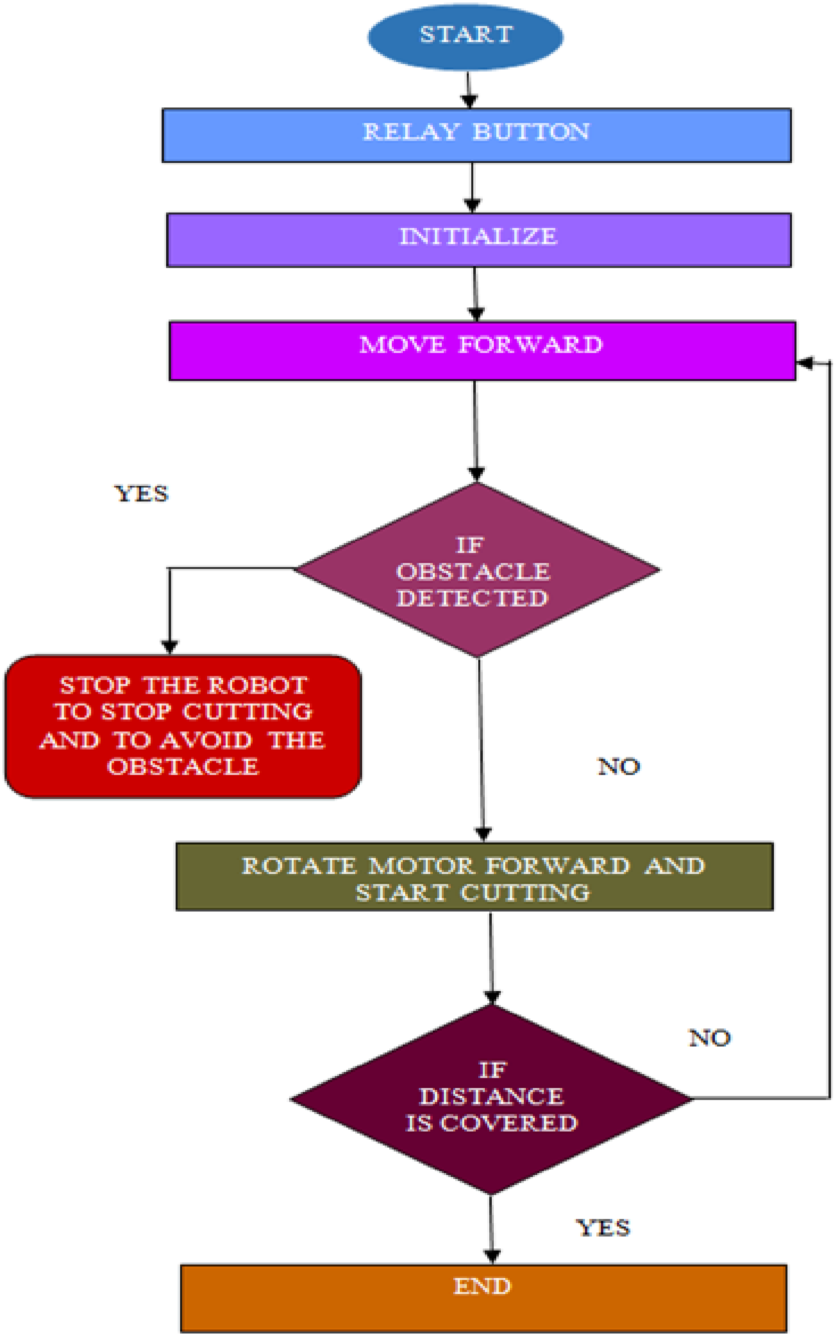


Fig. 2 Flow chart for methodology

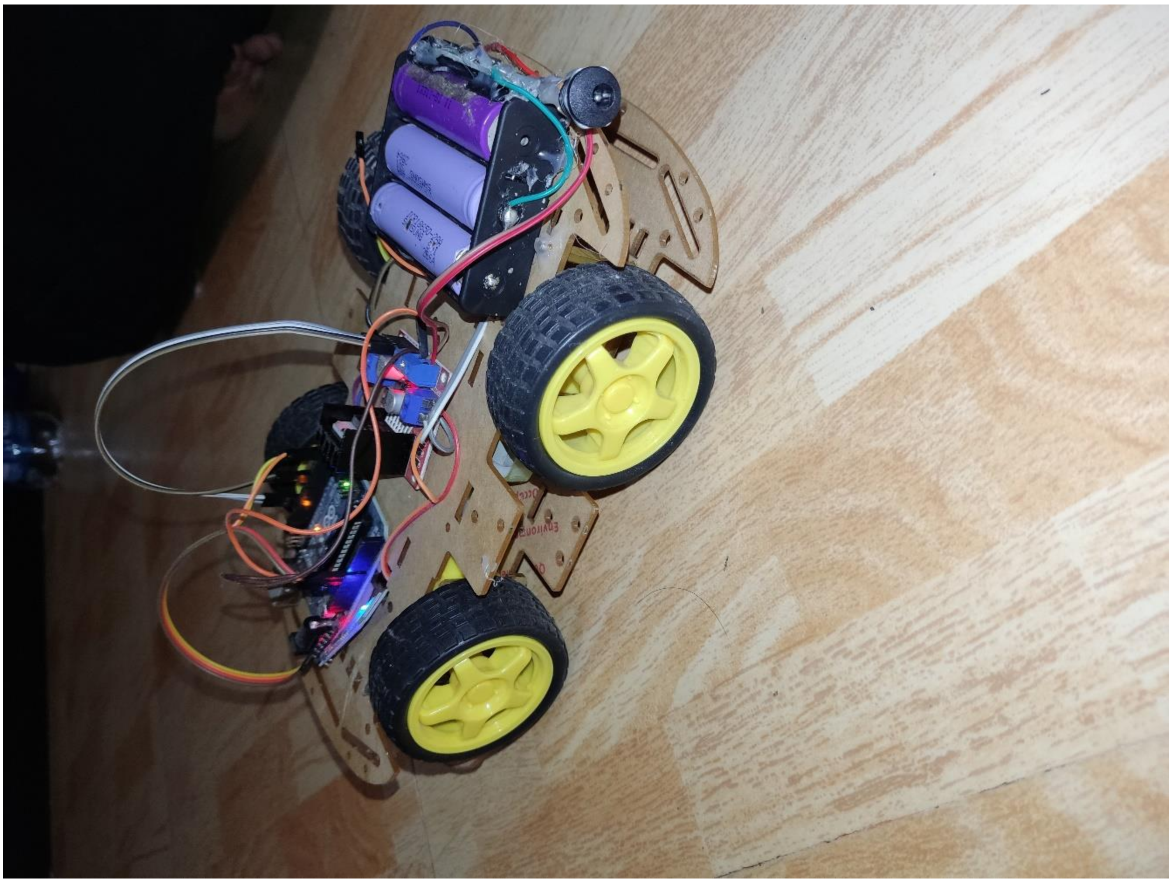
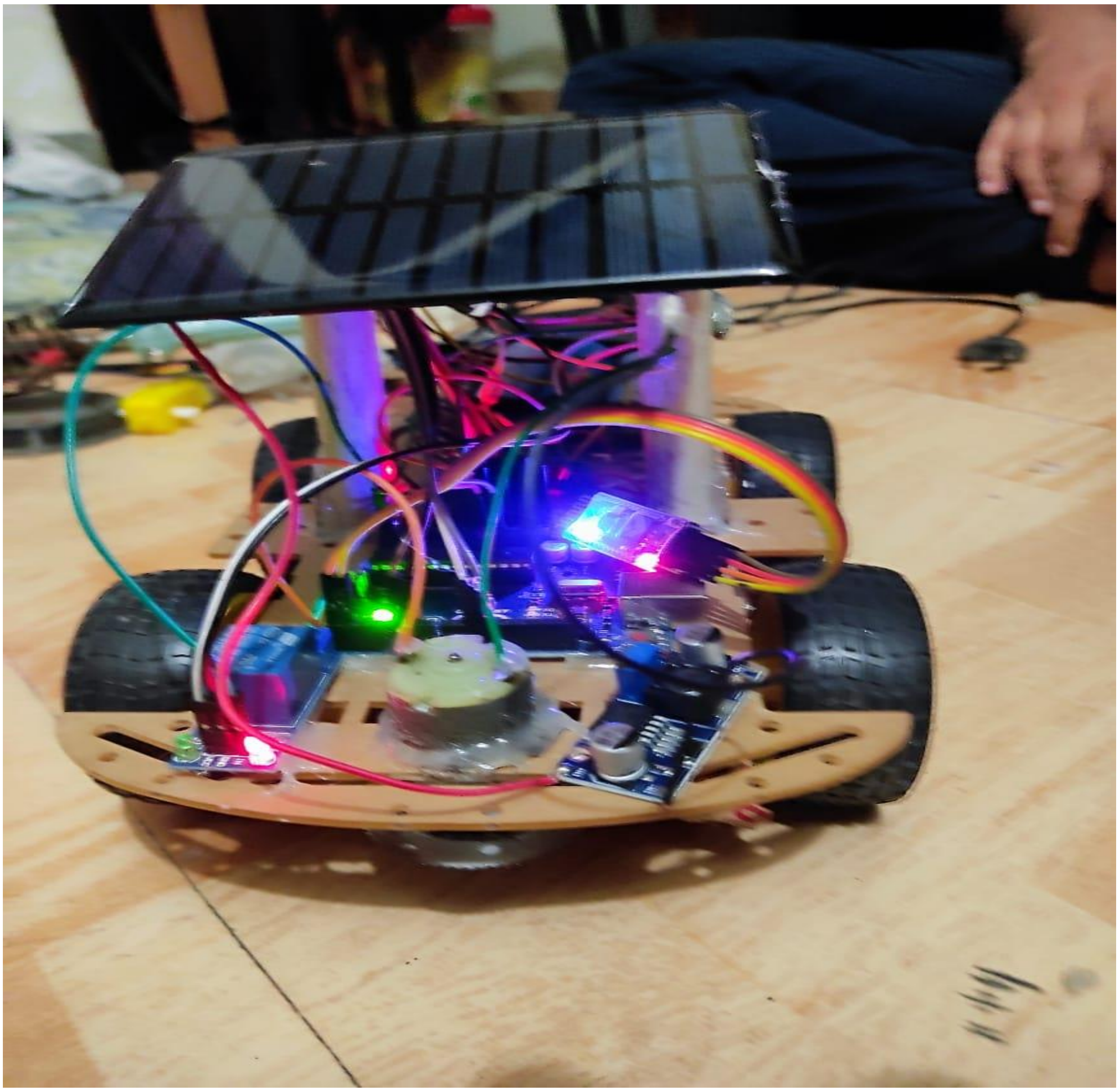


Figure-9: Project

We had successfully connected an android application that will provide user an interface to interact with the arduino powered vehicle. The interface is easy to use and provide feedback from the arduino microprocessor through the bluetooth after giving instruction to arduino for various actions through interface via bluetooth module. An appropriate program in the arduino microprocessor to interact with the android controller has been created successfully. The program has been successfully complied through arduino IDE to the arduino microprocessor & loaded in to it after proper checking of logic to decrease any loss/damage of hardware.



CHAPTER 7

7.1 DISCUSSION

DISCUSSION

In the course of developing this project we have achieved the following milestones. The solar grass cutter has been created successfully and testing has been done for all the known cases regarding the usage of project. We had successfully connected an android application that will provide user an interface to interact with the arduino powered vehicle. The interface is easy to use and provide feedback from the arduino microprocessor through the bluetooth after giving instruction to arduino for various actions through interface via bluetooth module. An appropriate program in the arduino microprocessor to interact with the android controller has been created successfully. The program has been successfully complied through arduino IDE to the arduino microprocessor & loaded in to it after proper checking of logic to decrease any loss/damage of hardware. The project has completed its aim to designing an automated solar grass cutter with program in to the arduino microprocessor. This solar grass cutter was basic mobility features. The grass cutter which will be get rotating power by using motor and the motor will be powered by battery. We are also able to control this vehicle as per our requirement in the field of application. So we think this solar grass cutter will have much potential in the field of agricultural.

Conclusion

7.2 CONCLUSION

In this work solar powered grass cutter has been successfully fabricated built in with microcontroller. Generally, the solar grass cutters are disadvantageous which we have already discuss in chapter 2 in the sense of unfriendly for our environment as well as human life by producing harmful gas. These kinds of problems have been solved using solar vehicle which gives us little more comfort in the sense of environment pollution. The efficiency of the solar panels which is used to produce electricity i.e. power to operate this vehicle and at the same time to rotate to grass cutting blade. As we have been seen that future energy which will be used should be clean and environment friendly so we have to focus our agricultural activity on renewable energy like solar energy. On this issue, we can design and manufacture this type of solar power based grass cutter in coming year which we think very useful for practical application. The future of energy sector lies solely on alternative energy resources. The cost of this type of grass cutter is more costly than the conventional one but they are more efficient and cause less exhaust emissions. This challenge now can turn out to be a good scope for further development of a pollution free grass cutter. The project titled solar grass cutter using Arduino is an application based on popular open source technology - Android and Arduino The aim of the project was to create an arduino integrated with the vehicle that has to be controlled through an application that runs on the android operating system. The project has been completed with success with the utmost satisfaction. The constraints square measure met and overcome with success. The system styled /is meant/ is intended as find it irresistible was set within the design section. Validation checks iatrogenic have greatly reduced errors. Provisions are created to upgrade the code. The applying has been tested with live information and has provided a prosperous result. Thence the code has proven to figure expeditiously. The system created met its objectives, by being straightforward to use, implement and secure. This code is developed with measurability in mind. Further modules may be simply other once necessary. The code is developed with standard approach. All modules within the system are tested with valid information and invalid information and everything work with success. The project The project has been completed with success with the utmost satisfaction. The constraints square measure met and overcome with success. The system styled /is meant/ is intended as find it irresistible was set within the design section. Validation checks iatrogenic have greatly reduced errors. Provisions are created to upgrade the code. The applying has been tested with live information and has provided a prosperous result. Thence the code has proven to figure expeditiously. The system created met its objectives, by being straightforward to use, implement and secure. This code is developed with measurability in mind. Further modules may be simply other once necessary. The code is developed with standard approach. All modules within the system are tested with valid information and invalid information and everything work with success. We hope this type of solar grass cutter is highly feasible and suitable in the séance of modernization of our agricultural sector and where need it should be well fitted.

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