IC 201P – Design Practicum

Solar Powered Ground maintenance system

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Certificate

This is to certify that the work contained in the project report entitled "Solar Powered Ground Maintenance System", submitted by Group 48 to the Indian Institute of Technology Mandi, for the course IC 201P – Design Practicum, is a record of bonafide research works carried out by them under our direct supervision and guidance.

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Abstract

The paper proposes an innovative, effective method for cutting grass that is also environmentally beneficial. The system comprises a mobile-controlled solar-powered grass cutter. The tool is furnished with a blade that can swiftly and accurately cut grass. Additionally, the machine has a motor that assists in sweeping the chopped grass into a storage chamber.While the remote control ensures that the user may watch and control the functioning of the device from a safe distance, the use of solar energy enables entirely independent operation. The technique is extremely effective, requiring less time and effort to cut the grass, and is perfect for usage in parks, golf courses, and other outdoor spaces. The suggested method provides the operator with a high degree of comfort and ease of use while also offering a sustainable and economical solution to the issue of grass cutting.

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Chapter 1

Introduction

Our project aims to provide an economical and environmentally responsible solution to the problem of sustaining large fields of grass or plants. Traditional maintenance techniques, including using gasoline-powered lawnmowers or physical work, can be costly and environmentally damaging. We have a more effective, economical, and greener solution: a remote-controlled, solar-powered grass cutter. Costs and environmental effects are decreased because it doesn't require gas or electricity to operate. The remote-control capability enhances control and precision, improving the effectiveness and efficiency of maintenance. The remote-controlled, solar-powered grass cutter is easy to operate. With your phone acting as a remote, you can operate it by giving Arduino commands. These commands then direct the motors, which move the lawn cutter. Additionally, the front of the vehicle has an ultrasonic sensor that can detect an object and halt the wheels, avoiding any collisions. The grass is continuously cut by the grass cutter motor, and a storage area for the grass is collected by the sweeper cleaner at the back. The lawn cutter motor's height is another adjustable feature. As its name implies, the grass cutter is powered by solar energy. However, we also provide a charging alternative, enabling the solar panel to be taken off.

Problem statement: The lawns and open areas on a campus will demand less time and human effort thanks to our project's design. This means that it will greatly aid in streamlining and improving the maintenance procedure.

The remote-controlled, solar-powered grass cutter improves the market in several ways. By effectively cutting grass with little human involvement, lowering labor expenses, and boosting production, it saves time and labor. It is also an alternative that supports sustainable practices and is simple to use, especially for novice users. In addition to being more affordable than standard lawn mowers, the grass cutter has low running and maintenance costs, making it a smart long-term investment.

Chapter 2

Market Research

The process of gathering and examining data regarding a product's potential buyers, rivals, and market trends is referred to as market research. It is essential to producing a product and coming up with a winning marketing plan. Numerous techniques, including surveys, focus groups, interviews, and data analysis, can be used in market research. Here, the research is carried out by looking at a variety of online surveys and interviews. We referred to the workers who had the job of maintaining the grass beds across the entire campus. We observed that since there were only a few hand held grass cutters on campus the rest had to use a sickle to manually cut the grass in the scorching sun . Grass cutting and collection services are needed by both households and the government (to maintain diverse lawns and gardens of various government institutions), as we discovered after performing a case study. The capacity for collecting grass and the cutting width and height were determined to be the most crucial elements.

We have not found anything which is similar to our concept of integrated solar powered grass cutter and grass collector that intends to offer the option of charging the battery in either way the solar panel is kept attached to the model or it can also be detachable.

In our research,we found that currently 60% of the users use a gas-powered lawn mower, 30% use an electric and battery lawn mower while the remaining others use a manual lawn mower. A gas-powered lawn mower, naturally, use petrol as fuel and is capable of delivering the maximum power and should be considered for lawns over 200 meters square or where mowing the lawn may be difficult due to slopes or uneven surfaces.It is also relatively inexpensive.But it requires significant maintenance regularly,can be difficult to start, it necessitates pre-start routine (check oil and gas levels) and the most importantly, it is not at all environmentally friendly since it pollutes the air and generates noise. With enough power, an electric lawn mower can mow as many lawns as those that are less than 300 square meters in size. An electric power mower has the benefit of being low maintenance because there is no engine to maintain. Electric lawn mowers are far lighter than gasoline lawn mowers and emit no harmful exhaust fumes, but they are more expensive, corded versions' restricted reach and potential for tripping hazards, the possibility of electrical issues in damp environments, the lower runtime of cordless versions, and their inability to effectively tackle tall or thick patches of grass are some of its negative factors. A manual lawn mower causes less sound,uses no fuel or oil, is lightweight, there are no strings-pulling to start it up and there is no exhaust. But it is not very efficient, you have to keep sharpening the blades which could be quite challenging and regular maintenance is a must to get the best performance making it a little bit high maintenance.

A solar powered grass cutter that is made by using a twin solar panel of 75A/130W capacity each is capable of mowing a total area of 552 square meters of lawn with battery charging time of approximately 2 days.Here, though, for our prototype, we will be using one solar panel of 12V 20W.It will approximately take 17 hours of direct sunlight for our 7.5AH battery to get charge by our solar panel.The system will have some automation work for guidance and other obstacle detection.We are using a ultrasonic sensor for obstacle detection.We will also be using a bluetooth module to control the movement of mower.

Our product has environmental benefits,it is cost efficient and easy to use.With all the other calculations we will also focus on the product should have a cutting width and height, which should match client expectations, and its grass gathering capacity, which should be adequate for the target market.

In general, a solar-powered grass cutter may cost more upfront due to the inclusion of the solar panel and electronic components, but it may save money in the long run by not requiring fuel or electricity to operate. In contrast, a manual grass cutter may be less expensive upfront but will require more physical effort and may require ongoing expenses for fuel or electricity if it is motorized. Additionally, a manual grass cutter may not be as efficient or accurate as a solar-powered grass cutter, which may impact its effectiveness and overall value.

Table-1

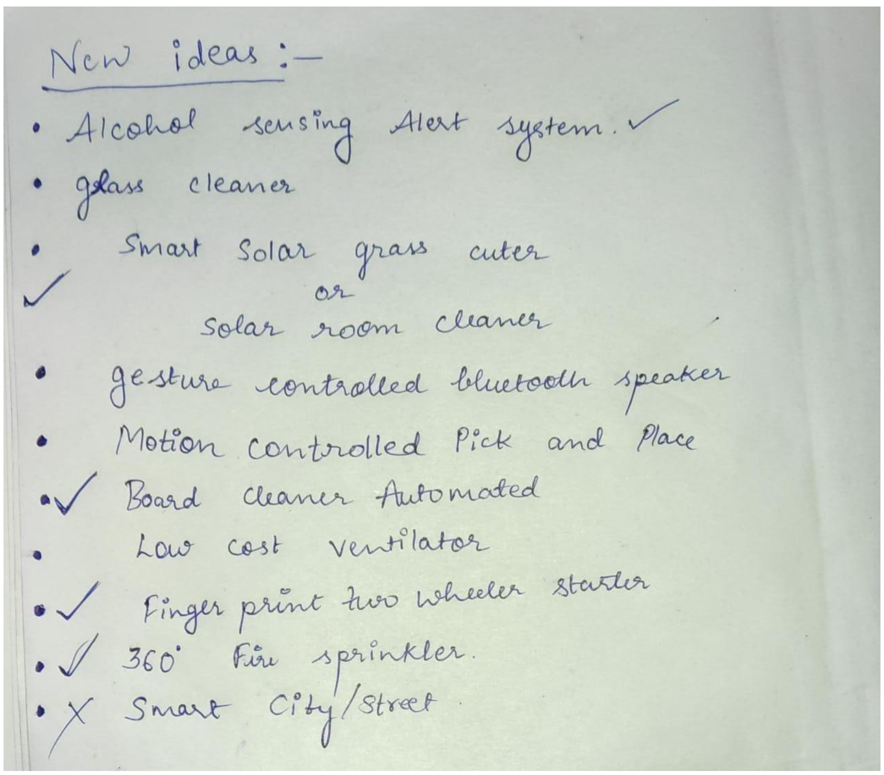
Feature	Solar-Powered Grass Cutter	Grass Mower	Grass Cutter
Power Source	Solar panels, battery	Gasoline, electricity or battery	Manual
Cutting Width	Usually Less than 30 cm	Greater than 30 cm	Usually Less than 30 cm
Cutting Height	Adjustable	Adjustable	Fixed
Cutting Mechanism	Rotary Blades	Rotary Blades or Reel Blades	Reel Blades
Weight	Lighter than grass mower	Heavier than both solar and manual grass cutter	Lighter than grass mower
Noise Level	Quieter than grass mower	Can be noisy	Silent
Environmental Impact	Zero Emission	High Emission	Zero Emission
Maintenance	Minimal	Regular	Minimal
Cost	20,000	30,000	10,000

Chapter 3

Conceptual Design

- We initially had spent two weeks on finalizing an idea and finally came up with a list of 10 ideas . Out of these 10 ideas we were able to narrow it down to 5 out of which the solar powered grass cutter seemed the most feasible and open to more innovations .

  The ideas in our initial stage were as follows :



New ideas :-

- Alcohol sensing Alert system. ✓
- glass cleaner
- ✓ Smart Solar grass cuter or Solar room cleaner
- gesture controlled bluetooth speaker
- Motion controlled Pick and Place
- ✓ Board cleaner Automated
- Low cost ventilator
- ✓ Finger print two wheeler starter
- ✓ 360° Fire sprinkler.
- ✗ Smart City/Street

Fig-1 : Initial Ideas

While we were considering all the ideas we observed that for maintenance of the ground, an old mower is used in many areas which causes air pollution due to the combustion of fuel.Also our mentor suggested choosing the problem which is basic and can help solving the day-to-day problems.Seeing all this,we decided to go for Solar Powered grass Mower which has integrated grass collection system to solve not one but several problems like pollution,wastage collection etc at the same time.These problems forced us to think of some solution to make a device that can cut the grass with less air pollution, for this the device should not use fuel.Modern mowers use electricity instead of fuel to power the mower. But as we know that electricity needs to also be saved. For this, we can use solar energy to run the grass cutter.So, we made a solar grass cutter to solve these problems and we have added grass cleaner to this also to clean the grass after cutting.

Brainstorming and Idea generation –

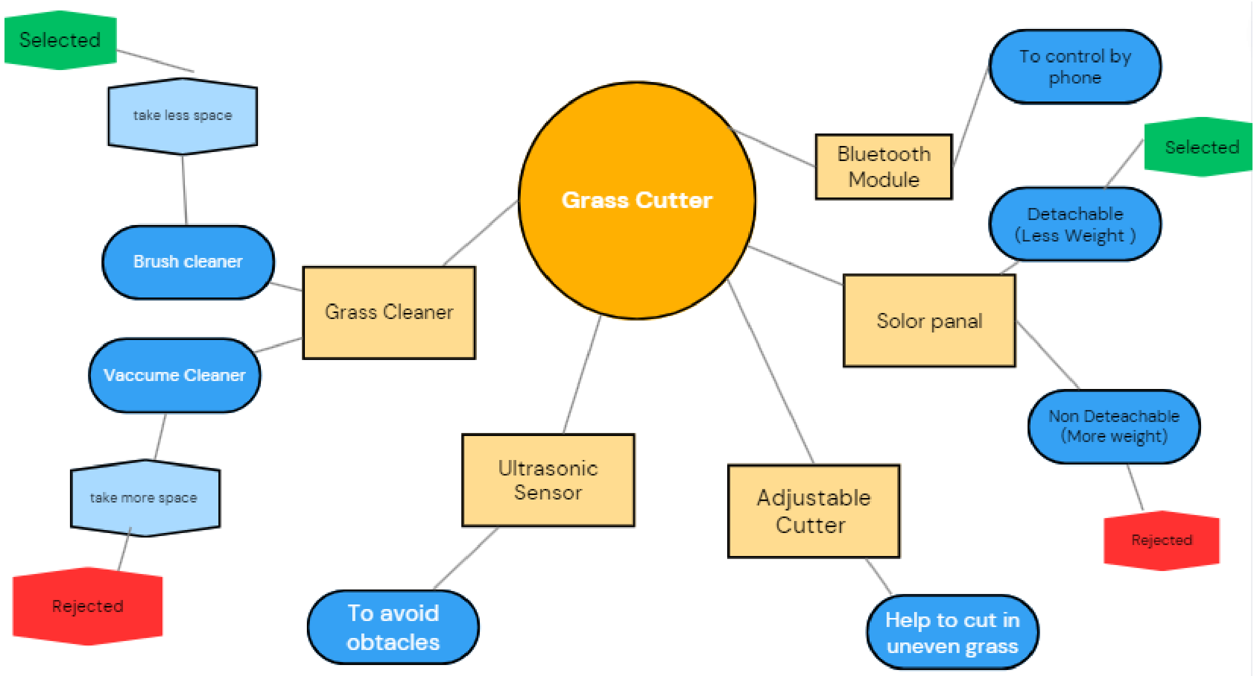


Fig-2 : Idea Finalization

We framed the problem and presented it to mentors, who discussed it with us and helped us narrow it down. They also walked us through the obstacles we would face throughout the ideation process.After that, we got together and talked more about it, covering topics like how problematic the current system is, how challenging it is to use solar panel, how we're going to manage the motion, and other issues that might be resolved utilizing the tools at our disposal.We examined the working of Solar Panels.We did our research on it and discussed it with faculty members who had previously worked with solar panels.We find out several things like.We brainstormed to decide what are the components we ought to use and what other requirements are related to it. We once more held a number of brainstorming sessions where we talked about the costs associated with each mechanism as well as other issues like splitting the task, creating a CAD model, designing the fundamental structure of our prototype, choosing the material, and setting deadlines.We developed a solution for our problem statement after deliberating on all facets of the issue and potential obstacles.

- **Selection** of the most viable ideas proposed.

Idea 1. The first idea was to make a simple bluetooth controlled grass cutter with a battery. Since a huge chunk of the population has smartphones, it was decided to make the device portable to any android application so that it would take a simple installation and setup to start using our machine.

Idea 2. Charging the battery of a bluetooth controlled grass cutter by solar power. We would have to first research the methods by which we could charge our battery . We were unsure between 20 W panel and 12 W solar panel needed. We also learned while ideating that a solar charge controller was needed.

Idea 3. Adding a grass collector as a grass cleaner that will clean the grass after cutting. We were thinking of using an Brush in a sweeping motion to collect the grass.

Idea 4. Including an ultrasonic sensor in the front to detect obstacles or small rodents like squirrels. This was to ensure that the grass cutter does not get stuck or the grasscutter doesn't cause an accident while cutting.

Idea 5. Creating an adjustable height mechanism for the grass cutter from scratch to give the user the choice of what height he wishes to cut the grass to.

- We rejected the Smart Street idea as it was far too complex and could not be completed in the given time frame.Gesture Controlled bluetooth speaker was a good idea but it was attempted earlier as well and we were not able to come up with good and efficient modifications.Glass Cleaner was rejected as few other teams were trying to attempt it and we didn't think that there is much we can modify in it to make the product unique and distinguishable.Due to the dearth of effective suggestions for the changes that could be made, a number of other proposals were also rejected.We selected our current solar power grass cutter idea based on what we observe and believe needed a solution,which we think we can implement keeping in mind the time frame given to us and budget limit.We mainly focused to reduce the pollution caused and find a sustainable solution for our problem which is environmental friendly as well as efficient enough.These issues compelled us to consider a way to create a device that can cut grass while producing less air pollution and in order to achieve this, the gadget should not need fuel.Hence we proposed a device that will use solar power to recharge its battery using various components and we decided to integrate a grass collection system in order to have a proper waste management system.We decided to keep the solar panel detachable in case if there is hindrance in the motion of model due to increased weight then it can resolved.

Chapter 4

Embodiment and Detailed Design

1. **Product architecture -**

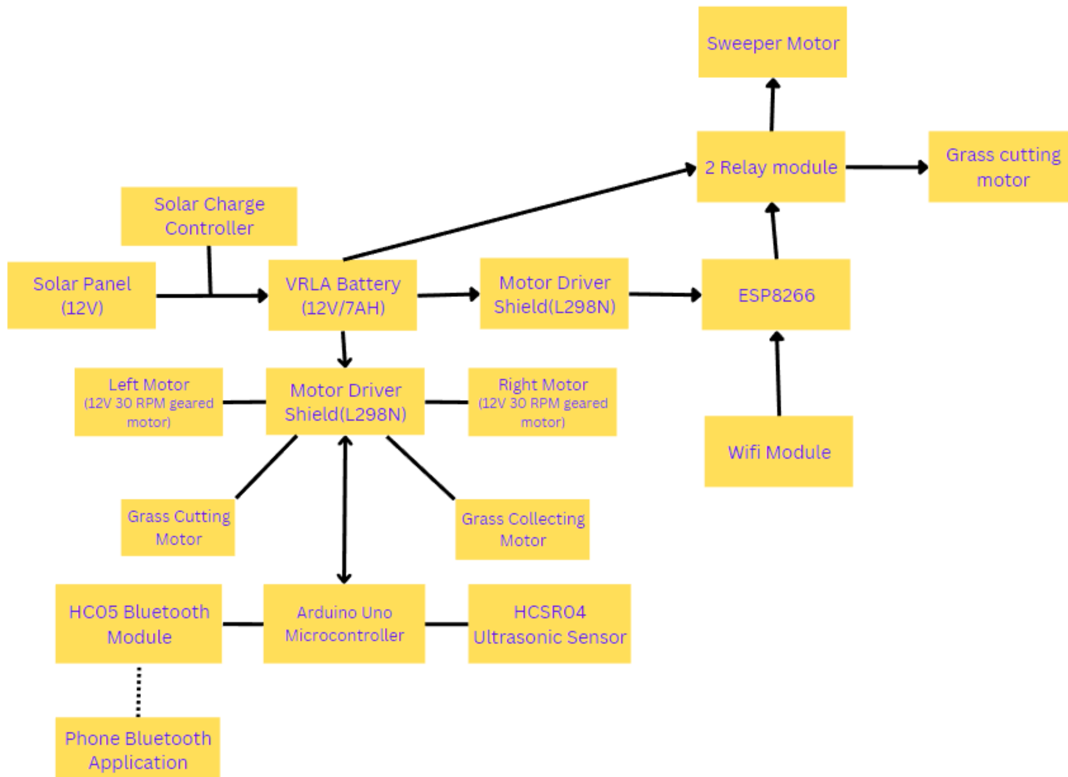


Fig-3 : Block diagram of components

The model consists majorly of 3 phases into which the components are divided based on the disjoint areas of use: Power Generation , Mechanical Components , Sensory and Communication Devices:

- Power Generation : Since our project is based on harnessing the renewable energy in the solar form it is crucial to have a solar panel to aid in conversion of energy , a solar charge controller to maintain a constant voltage , a battery to store this energy produced and a motor driver shield to distribute this power to components .
- Mechanical components : This majorly consists of 2 high torque motors to carry the weight of the components along with the grass collected and includes the grass cutting motor which has to be high speed and low torque to ensure smooth and even cutting of the grass by the aid of a blade attached

to the shaft adapter . Finally we have a motor that ensures the cut grass is collected in a box by the sweeping rotation.

- Sensory and Communication Devices: These components are essential to ensure that core working of the robot is executed . They provide the functionality of creating a communication network channel between the first 2 components . These include an Arduino Microcontroller that is the brain of the model and instructs every component along with a Ultrasonic sensor to detect any underlying obstacles to course correct the robots path. Bluetooth module to receive instructions from the mobile phone which may be at any distance .

2. **System-level design -**

The working of our robot is relatively easy to understand . We are trying to power four motors at once simultaneously using a motor driver shield. Thai motor driver shield powers the motor based on the input it gets from the arduino microcontroller . This arduino uno passes the command received from the bluetooth module to shield to carry out instructions from the mobile application. The battery which 12 V 7AH provides the power needed to run these 4 motors.

The battery has to be charged to replenish its charge. Here is where our solar panel comes in . It captures the sunrays to generate a voltage greater than 13.6 volts to charge the battery . A solar charge controller ensures a steady flow of current to the battery and stops charging when the battery is fully charged .

Two of the motors are needed to move the model which is constantly changing its direction and motion to cause curvilinear motion. The grass cutter motor is connected to a shaft adapter which holds the blade that we built to cut the grass. The motor at the back is for grass sweeping application to sweep the grass into the collection box.

The power generation components consist of a solar panel , solar charge controller, battery and a motor driver shield. Their functionality is as follows:

- **SOLAR PANEL** : The solar panel that we have used is compatible with a 12 V lead acid battery at a power rate of 12 Watts which is the optimal charging rate according to our research . The solar panel actually generates a voltage greater than 13.6 V when hit by sunshine because this is the threshold voltage above which a device can charge a 12 V battery under worse conditions . Solar panels (Mono or Polycrystalline) are created from multiple ‘wafers’ of silicon connected together in series and/or parallel to form a solar ‘module’. These wafers are created from silicon ingots. The underlying principle in a solar panel is the photovoltaic effect. At the base level the solar cells are made up of 2 layers of silicon that are doped with a pentavalent (n type) or trivalent (p type) material to create a disturbance in equilibrium. This creates an electric field at the junction between the two layers . These electrons move from n-type layer to the p-type layer resulting in formation of depletion zone.

Fig-4 : Solar Panel

When sunlight strikes a solar cell, electrons in the silicon are ejected, which results in the formation of “holes”—the vacancies left behind by the escaping electrons. If this happens in the electric field, the field will move electrons to the n-type layer and holes to the p-type layer. If you connect the n-type and p-type layers with a metallic wire, the electrons will travel from the n-type layer to the p-type layer by crossing the depletion zone and then go through the external wire back of the n-type
layer, creating a flow of electricity. This flow of electricity is further diverted to a solar charge controller to convert it into a stable form for use .

- **VRLA BATTERY (12V/7AH)** : In recent years, the use of VRLA (Valve-Regulated Lead-Acid) batteries, a form of rechargeable battery, has grown significantly, especially for emergency lighting, UPS systems, and backup power for telecommunications. In a sealed casing, the battery's plates and electrolyte are located. The electrolyte is absorbed into a separator substance, preventing spillage, and enabling the recombination of gas produced during charging. The valve releases extra gas during charging while controlling the pressure inside the battery. In contrast to conventional lead-acid batteries, VRLA batteries are rechargeable, have a longer lifespan, and are built for deep discharges. They are dependable backup power sources for important applications because of these properties. Due to the greatly decreased risk of explosion or fire, they are much safer to use.

Fig-5 : VRLA battery 7AH

- **DC-DC BOOST CONVERTER** : A DC-DC boost converter is an electronic circuit that increases the voltage of a DC power source to a higher level. To increase the voltage, it commonly employs two switches, an inductor, a diode, and a capacitor. The first switch closes and the second switch opens when the input voltage is supplied, allowing the inductor to store energy. The inductor transfers its stored energy into the load when the first switch is opened, increasing the voltage. The capacitor evens out the output voltage while the diode stops current from flowing back to the source of input. The boost converter's efficiency is determined by the parts utilized and the control circuitry.

- **MOTOR DRIVER SHIELD** : A motor driver shield L298N is used here.In robotics and automation, the L298N motor driver chip is employed. For DC or stepper motors, it regulates the direction and speed. It can manage voltage and motor rotation by switching the transistors in H-bridges. It makes precise movement control easier by coupling motors with a microprocessor

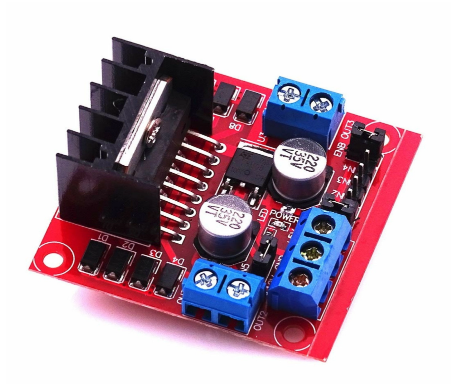


Fig-6 : Motor driver shield L298D

- **GEARED MOTOR(12V 30RPM)** : A geared motor is an electric motor and gearbox combination that generates a lot of torque at low speeds. The gearbox is helpful in robotics, automation, and industrial equipment because it lowers the motor's speed while boosting its torque.The motor has a rated torque of 254 N cm. When an electric current is passed through the motor's coils, a magnetic field is created that interacts with a permanent magnet to produce rotational motion. This motion is then transmitted to the output shaft via the gearbox, which offers a high torque output for precise motion in a variety of applications.

Fig-7 : Geared motor(12V 30RPM)

- **BLUETOOTH MODULE (HC05)**:· The Bluetooth module HC-05 is a wireless communication device that creates a short-range wireless connection between two devices using Bluetooth technology. It has a range of up to 10 meters and operates in the 2.4 GHz band. The module may be set up using AT commands to modify its parameters and communicate with the host device via a serial interface. The AT command mode and the data mode are the two modes in which it can function. The host device can send and receive data using the Bluetooth connection when it is in data mode, which transforms it into a wireless serial port.

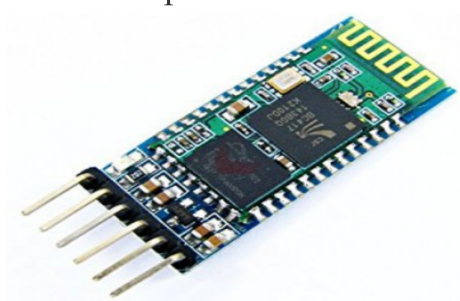


Fig-8 : HC05 Bluetooth module

- **ULTRASONIC SENSORS (HCSR04)** : Ultrasonic sensors like the HC-SR04 are frequently used in projects to detect distance. Triggering, transmission, receiving, and calculating are the sensor's four primary processes. The sensor emits a burst of sound waves in response to a trigger signal from the microcontroller. The waves propagate through the atmosphere, hit a target, and are picked up by the receiver. An electrical pulse is produced by the receiver and returned to the microcontroller for processing. Based on how long the sound waves took to travel, the microcontroller determines how far away the object is. The sensor needs a steady power source, and sound waves must be able to bounce off a surface perpendicular to the sensor for precise measurements.

Fig-9 : HC-SR04

- **ARDUINO UNO Microcontroller** : The Arduino Uno's microprocessor runs the programme created in the Arduino Integrated Development Environment (IDE) and communicates with the board's inputs and outputs to carry out the intended activities.The board features a variety of input/output pins, including digital input/output pins, analogue input pins, and PWM output pins. The analogue input pins can be used to read data from sensors like temperature sensors, light sensors, and more, and the digital input/output pins can be used to control LEDs, motors, and other electrical devices. To regulate the brightness of LEDs or the speed of motors, analog-like signals can be produced using the PWM pins. Additionally capable of serial transmission, the Arduino Uno can be fueled by a USB connection or an external power source. The Arduino serves the function of processing the signals received by the bluetooth module and relaying the necessary instructions to all 4 motors including ones related with motion , grass cutting and collection.

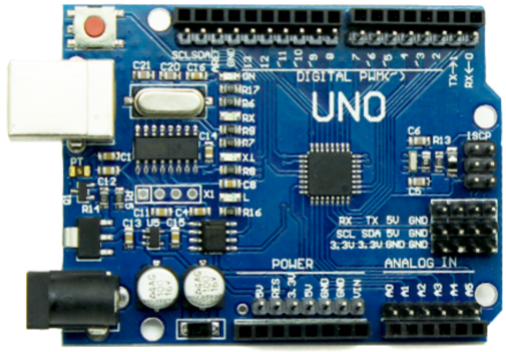


Fig-10 : Arduino Uno

- **RS775 HIGH SPEED MOTOR** : High-power motors like the RS775 DC motor are frequently employed in a variety of applications. It uses electromagnetic theory to function. A stator with copper windings and a rotor made of permanent magnets are both found inside the motor. The windings produce a magnetic field when an electric current passes through them, which causes the rotor to spin. The speed and direction of the motor can be adjusted by adjusting the direction and volume of current fed to the windings. Due to the RS775 motor's high torque and power characteristics, it is well suited for high speed machinery involving cutting.


Fig-11 : RS775 high speed motor

- **MOTOR SHAFTS :** Shaft dead axles are non-powered axles that are used in motors to sustain and direct the output shaft's rotation. Its size, which is typical for small motors, is shown by the 6mm diameter. It ensures appropriate alignment and effective power transfer to the load by supplying stability and preventing excessive force from being placed on the motor's bearings. The shaft dead axle's purpose is to increase the motor's toughness and performance.The output shaft of the motor is supported and guided during rotation by the shaft dead axle, a stationary component that improves the performance and longevity of the motor by reducing stress on its bearings.

- **ESP8266:**A popular Wi-Fi microcontroller module for Internet of Things (IoT) projects is the ESP8266. It enables devices to connect to Wi-Fi networks and communicate online by fusing a microcontroller unit (MCU) with Wi-Fi capabilities. You can use Arduino or other development platforms to programme the ESP8266. Its MCU runs programmes, manages attached sensors or actuators, and communicates with other devices through Wi-Fi. It can host web servers, serve web pages, and transport data to and from remote servers because it supports TCP/IP protocols. It is a popular option for IoT applications due to its small size and low cost.

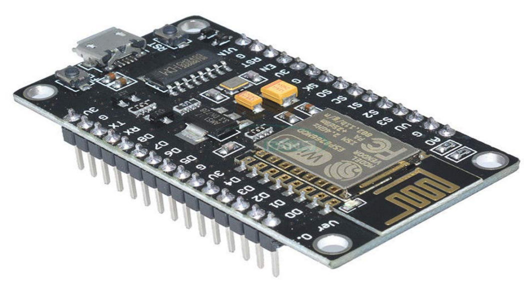


Fig-12 : ESP8266 WiFi module

- **MPPT CHARGE CONTROLLER:**Solar power systems employ MPPT (Maximum Power Point Tracking) charge controllers to maximize the effectiveness of charging batteries. To function at the maximum power point, where the solar panels produce the most electricity, they continuously change the voltage and current from the panels. By keeping track of this moment, MPPT controllers draw the greatest amount of energy possible from the solar panels and transmit it to the batteries, resulting in quicker battery charging and greater system efficiency.

Fig-13 : MPPT charge controller

3. **Design configuration -** In the manufacturing process of our product, we chose to use a wooden sheet as the base. This decision was based on the fact that wood is lighter in weight and less expensive compared to other materials, and it also has a higher weight-bearing capacity, making it suitable for our needs. To create the necessary holes for our design, we used drilling, which allowed us to create precise holes in the wood. We then attached the motor mount to the wooden sheet using screws, providing a secure and stable connection. We also made sure to include a 10x20 cm hole to provide enough space for the sweeping of the cut grass. To provide a suitable height to our product and allow for a variable-speed grass cutting motor, we used 10 x 4 cm robotic wheels. We designed the collection box to be 15x30 cm, providing ample space for the cut grass to be stored, which increased the product's run time. By allowing for a larger collection box, our product can cut a larger length of grass, making it more efficient. To ensure stability in our design, we placed the battery and Arduino in the center of the model. We then placed the collection box at the end above the motor to provide space for the grass to accumulate between the brush and the 10x20 cm hole. As the brush is slightly in front of the hole, this design allows for efficient sweeping of the cut grass. Additionally, we decided to make the collection box transparent to enable the user to easily monitor the amount of grass that has been collected at any given time. Overall, our design process focused on creating a product that is both efficient and cost-effective. By using wood as the base and carefully designing the necessary components, we were able to create a product that meets our needs while still being affordable and functional.

4. **Detailed design –** This must include the following:
   - **Electrical/Electronics aspect:**

   The electronic devices included in our model are :

1)Arduino Uno R3
2)L298N Motor driver shield
3)HC05 Bluetooth module
4)HCSR04 Ultrasonic sensors
5) DC-DC Boost converter
6) Solar Panel 12V
7)Solar charge controller
8)Motors
9)Esp8266
10)Relay module
11)Breadboard

We were required to run four motors through our setup which included two motors of 12 V, 30 RPM and torque capacity of 254 N-cm and load current max of 1.55 A . We have two such motors .

Vin = 12V I = 1.3A

Power (geared) = 12*1.3*2 = 31.2W

The grass cutter motor has the speed 6980 RPM and has a torque of 22.5 N-cm

Vin = 12V I = 1.79 A

Power(high speed) = 12* 1.79 = 21.48W

The grass collection motor according to our estimate should be 1000 RPM at 12V

Vin = 12V I= 0.3A

Power (collection) = 12*0.3 = 3.6 W

Total Power Consumed (Theoretical) = 31.2 + 21.48 +3.6 = 56.28 W

The battery selected has an energy storage capacity of (12*7 =) 84 J

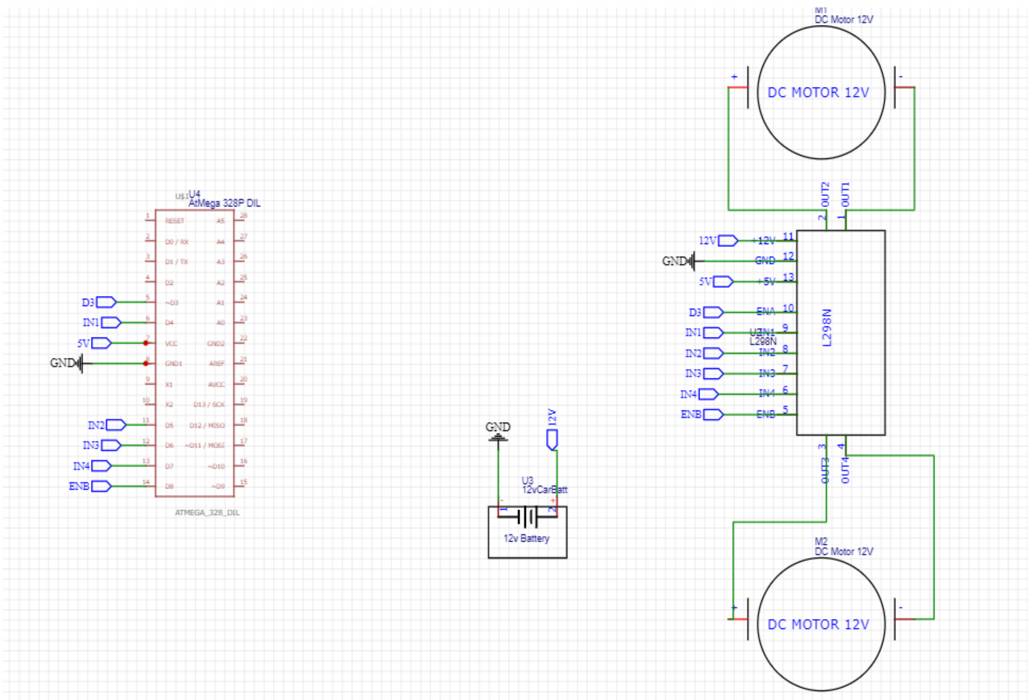


Fig-14 : Easyeda Diagram of base level grass cutter using Arduino

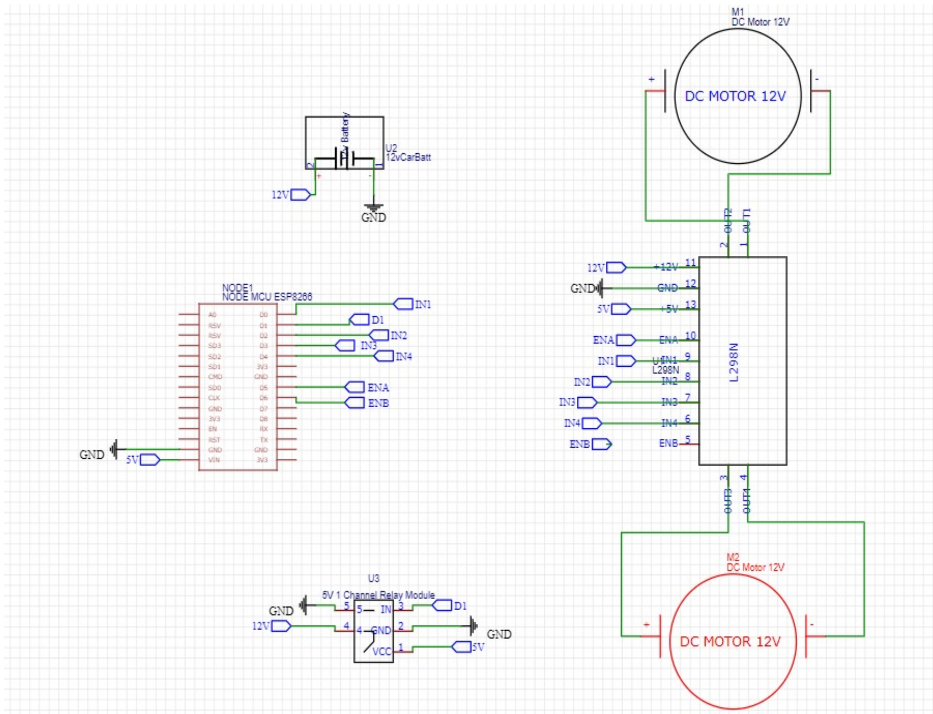


Fig-15 : Easyeda Diagram of base level grass cutter using ESP8266 and 1 channel relay module

- **Software part:** Algorithm and its analysis

  We have used a bluetooth module and ultrasonic sensor on the same microcontroller based on whose input the PWM pins provide signals to the motor driver to run the motor.

```
int ena = 3;
int enb = 10 ;
int in4 = 12;
int in3 = 8;
int in2 = 7;
int in1 = 4;
char val;

byte trig = 2;                          //Assign the ultrasonic sensor pins
byte echo = 13;
byte maxDist = 150;                     //Maximum sensing distance (Objects further than this distance are ignored)
byte stopDist = 50;                     //Minimum distance from an object to stop in cm
float timeOut = 2*(maxDist+10)/100/340*1000000;   //Maximum time to wait for a return signal


int speed1 = 125;
void setup()
{
pinMode(ena, OUTPUT);
pinMode(enb, OUTPUT);
pinMode(in4, OUTPUT);  // Digital pin 10 set as output Pin
pinMode(in3, OUTPUT);  // Digital pin 11 set as output Pin
pinMode(in2, OUTPUT);  // Digital pin 12 set as output Pin
pinMode(in1, OUTPUT);  // Digital pin 13 set as output Pin
Serial.begin(9600);
}

void loop()
{
  while (Serial.available() > 0)
  {
  val = Serial.read();
  Serial.println(val);
  }

  if( val == 'F') // Forward
    {
      digitalWrite(in4, LOW);
      digitalWrite(in3, HIGH);
      digitalWrite(in2, LOW);
      digitalWrite(in1, HIGH);
      analogWrite(ena,speed1);
      analogWrite(enb,speed1);
      distance = getDistance();
      if(distance <= stopDist)                    //If there are objects within the stopping distance, stop moving
     {digitalWrite(in4, LOW);
      digitalWrite(in3, LOW);
      digitalWrite(in2, LOW);
      digitalWrite(in1, LOW);
      analogWrite(ena,speed1);
      analogWrite(enb,speed1);
      }
```

Fig16 : snippets of code

In the above code we have connected the bluetooth module to read instructions sent by the mobile application to the robot. In1 and In2 respectively are used to control the direction of rotation of the left motor . Similarly in3 and in4 controls directions of right motor rotation by the manner of digital write which operates in high and low signals. We next set the speed of the motors speed1 and speed2 which takes values between 0 and 255. For the forward function we need both the wheels to move in an anticlockwise direction which is done by sending high signals to in3 and in1.

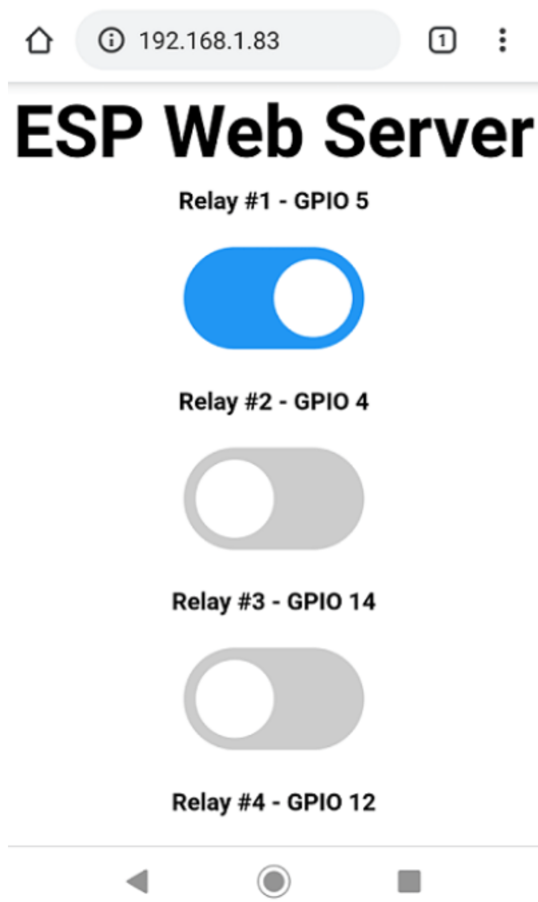
```
else if(val == 'B') // Backward
  {
   digitalWrite(in4, HIGH);
   digitalWrite(in3, LOW);
   digitalWrite(in2, HIGH);
   digitalWrite(in1, LOW);
   analogWrite(ena,speed1);
   analogWrite(enb,speed1);
    distance = getDistance();
   if(distance <= stopDist)                        //If there are objects within the stopping distance, stop moving
  {digitalWrite(in4, LOW);
   digitalWrite(in3, LOW);
   digitalWrite(in2, LOW);
   digitalWrite(in1, LOW);
   analogWrite(ena,speed1);
   analogWrite(enb,speed1);
   }

  }

  else if(val == 'L') //Left
  {
  digitalWrite(in4, LOW);
  digitalWrite(in3, LOW);
  digitalWrite(in2, HIGH);
  digitalWrite(in1, LOW);
  analogWrite(ena,speed1);
  analogWrite(enb,speed1);
   distance = getDistance();
   if(distance <= stopDist)                        //If there are objects within the stopping distance, stop moving
  {digitalWrite(in4, LOW);
   digitalWrite(in3, LOW);
   digitalWrite(in2, LOW);
   digitalWrite(in1, LOW);
   analogWrite(ena,speed1);
   analogWrite(enb,speed1);
   }

  }
  else if(val == 'R') //Right
  {
  digitalWrite(in4, HIGH);
  digitalWrite(in3, LOW);
  digitalWrite(in2, LOW);
  digitalWrite(in1, LOW);
  analogWrite(ena,speed1);
  analogWrite(enb,speed1);
   distance = getDistance();
   if(distance <= stopDist)                        //If there are objects within the stopping distance, stop moving
  {digitalWrite(in4, LOW);
   digitalWrite(in3, LOW);
   digitalWrite(in2, LOW);
   digitalWrite(in1, LOW);
   analogWrite(ena,speed1);
   analogWrite(enb,speed1);
   }

  }
```

```
int getDistance()                                    //Measure the distance to an object
{
  unsigned long pulseTime;                           //Create a variable to store the pulse travel time
  int distance;                                      //Create a variable to store the calculated distance
  digitalWrite(trig, HIGH);                          //Generate a 10 microsecond pulse
  delayMicroseconds(10);
  digitalWrite(trig, LOW);
  pulseTime = pulseIn(echo, HIGH, timeOut);          //Measure the time for the pulse to return
  distance = (float)pulseTime * 340 / 2 / 10000;     //Calculate the object distance based on the pulse time
  return distance;
}
```

The following function is used to produce the distance of a high enough obstacle from the front of the model. We calculated the distance using the time taken for the sound waves to travel back from the obstacle .Assuming the speed of waves to be 340 we then calculated the distance and returned to the calling function.

```
// Import required libraries
#include "ESP8266WiFi.h"
#include "ESPAsyncWebServer.h"

// Set to true to define Relay as Normally Open (NO)
#define RELAY_NO    true

// Set number of relays
#define NUM_RELAYS  5

// Assign each GPIO to a relay
int relayGPIOs[NUM_RELAYS] = {5, 4, 14, 12, 13};

// Replace with your network credentials
const char* ssid = "Howaru";
const char* password = "goldroger";

const char* PARAM_INPUT_1 = "relay";
const char* PARAM_INPUT_2 = "state";

// Create AsyncWebServer object on port 80
AsyncWebServer server(80);
```

The following code is used to access the esp82666 from our mobile phone using the inbuilt Wifi Module on esp8266. We send signals to the GPIO pins to turn on and off a motor by a relay switch . We had to set up the module first to catch our wifi network by connecting it to our hotspot. We then proceeded to use a code to note the Web Ip address of the Node MCU in order to open the webpage of the device.



We now control the grass cutter motor using the above relays. Currently we are using a 2 relay module so only relay 1 and relay 2 were of use here.We send the inputs through this webpage to the esp8266 which carries out the respective on/off operation in in1 or in2 of relay.

- **Mechanical Aspects:** Solid works model. Orthographic views and 3D view.

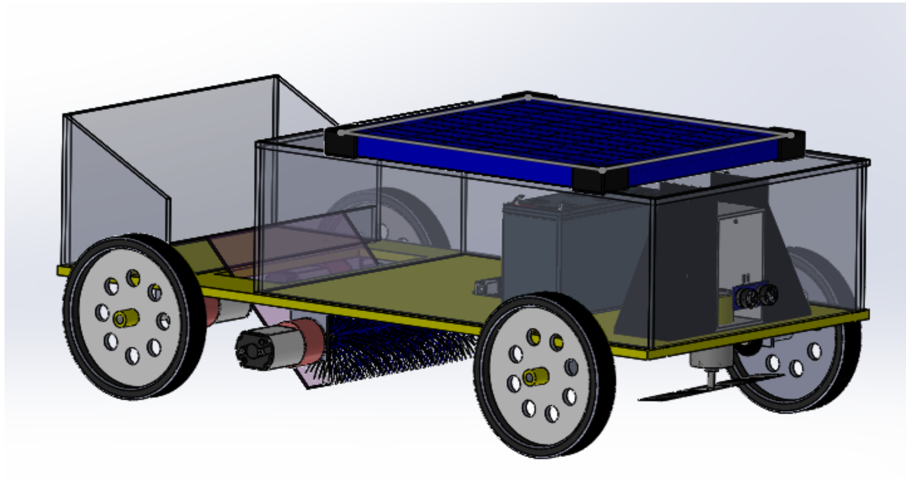


Fig-17 : Orthographic projection

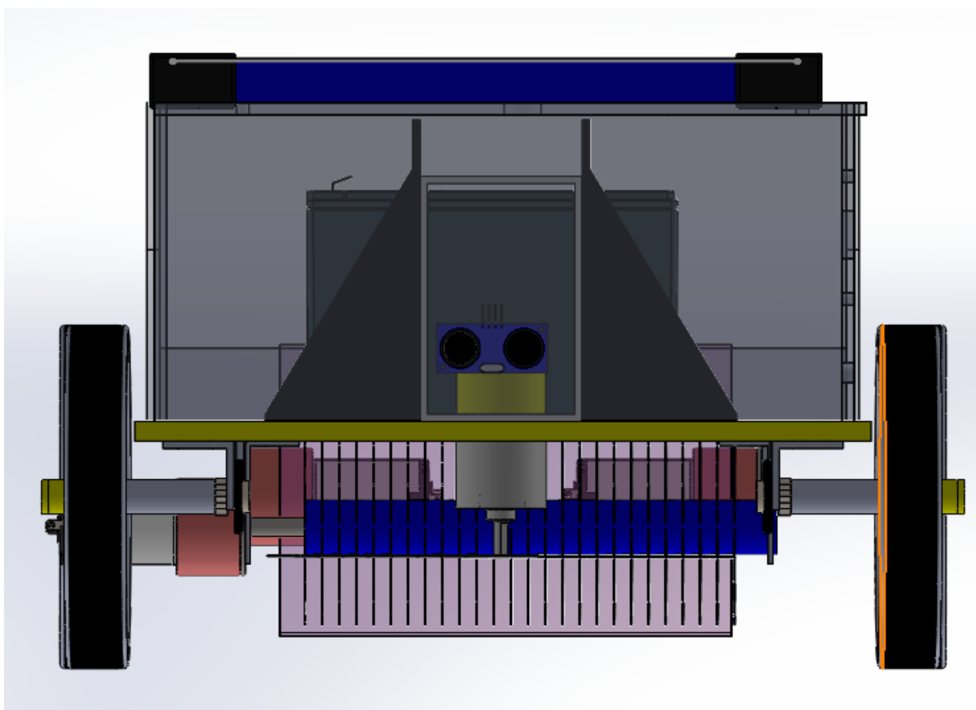


Fig-18 : Front view-1

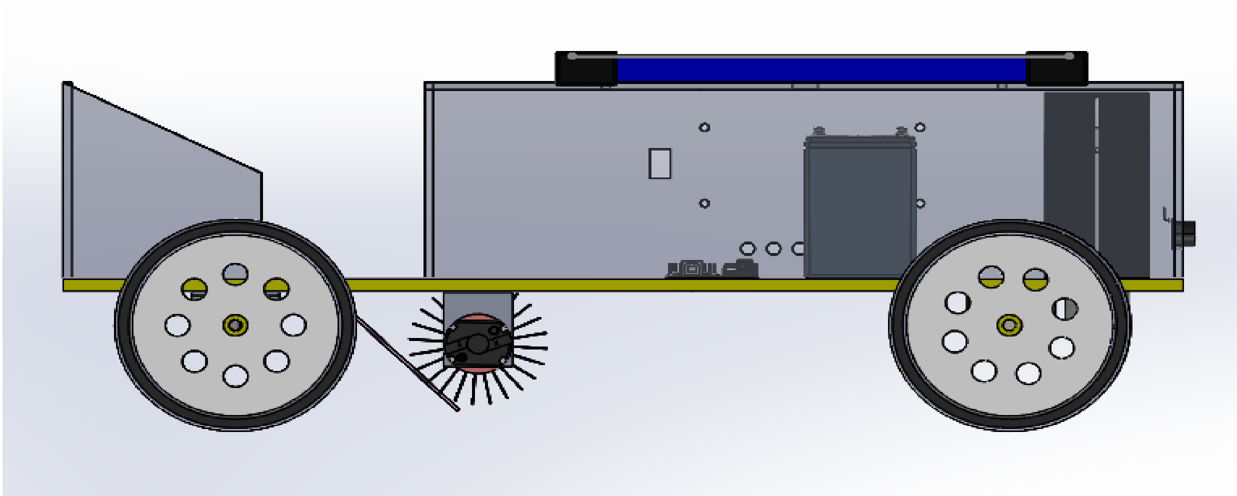


Fig-19 : Side view-2

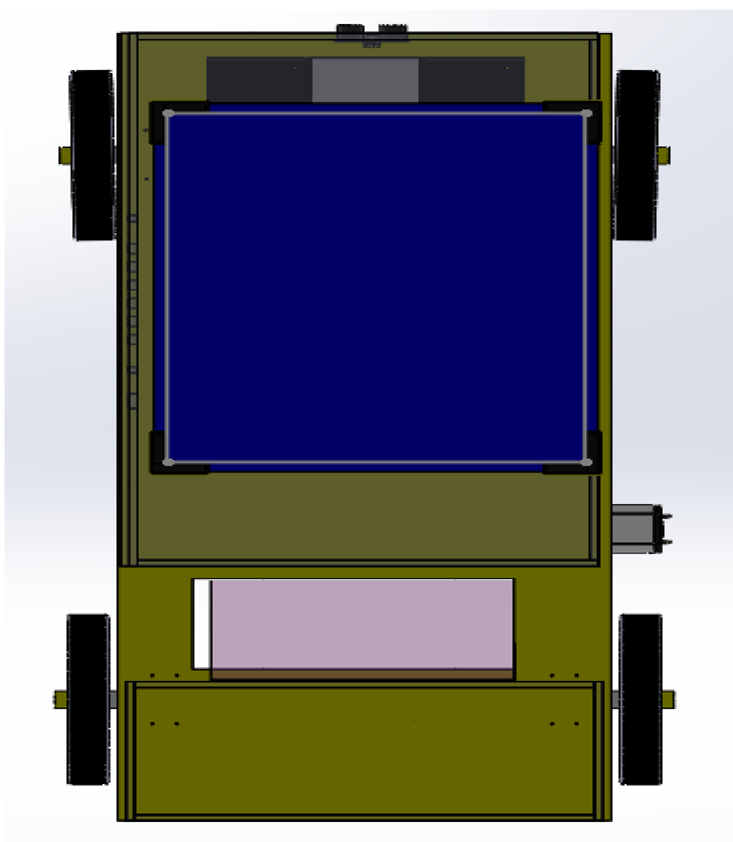


Fig-20 : Top View

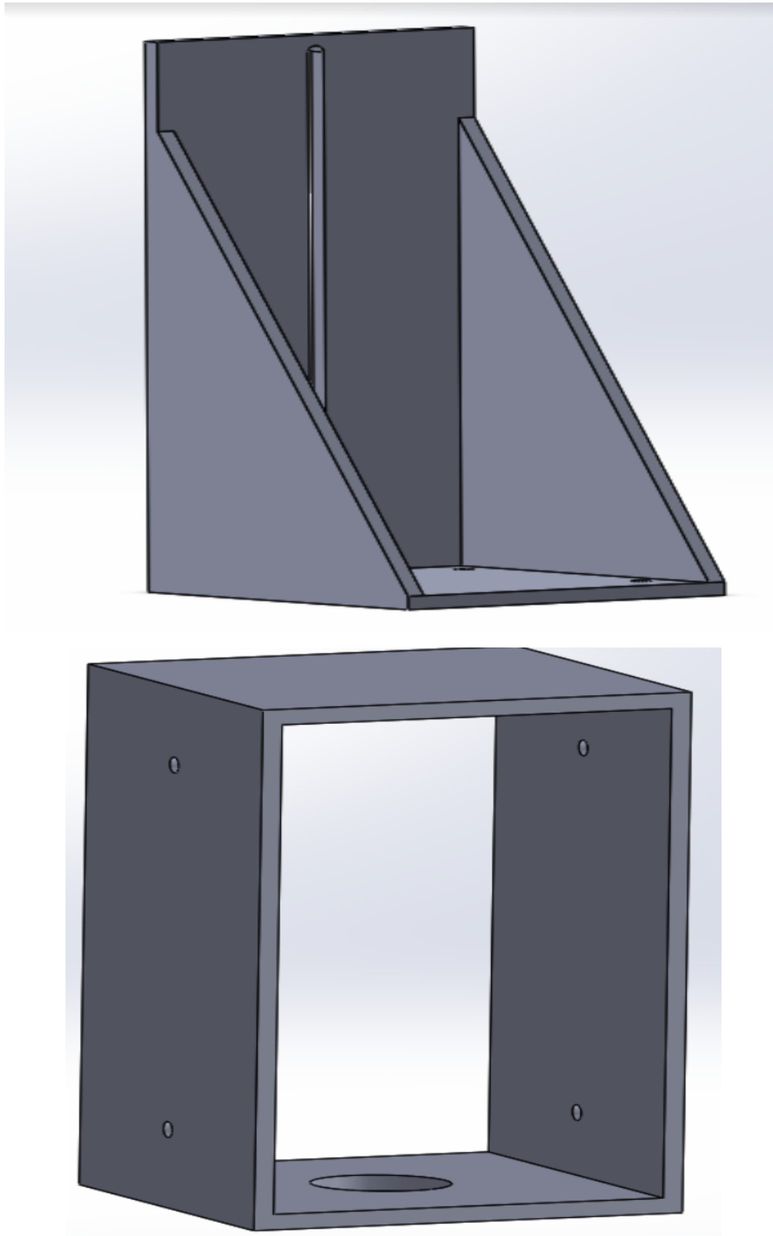


Fig-21 : components of Adjustable height mechanism

5. Results and Discussion:

This section described in detail the planning and execution of our prototype manufacturing, along with the reasons at every stage for selection of these specific components and dimensions or design strategies. We believe that all these aspects of the prototype will work well together , leading to a functional design at the open house exhibition. The scope for changes and improvements, and scale-up when creating a real world installation have also been mentioned within the text wherever necessary.

Chapter 5

Fabrication and Assembly

The fabrication plan shall be discussed in this chapter. Following points must be included.

1. Bill of Materials (BOM).

Table-2

S.NO.	ITEM NAME	Price (in Rs.) (Including GST)	QUANTITY	TOTAL PRICE (in RS.)
1	HC-05 bluetooth module	390	1	390
2	HC-SR04 ultra Sonic	61	2	122
3	Digital Multimeter	199	1	199
4	L293D driver	143	1	143
5	Arduino cable	29	1	29
6	Arduino uno board	499	1	499
7	Delivery charges			99
8	12V 30RPM DC motor	952	1	952
9	Delivery charges			99
10	wheels dc gear motor 4cm	120	2	240
11	Battery 12V 7AH	1100	1	1100
12	Ribbon wire 10 core	40	2	80
13	Jumper wire f to f	3	40	120
14	Jumper wire m to f	3	40	120
15	Jumper wire m to m	3	40	120
16	Switch Roker 2 pin medium	15	3	45
17	Switch push	30	3	90
18	Convertor DC-DC	90	1	90

19	Glue Gun	348	1	348
20	Back Wheels 4cm	120	2	240
21	Spare wheels 4cm	145	2	290
22	Wheels DC gear motor shafts	137	2	274
23	9mm Plywood	720	1	850
24	motor clump jenson	50	4	200
25	Motor DC RS555	290	1	290
26	Screw 3*10mm	30	1 pcs	30
27	Charger 12V 7AH Battery	550	1	550
28	Arduino Motor Shield	250	2	500
29	Arduino Uno 328 SMD	590	1	590
30	Screw 3*20 mm	40	1 Pcs.	40
31	Battery Snapper for arduino	50	2	100
32	DC-DC buck convertor 300W 20A	750	1	750
33	Battery terminal clip 7AH	5	2	10
34	Motor sheild	250	2	500
35	Battery 9V	25	1	25
36	Crypton Motor Driver	729	1	729
37	Delivery charges			99
38	Solar Panel 12V 10W	907	1	907
39	Solar charger Controller	620	1	620
40	shaft adaptors 555	280	1	280
41	bread board	127	1	127
42	RS 775 motor	330	1	330
43	RS 775 motor spare	318	1	318
44	shaft adaptors 775	99	3	297
45	l298n driver	440	2	880
46	blades	45	2	90
47	bolts 20mm	13	4	52
48	Male to female plugs	40	2	80
49	speaker wire	30	6	180
50	DC motor clamp L	35	1	35

51	Motor clamp jensen	45	1	45
52	Screw 3*10mm	40	1	40
53	NutBolt 3mm	16	8	16
54	Nutbolt 5mm	24	12	24
55	Fevilite adhesive	200	1	200

Total:15473

2) Drawings:

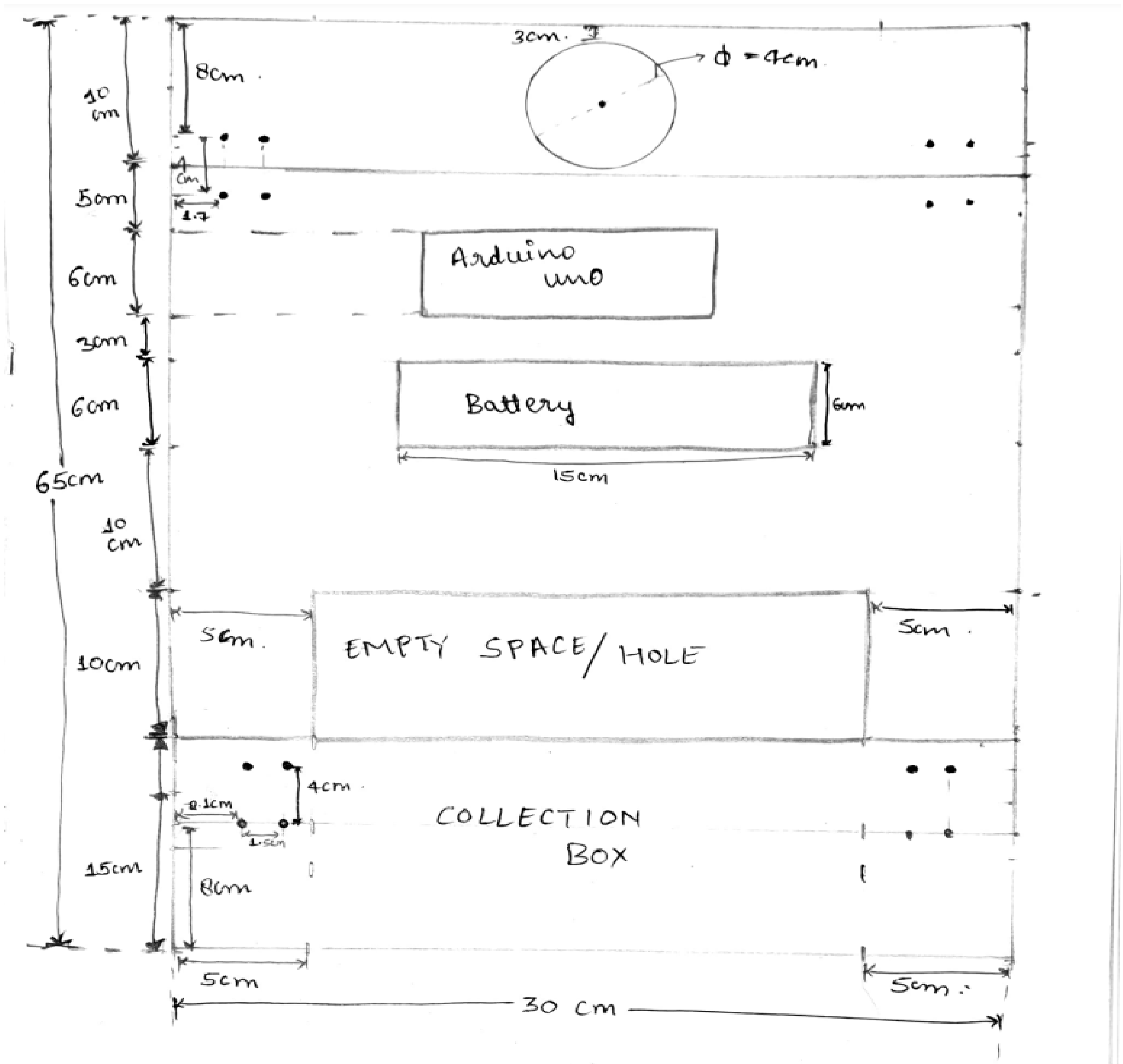


Fig-22 : Dimensioning

Table-3

S.No.	Component	Length(in cm)	Breadth(in cm)	diameter (in cm)	thickness
1.	Battery	15	6	nil	nil
2.	Arduino	6	6	nil	nil
3.	grass cutter motor	nil	nil	4	nil
4.	30 rpm motor	3	nil	4	nil
5.	motor mount	nil	nil	0.1	nil
6.	motor driver	6	6	nil	nil
7.	main board	65	30	nil	0.8
8.	collection box	15	30	nil	tbd

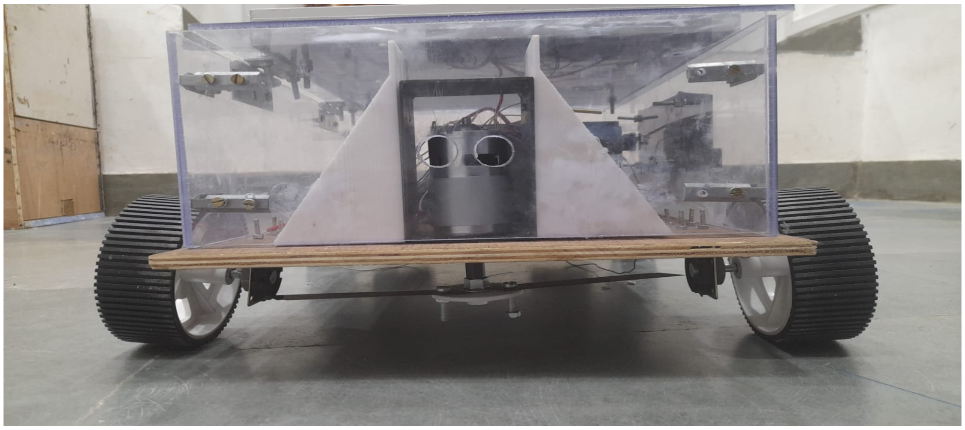
2. **Manufacturing Process Description:** The initial plan was to develop the product using acrylic sheets and using the laser cutting technique. But we found plywood to be a better alternative as it was lighter and stronger. A wooden plank of the dimension 6x6(in inches) was bought, which we had to cut up in half for logistic purposes using the jigsaw. The final dimensions of our base is 65x30(in cm). We had to check the placement of the holes for the motor mount.

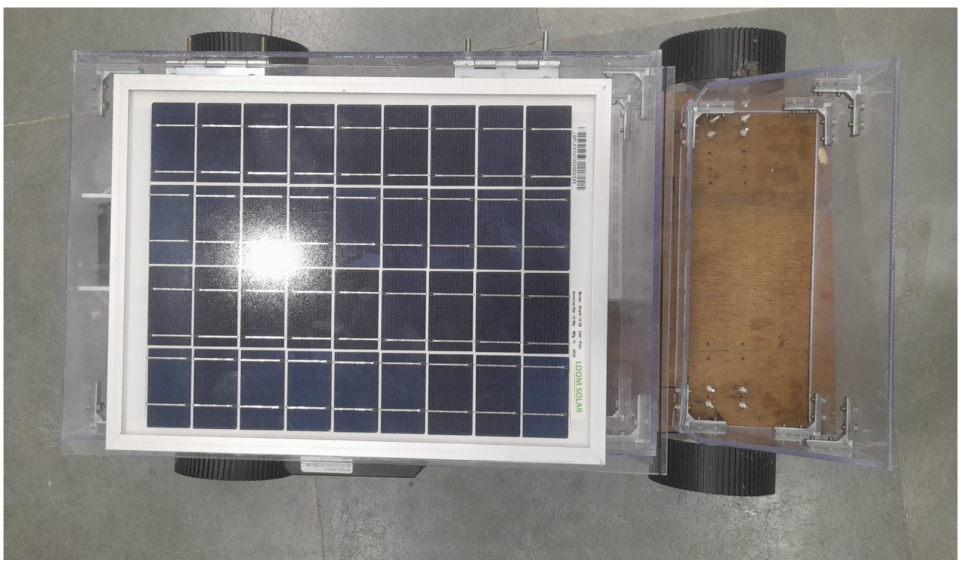
We drilled 6 holes on each corner of the rectangular board which each of diameter 3 mm and one big hole for holding the grass cutter motor of the diameter 4 cm, we drilled 2 more holes in the middle of the board to provide connection between motors and motor driver shield, these two holes were of the diameter 2 cm. Furthermore, we have to build an adjustable motor ride mechanism. We are yet to decide the material we are going to use. Metal component mechanism requires us to develop a 2-D CAD model and laser cutting from the workshop. The individual components have to be welded together.

Fig-23 : Cut Wooden Plank

3. **Assembly:** We had to attach the motor mount first to the wooden base. For this we needed nuts and bolts of diameter 3 mm and length more than 10 mm. We had to screw the motor into the motor mount. Then the battery, arduino and motor driver shield were attached. We had to connect the battery to the motor driver shield. We set up a switch in between the motor driver shield and battery to prevent any unnecessary current flow. Then setup the bluetooth module close to the arduino to communicate with the mobile application. We then had to set up two ultrasonic sensors in the front to detect obstacles. Then, we connected a grass cutter motor to the motor driver shield and the grass cutter motor will be

placed in the motor holding mechanism which will be set up. Then we connected the left and right motors after which we set up the switches. We then upload the program code using a USB cable. Then we connect the machine to our phone using Bluetooth and operate it from the app.





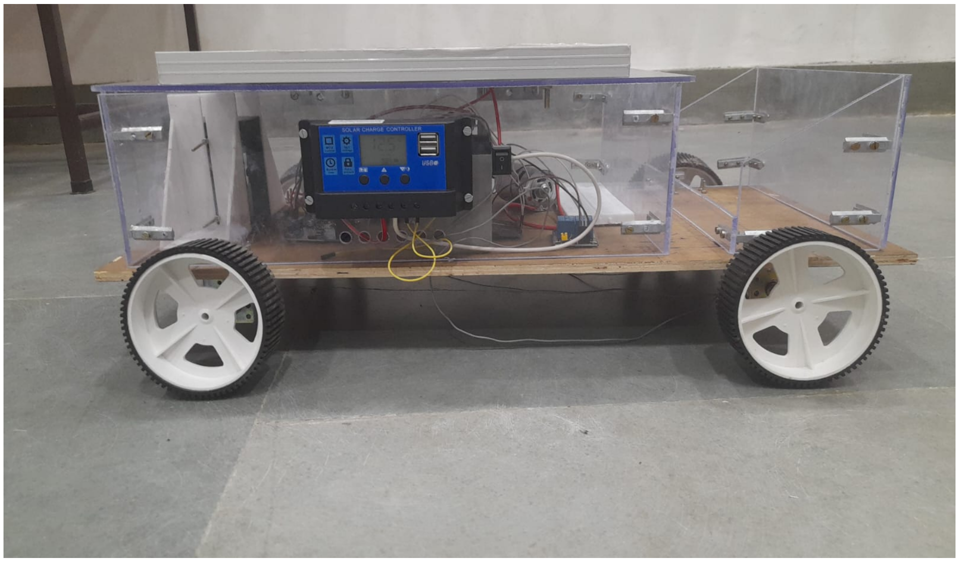


Fig-24 : Assembly until this point

4. **Limitations and Challenges:**
   - ❖ We had difficulty in deciding the product design and material to be used for the base .We were initially skeptical about using wood and were opting for acrylic but on doing ground research in person we realized it would be better to use wood due to its light and sturdy composition.
   - ❖ We were initially in the hopes of training the grass cutter to just mow the entire lawn once and store the entire mapped area in its memory is that it would not need to be remotely controlled anymore . But we soon realized that it would require a lot of onboard memory and also would not be logical if an obstruction appears it would derail the entire code.
   - ❖ Taking on the solar powered idea was a gamble because the weather was not favorable during the time we came up with the idea in march with little rays of sunshine. There was hope in April when finally the clouds retreated and we could continue on our solar venture.
   - ❖ The front wheels need a mechanism to attach to the motor mount and how to connect the blade to the motor . At the time we did not know about a dead axle shaft and hence it took some time to come across it. We soon got to know about the shaft adapter too which is being used to connect to the blade.

5. **Scheduling plan:**

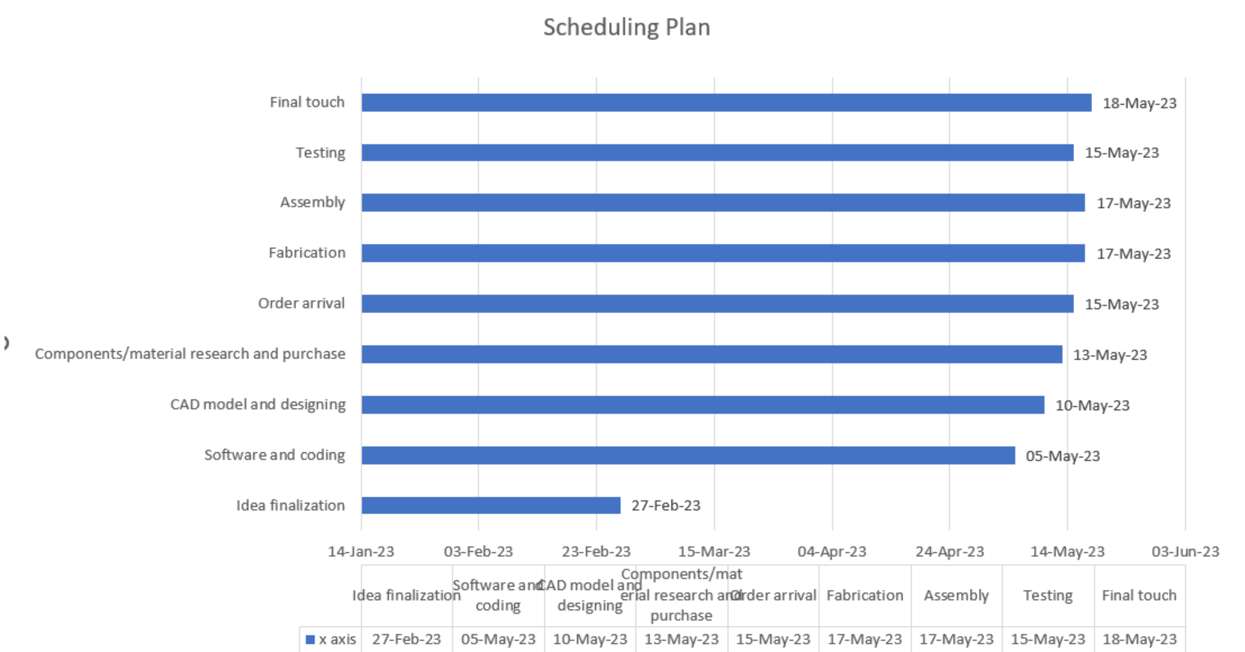


Fig-25 : Schedule Plan

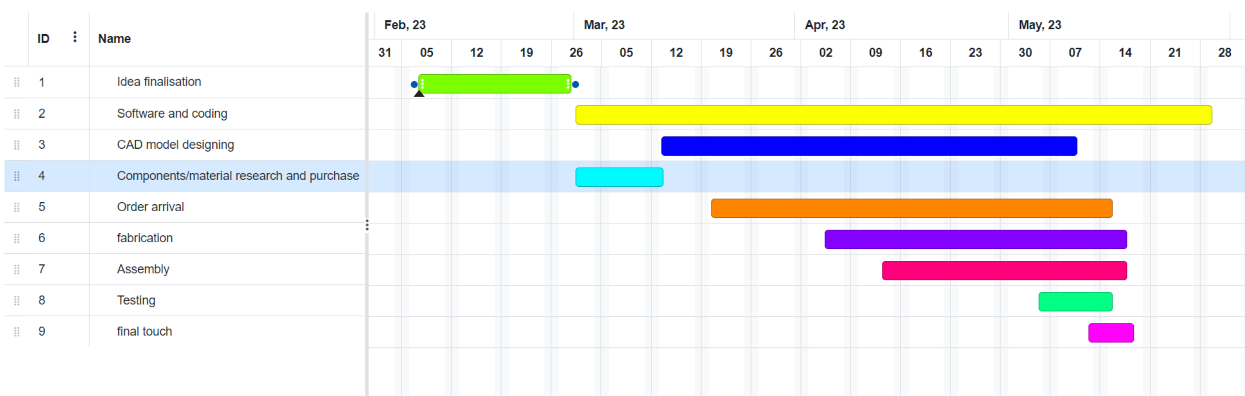


Fig-26 : Gantt Diagram

6. **Contribution:** The contribution of each team member must be listed here

1)Rishab Bairi:

- Helped with project overview and brainstorming in the initial stages
- Selection of battery and components to be used after calculating power usage, researching alternatives and scope for improvements

- Overlooking the programming code required for the functionality
- Designed circuitry that is to be used in the model and code for motors and sensors
- Purchasing of components in person
- Carrying out the fabrication of the base material in the workshop
- Testing of the motors in initial stages of project leading to purchase of further component
- Assembling the final circuitry of the model.

2)Vallabhi Upadhyay:
- Designing and fabrication of final body of model
- Purchasing of components required both in person and online
- Designing circuitry that is to be used in the model
- Enquiring about the feasibility of fabrication of the model
- Assembling the final product and overlooking the placement of wiring needed in the end product
- Brainstorming initial designs for the various ideas
- Handling the budget needed
- Helping out in CAD model design and dimensioning

3)Srijan Sood:
- Purchase of components required in person
- Brainstorming and narrowing down of ideas for the final project
- Dimensioning of the base model
- Mapping out the placement of components on our base design
- Making the report by collecting market research

4) Preeti Prajapat:
- Brainstorming in the initial phase of project by looking for grass collection mechanism
- Dimensioning the entire base model of the project
- Overlooking assembly of the parts
- Designing the entire CAD model of the grass cutter that is to be assembled
- Designing parts that are to be to be 3D Printed , Laser cut
- Fabrication of parts in workshop

- Making the report

5)Darshan Sripadh :

- Looking for scope of improvement in the ideas suggested
- Assembling the model along with placement of circuitry
- Fabrication of components
- Purchase of components
- Making the report

7. **Conclusions:** This project work presents a low cost and user friendly concept for the household grasscutter . We are trying to minimize the high fuel costs consumed by the ordinary grasscutter. We were also successful in saving on the maintenance and operational costs while providing respite to the daily worker. The model we have built is suitable for various fields be it playing ground , backyard or just any parklands without any effort . This project can be further modified to a cleaner.

References

1)Tony DiCola , “Adafruit Motor shield library for arduino”
Available:https://github.com/adafruit/Adafruit-Motor-Shield-library ,
Dated:Dec 7 , 2018

2)https://www.researchgate.net/publication/335146990_Development_of_a_Solar_Powered_Lawn_Mower

by Okafor, Ehujuo and Igbokwe Dated:March 2016

3)http://ijariie.com/AdminUploadPdf/A_Survey_Paper_on_Solar_Based_Automatic_Grass_Cutter_ijariie9347.pdf

by Singh Suraj, Salve, Rahul Rajendra, Bangar mamata Pandhari and U.V.Patil Dated:2019

4)https://www.youtube.com/watch?v=kBCvqOuhxzk

by SSI projects Dated:2 November , 2019

5)https://www.prateeks.in/2020/01/automatic-lawn-mower-grass-cutter-make.html

by just do electronics

6)https://lazyhomesteader.com/2012/04/24/pros-and-cons-of-a-push-reel-mower/

by anisa

7)https://www.lawnsmith.co.uk/lawn-care-advice/lawn-mowers/lawn-mower-power

by lawnsmith

8)https://www.twi-global.com/technical-knowledge/faqs/how-do-solar-panels-work

by TWI

9)https://www.instructables.com/Charging-Lithium-Ion-Battery-With-Solar-Cell/

by Micheal Coma

10)https://www.homemade-circuits.com/how-to-make-solar-battery-charger/

by swagatam