MAJOR PROJECT STUDY REPORT

On

Smart Grass cutting Machine

submitted in partial fulfillment for the award of the Degree of

Bachelor of Technology

In

Mechanical Engineering

By

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CERTIFICATE

This is to certify that the Major Project Study report on "**SMART GRASS CUTTING MACHINE**" submitted by **M.NIROSHA(R170697), J.NagaPushpa(R170827), V.THEJA(R170831), S.SABIYA BANU(R171009), G.GAYATHRI(R171129)** the bonafide record of the work carried out by him, is accepted as the Major Project Study Report submitted in partial fulfillment of the requirements for the award of the Degree of Bachelor of Technology in Mechanical Engineering during (2021-22) at IIIT-RK Valley, RGUKT.

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At the outset, We thank RGUKT for providing all the necessary resources to complete my coursework successfully.

Yours sincerely,
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Abstract

A grass cutter is a machine that uses sliding blades to cut a lawn at an even length. Even more sophisticated devices are there in every field. Power consumption becomes essential for the future. Smart grass cutter is a very useful device which is very simple in construction. It is used to maintain and upkeep lawns in gardens, schools, colleges etc. We have made some changes in the existing machine to make its application easier at reduced cost. Our main aim in pollution control is attained through this. Unskilled operation can operate easily and maintain the lawn very fine and uniform surface look. In our project a grass cutter is used to cut the different grass for different applications.we have made some changes in existing machines by adding sensors and batteries to make its applications easier at reduced cost.

CONTENTS

1.Need of Grass cutting machine

Nowadays,over growing of grass at lawns is a hectic issue to most of the residents ,we know that most grass seed will start growing in about 10-14 days,we are investing most of the time and our energy in clearing and maintaining the hygienic grass,as we know that overgrown grass leads to water pollution,causing of diseases via harmful insects those are being attracted to the stagnated water and grass. Maintaining a healthy, thick lawn also benefits the environment.

Unlike hard surfaces such as concrete, asphalt, and wood, lawn grass helps clean the air, trap carbon dioxide, reduce erosion from stormwater runoff, improve soil, decrease noise pollution, and reduce temperatures.

The fully automated grass cutter is a fully automated grass cutting robotic vehicle powered by 12V Batteries that also avoids obstacles and is capable of fully automated grass cutting efficiently.

2. Motivation

The main idea behind developing the smart grass cutting machine is to maintain a sustainable environment,to maintain a healthy life and to save the time consumption of human beings. The smart grass cutting machine is a fully automated machine power-driven by electric batteries and sensors functions. It cuts the grass at a very high RPM. The smart grass cutting machine is a fully automated machine power-driven by electric batteries and sensors functions. It also detects the obstacles in the path based on that changes the movement direction.

Versatility

Brush cutters have compatibility with many blade attachments so that you may use the tool on diverse materials. You need a single device to accomplish landscaping tasks rather than purchasing different agricultural tools.

Durability

Grass cutters or brush cutters consist of heavy-duty metals. Hence, they may last for a long time if you maintain them properly. In many cases, you can use the same one for many years. Only, you have to replace or sharpen the blade periodically before using the device on thick branches and power equipment. Working with a blunt blade not only reduces the lifespan of your tool but also leads to many safety hazards.

Power

The design of the grass cutting machine allows it to power through various woody areas. It works well in those areas where an overgrown brush, a conventional line trimmer, or lawnmower cannot work. The blades are available in many variations to work well in tight areas, where you cannot use any large equipment**.**

Comfort

Operating power equipment for many hours may sometimes become cumbersome. It also puts you at a risk related to a severe accident. Many designers design their grass-cutting devices by considering the requirements of their users. Hence, they always include certain features, like anti-vibration technology, and a straight shaft to avoid discomfort at the time of work. The application of a harness will let you control the tool easily. Simultaneously, you may reduce the strain level on your back and arms.

3.Introduction

A smart grass cutting machine that uses cutting blades or strings which is used **to cut the grass in gardens or yards at an even length without the intervention of the human being.**

In the past and even until now, cutting of grass in the schools,sports tracks, fields, industries, hotels, public centers, etc. was done with a cutlass. This method of manual cutting is time consuming because human effort is needed for the cutting. Also inaccuracy in cutting level was observed using the manual cutting method. This work deals with the cutting of verdant(shrubs, stubborn, grass, flowers, leaves of trees) and also with the design of the machine, its efficiency, rigidity, mode of operation and the selection of materials. The design gives a greater degree of flexible mobility and interchangeability.

Grass cutter machines have become very popular today. Most common machines are used for soft grass furnishing. In our project Grass cutter machine we are aimed to develop for operation and construction. Agriculture is the most important sector in the Indian economy. In India there is a great scope of grass cutter machines. In our country as well as other countries it is also used in various fields for cutting the grass. The machine may consist of two, three or four blades depending upon the machine. The grass cutting machine is known as a lawn mower. The grass cutting machine is available in the various types like reel (cylinder) mower,rotary and mulching mower, hover mower, riding mower, professional mower etc. but these are very costly and unaffordable also.
Also, it requires a skilled person to operate it. Hence, it was found necessary to have a grass cutter with minimum initial cost and can be operated by unskilled labor.

The machines required for manufacturing include welding machines, grinding machines etc. Working principle of the grass cutter is providing a high speed rotation to the blade, which helps to cut the grass. The blade will get kinetic energy while increasing the rpm.
The cutting edges are very smooth and accurate. Also Electric Grass Cutting Machines are much easier to be used in garden, lawn and grass fields. In order to enhance the beauty of home-lawns and gardens, Grass cutting machines are the best available option in the industry. With the help of a lawn mower which is a machine with revolving blades to help us cut lawns at even length, people can easily maintain and beautify their lawns and gardens without any hassle. Now-a-days, there are plenty of options starting from the simplest push along mower to the most advanced electric grass cutting machine.

Fig 3.1:Smart Grass Cutter

4. Literature

4.1.Components

4.1.1.Electronic Components

Arduino

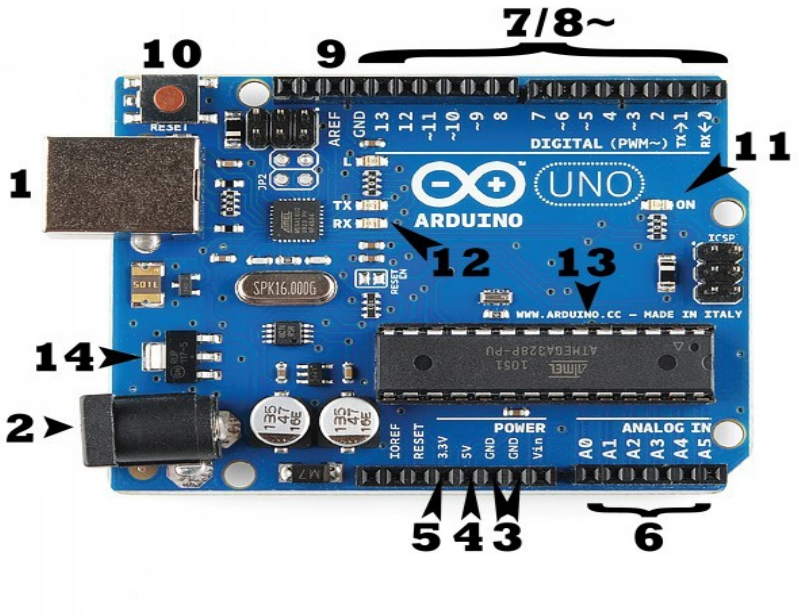

Fig 4.1:Arduino UNO

Arduino is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board.Arduino microcontroller is the brain of the prototype.

The functionalities of the Arduino UNO include: 5 Volts, operating voltage 7 to 20 volts as the input voltage I/O Pins for Digital: 14 (of which 6 can provide PWM output) 6 DC Analog Input Pins I/O current per Pin: 20 mA . DC Current at 3.3 volts Pin: 50 mA Size: 68.6 mm Dimensions 53.4 mm wide Size: 25 g. The features of the L298n motor driver are as follows: 2 and 3 motor channels Peak output current per channel is 2A, maximum working voltage is 46 V, and Minimum and maximum logic voltages are 4.5 and 7 volts, respectively.

What's on the board?

• Power (USB / Barrel Jack)

Every Arduino board needs a way to be connected to a power source. The Arduino UNO can be powered from a USB cable coming from your computer or a wall power supply that is terminated in a barrel jack. In the picture above the USB connection is labeled (1) and the barrel jack is labeled (2).

• Pins (5V, 3.3V, GND, Analog, Digital, PWM, AREF)

GND (3) : Short for 'Ground'. There are several GND pins on the Arduino, any of which can be used to ground your circuit.

Analog (6) : The area of pins under the 'Analog In' label (A0 through A5 on the UNO) are Analog In pins. These pins can read the signal from an analog sensor and convert it into a digital value that we can read.

Digital (7) : Across from the analog pins are the digital pins (0 through 13 on the UNO). These pins can be used for both digital input (like telling if a button is pushed) and digital output (like powering an LED).

PWM (8) : You may have noticed the tilde (~) next to some of the digital pins (3, 5, 6, 9, 10, and 11 on the UNO). These pins act as normal digital pins, but can also be used for something called Pulse-Width Modulation (PWM).

AREF (9) : Stands for Analog Reference. Most of the time you can leave this pin alone. It is sometimes used to set an external reference voltage (between 0 and 5 Volts) as the upper limit for the analog input pins.

• Reset Button

The Arduino has a reset button (10). Pushing it will temporarily connect the reset pin to ground and restart any code that is loaded on the Arduino. This can be very useful if your code doesn't repeat, but you want to test it multiple times.

• Power LED Indicator

Just beneath and to the right of the word "UNO" on your circuit board, there's a tiny LED next to the word 'ON' (11). This LED should light up whenever you plug your Arduino into a power source. If this light doesn't turn on, something is wrong.

• TX RX LEDs

TX is short for transmit, RX is short for receive. These markings appear quite a bit in electronics to indicate the pins responsible for serial communication. In our case, there are two places on the Arduino UNO where TX and RX appear -- once by digital pins 0 and 1, and a second time next to the TX and RX indicator LEDs (12).

• Main IC

The black thing with all the metal legs is an IC, or Integrated Circuit (13). Think of it as the brains of our Arduino. This can be important, as you may need to know the IC type(along with your board type) before loading up a new program from the Arduino software.

• Voltage Regulator:

The voltage regulator (14) is not actually something you can(or should) interact with the Arduino. The voltage regulator controls the amount of voltage that is let into the Arduino board. It has its limits, so don't hook up your Arduino to anything greater than 20 volts.

Motor Driver Shield

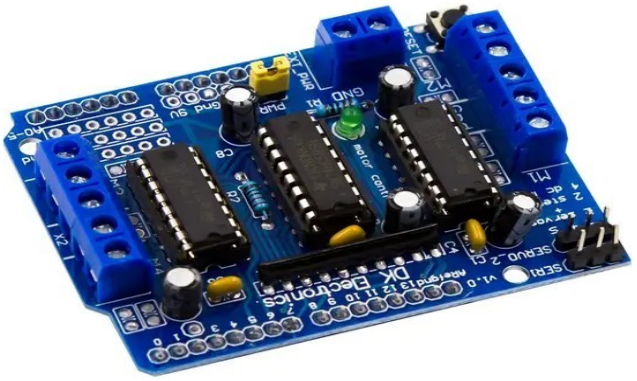

Fig 4.2:Motor Driver Shield

This is a motor driver IC that can drive two motors simultaneously. L293D IC is a dual H-bridge motor driver IC. One H-bridge is capable of driving a dc motor in bidirectional. L293D IC is a current enhancing IC as the output from the sensor is not able to drive motors itself so L293D is used for this purpose. L293D is a 16 pin IC having two enabled pins which should always remain high to enable both the H-bridges.

Ultrasonic Sensors

ULTRASONIC SENSOR The HC-SR04 is an affordable and easy to use distance measuring sensor which has a range from 2cm to 400cm (about an inch to 13 feet). The sensor is composed of two ultrasonic transducers. One is the transmitter which outputs ultrasonic sound pulses and the other is the receiver which listens for reflected waves. It's basically a SONAR which is used in submarines for detecting underwater objects.

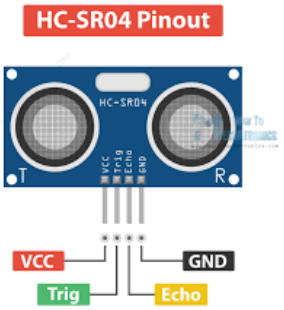

Fig 4.3: Ultrasonic Sensor

Here are its main specifications:

- Power Supply: 3.3V – 5V
- Operating Current: 8mA
- Working Frequency: 40Hz
- Ranging Distance : 3 cm – 350 cm/3.5m
- Resolution : 1 cm
- Measuring Angle: 15 degree
- Trigger Input Pulse width: 10uS TTL
- Dimension: 50mm x 25mm x 16mm

The sensor has 4 pins. VCC and GND go to 5V and GND pins on the Arduino, and the Trig and Echo go to any digital Arduino pin. Using the Trig pin we send the ultrasound wave from the transmitter, and with the Echo pin we listen for the reflected signal.

Battery

Fig 4.4: 12V Battery

Specifications of the battery are 12V 3Ah.

Switch

Fig 4.5:Switch

In electrical engineering, a switch is an electrical component that can disconnect or connect the conducting path in an electrical circuit, interrupting the electric current or diverting it from one conductor to another.

4.1.2.Mechanical Components

DC Motors

A DC motor is an electrical machine that converts electrical energy into mechanical energy. In a DC motor, the input electrical energy is the direct current which is transformed into the mechanical rotation.

Two major parts required for the construction of dc motor:

1) Stator – The static part that houses the field windings and receives the supply.

2) Rotor – The rotating part that brings about the mechanical rotations.

DC motor working is based on the principle that when a current carrying conductor is placed in a magnetic field, the conductor experiences a mechanical force.
The direction of this force is given by Fleming's left-hand rule and magnitude is given by;

F = BIL Newtons

According to Fleming's left-hand rule when an electric current passes through a coil in a magnetic field, the magnetic force produces a torque that turns the DC motor.
The direction of this force is perpendicular to both the wire and the magnetic field.
Basically, there is no constructional difference between a DC motor and a DC generator. The same DC machine can be run as a generator or motor.

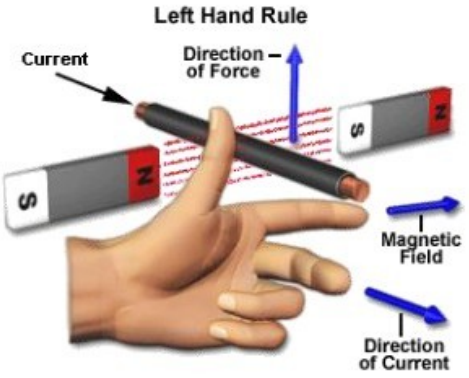

Fig 4.6: Left Hand Rule

Wheels with shaft lengths of 30 mm were driven by 12 V DC gear motors With rated speeds of 33 rpm and 25.4 N-mm of torque. For the Blade DC motor, the power is 350 rpm, the voltage is 12 V, and the shaft length is 30mm. The rated torque is 215.7 N-mm.

Working of DC Motor

When the terminals of the motor are connected to an external source of DC supply:

• The field magnets are excited to develop alternate North and South poles.
• The armature conductors carry currents.

All conductors under North-pole carry currents in one direction while all the conductors under South-pole carry currents in the opposite direction.

The armature conductors under N-pole carry currents into the plane of the paper (denoted as ⊗).And the conductors r under S-pole carry currents out of the plane of the paper (denoted as ⊙).Since each armature conductor is carrying current and is placed in the magnetic field, a mechanical force acts on it.

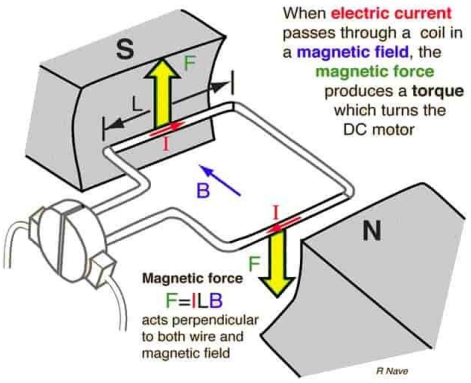

Fig 4.7: Motor Working

On applying Fleming's left-hand rule, it is clear that force on each conductor is tending to rotate the armature in the anticlockwise direction. All these forces add together to produce a driving torque which sets the armature rotates.

When the conductor moves from one side of a brush to the other,the current in that conductor is reversed. At the same time, it comes under the influence of the next pole which is of opposite polarity.Consequently, the direction of the force on the conductor remains the same.

It should be noted that the function of a commutator in the motor is the same as in a generator. By reversing current in each conductor as it passes from one pole to another, it helps to develop a continuous and unidirectional torque.

Chassis

Chassis for a car is analogous to the skeleton for a human body.Chassis, also known as ‘Frame’, is the foundation structure of any car that supports it from underneath. The purpose of the chassis is to bear the weight of the car in its idle and dynamic states. Given that, most people don’t get to choose the chassis of their car and many may not really care about them as much**.**

Fig 4.8:Chasis

Wheels

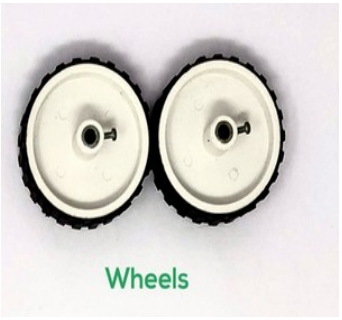

Fig 4.9:Wheels

God created legs for locomotion and man created wheels for the same purpose, which is one of the greatest inventions in human era.Wheels are your best bet for robots as they are easy to design, implement and practical for robots that require speed.
They also do not suffer from static or dynamic stability as the center of gravity of the robot does not change when they are in motion or just standing still and do not require complex models, designs and algorithms. The disadvantage is that they are not stable on uneven or rough terrain and also on extremely smooth surfaces as they tend to slip and skid.

Blade

Fig 4.10:Blade

Because of its strength and weight, low carbon CR steel ASTM A36 was chosen in the building of the cutting blade. This steel can transmit speed at a similar rate to that of a DC motor with a little less friction.

Connecting wires

Fig 4.11:Connecting wires

/

4.2.Building a simple robot

4.2.1. Assembling the Parts

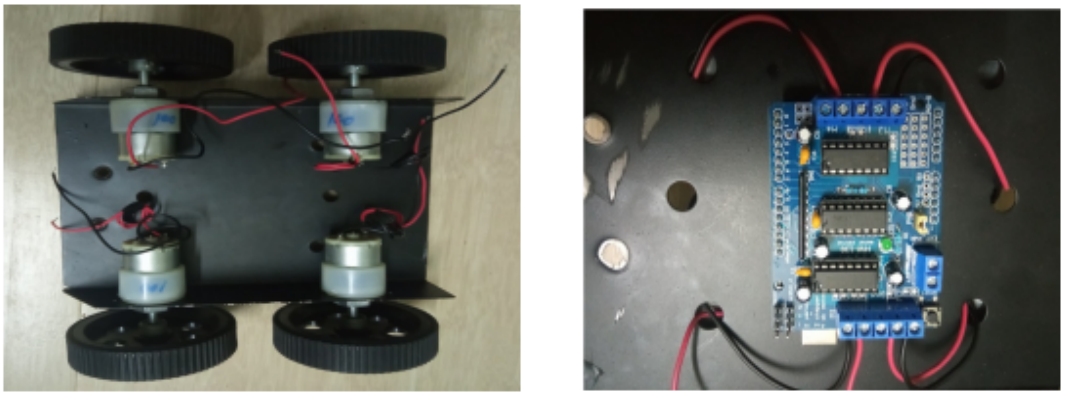

Fig 4.12:Motors fixing to L239D

4.2.2.Movements

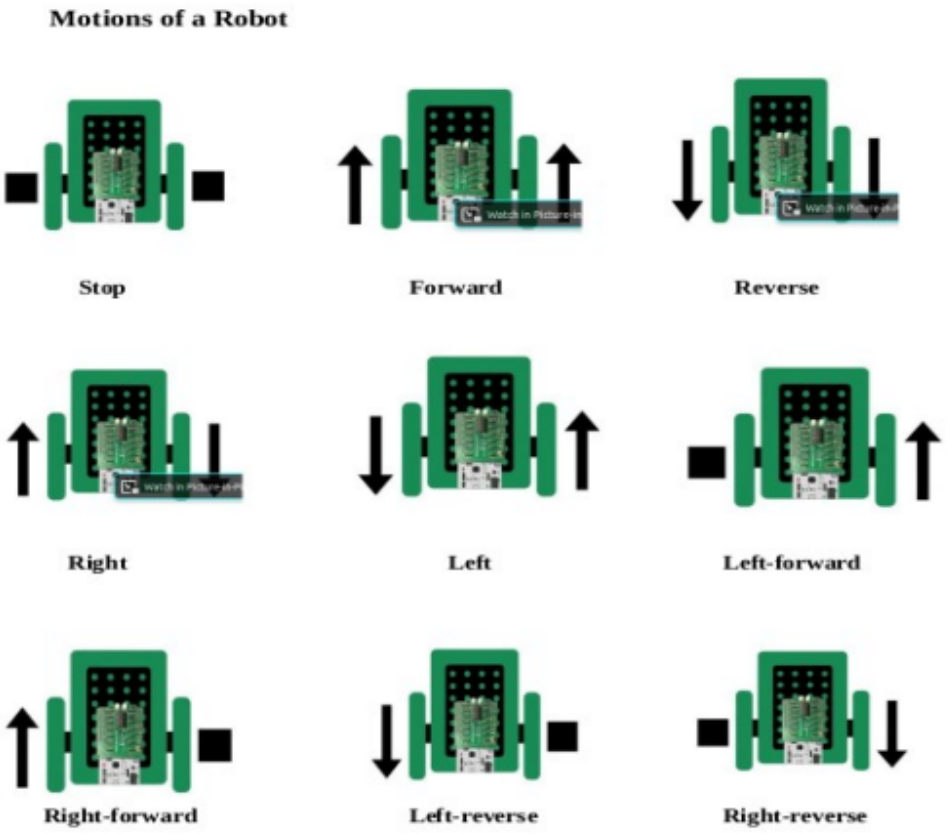

Fig 4.13: Wheel Movements

S.No	Robot Motion	Left Motor	Right Motor
1	Stationary	Stop	Stop
2	Forward	Forward	Forward
3	Reverse	Reverse	Reverse
4	Left	Reverse	Forward
5	Right	Forward	Reverse
6	Left-Forward	Stop	Forward
7	Right-Forward	Forward	Stop
8	Left-Reverse	Reverse	Stop
9	Right-Reverse	Stop	Reverse

Table 4.1:Movements of Simple robot

S.No	Robot Motion	Left Motor Control pin1	Left Motor Control pin2	Right Motor Control pin1	Right Motor Control pin2
1	Stationary	Low	Low	Low	Low
2	Forward	High	Low	High	Low
3	Reverse	Low	High	Low	High
4	Left	Low	High	High	Low
5	Right	High	Low	Low	High
6	Left-Forward	Low	Low	High	Low
7	Right-Forward	High	Low	Low	Low
8	Left-Reverse	Low	High	Low	Low
9	Right-Reverse	Low	Low	Low	High

Table 4.2:Movements of Simple robot

4.2.3.Arduino code

```
 #include <AFMotor.h>
#define Speed 80
AF_DCMotor M1(2);
AF_DCMotor M2(3);
AF_DCMotor M3(4);
AF_DCMotor M4(5);

void setup(){
  M1.setSpeed(Speed);
  M2.setSpeed(Speed);
  M3.setSpeed(Speed);
  M4.setSpeed(Speed);

}

void forward(){
  M1.run(FORWARD);
  M2.run(FORWARD);
  M3.run(FORWARD);
  M4.run(FORWARD);
}
void back(){
  M1.run(BACKWARD);
  M2.run(BACKWARD);
  M3.run(BACKWARD);
  M4.run(BACKWARD);
}
void right(){
  M1.run(FORWARD);
  M2.run(FORWARD);
  M3.run(BACKWARD);
  M4.run(BACKWARD);
}
void left(){
  M1.run(BACKWARD);
  M2.run(BACKWARD);
  M3.run(FORWARD);
  M4.run(FORWARD);
}
void stop(){
  M1.run(RELEASE);
  M2.run(RELEASE));
```

```
  M3.run(RELEASE);
  M4.run(RELEASE);
}
void loop(){
  forward();
  delay(5000);
  back();
  delay(5000);
  right();
  delay(5000);
  left();
  delay(5000);
  stop();
  delay();

}
```

4.3 Building the Automated Grass Cutter

4.3.1 Assembling the components

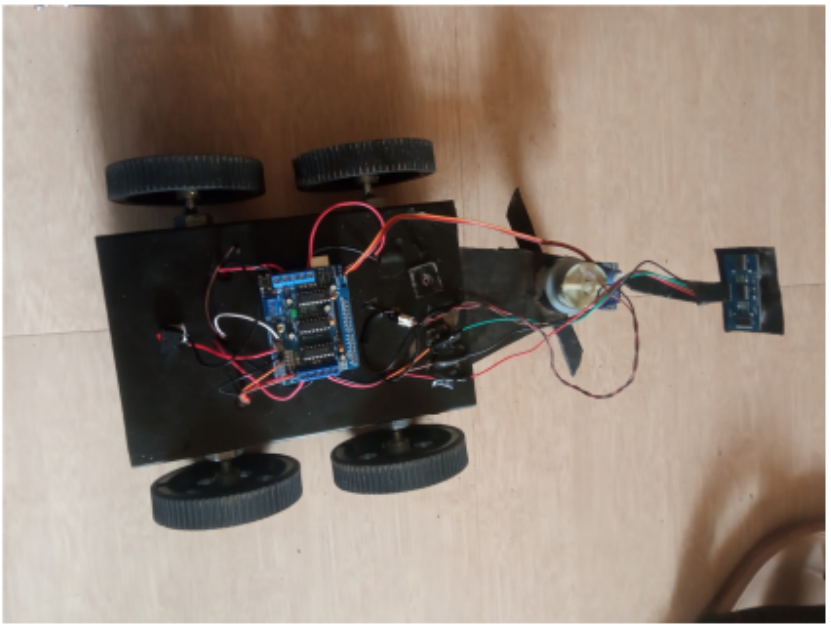

Fig 4.14:Automated Smart Grass Cutter

Circuit Diagram

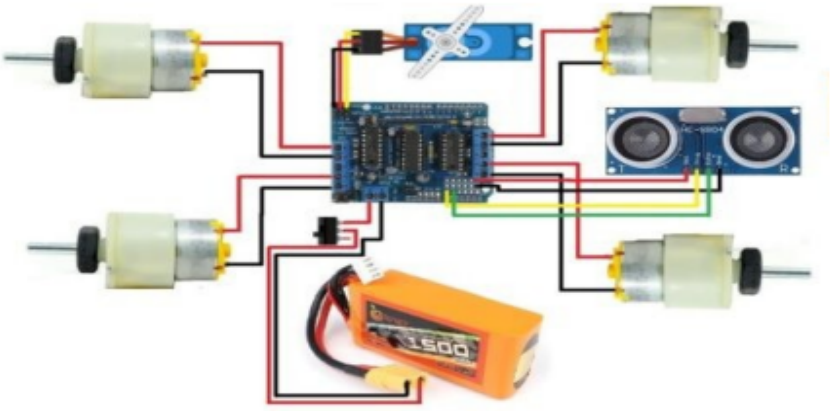

Fig 4.15:Circuit Diagram

4.3.2.Working

Block Diagram:

Automatic Grass Cutting Robot using Arduino The block diagram of Arduino Automatic Grass Cutting Robot shows how the different components are connected and how they interact with one another to perform the task of cutting grass automatically. The Arduino board acts as the brain of the robot, controlling all the other components and executing the programmed instructions. The ultrasonic sensor is used to detect the location of grass and obstacles in the robot's path.

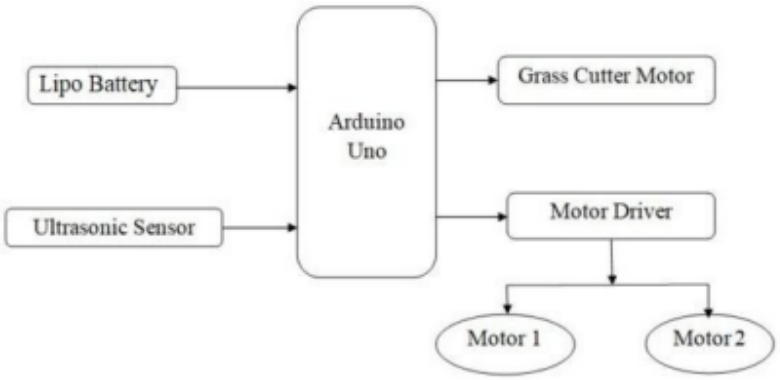

Fig 4.16:Block Diagram

The L293D motor driver Shield is used to control the movement of the robot and is connected to the microcontroller. The 4 DC Gear motors are used to power the movement of the robot. And Servo Motor SG90 is attached at the head so pan motion to look for an obstacle on the left, right, and front.

4.3.3.Arduino code

```
#include <AFMotor.h>
#include <NewPing.h>
#include <Servo.h>

#define TRIG_PIN A0
#define ECHO_PIN A1
#define MAX_DISTANCE 200
#define MAX_SPEED 100
#define MAX_SPEED_OFFSET 20

NewPing sonar(TRIG_PIN, ECHO_PIN, MAX_DISTANCE);

AF_DCMotor motor1(1, MOTOR12_1KHZ);
AF_DCMotor motor2(2, MOTOR12_1KHZ);
AF_DCMotor motor3(3, MOTOR34_1KHZ);
AF_DCMotor motor4(4, MOTOR34_1KHZ);
Servo myservo;

boolean goesForward=false;
int distance = 100;
int speedSet = 0;

void setup() {

  myservo.attach(10);
  myservo.write(115);
  Serial.begin(9600);
  delay(2000);
  distance = readPing();
  delay(100);
  distance = readPing();
  delay(100);
  distance = readPing();
  delay(100);
  distance = readPing();
  delay(100);
}

void loop() {
 int distanceR = 0;
 int distanceL =  0;
 delay(40);
 Serial.println(distance);
```

```
 if(distance<=30)
 {
  moveStop();
  delay(100);
  moveBackward();
  delay(500);
  moveStop();
  delay(200);
  distanceR = lookRight();
  Serial.print("DistanceR ");
  Serial.println(distanceR);
  delay(200);
  distanceL = lookLeft();
  Serial.print("DistanceL ");
  Serial.println(distanceL);
  delay(200);

  if(distanceR>=distanceL)
  {
          Serial.println("Right turn");
          turnRight();
          moveStop();
  }else
  {
          Serial.println("Left turn");
          turnLeft();
          moveStop();
  }
 }else
 {
  moveForward();
 }
 distance = readPing();
}

int lookRight()
{
          myservo.write(20);
          delay(500);
          int distance = readPing();
          delay(100);
          myservo.write(115);
          return distance;
}

int lookLeft()
```

```
{
        myservo.write(170);
        delay(500);
        int distance = readPing();
        delay(100);
        myservo.write(115);
        return distance;
        delay(100);
}

int readPing() {
  delay(70);
  int cm = sonar.ping_cm();
  if(cm==0)
  {
        cm = 250;
  }
  return cm;
}

void moveStop() {
  motor1.run(RELEASE);
  motor2.run(RELEASE);
  motor3.run(RELEASE);
  motor4.run(RELEASE);
  }

void moveForward() {

 if(!goesForward)
  {
        goesForward=true;
        motor1.run(FORWARD);
        motor2.run(FORWARD);
        motor3.run(FORWARD);
        motor4.run(FORWARD);
   for (speedSet = 0; speedSet < MAX_SPEED; speedSet +=2)
   {
        motor1.setSpeed(speedSet);
        motor2.setSpeed(speedSet);
        motor3.setSpeed(speedSet);
        motor4.setSpeed(speedSet);
        delay(5);
   }
  }
}
```

```
void moveBackward() {
        goesForward=false;
        motor1.run(BACKWARD);
        motor2.run(BACKWARD);
        motor3.run(BACKWARD);
        motor4.run(BACKWARD);
  for (speedSet = 0; speedSet < MAX_SPEED; speedSet +=2)
  {
        motor1.setSpeed(speedSet);
        motor2.setSpeed(speedSet);
        motor3.setSpeed(speedSet);
        motor4.setSpeed(speedSet);
        delay(5);
  }
}

void turnLeft() {
  motor1.run(BACKWARD);
  motor2.run(BACKWARD);
  motor3.run(FORWARD);
  motor4.run(FORWARD);
  delay(500);
  motor1.run(FORWARD);
  motor2.run(FORWARD);
  motor3.run(FORWARD);
  motor4.run(FORWARD);
}

void turnRight() {
  motor1.run(FORWARD);
  motor2.run(FORWARD);
  motor3.run(BACKWARD);
  motor4.run(BACKWARD);
  delay(500);
  motor1.run(FORWARD);
  motor2.run(FORWARD);
  motor3.run(FORWARD);
  motor4.run(FORWARD);
}
```

5.Future Scope

In this design, more sensors can be incorporated for accurate precision and improved automation. If the solar panel is used with high watt, then the machine can be used during night time for the garden lighting or room lighting, because we can accumulate more power and at night time however you keep it apart, so the power in the battery can be used for this purpose. Grass cutting can be made more proficiently after modifying for the small rice harvesting. Programming can be enhanced to make the device perform for different operations. We can install the grass collector to collect the grass, instead of leaving behind it.

6.Conclusion

Nowadays, a lot of energy is wasted for grass cutting in different areas of the world and also takes lots of human effort for the work. We have made the solar powered automated robotic grass cutter system which has resulted in cutting grass in a smart and efficient way with lesser human effort. We are trying to get better results with this design.

7.References

1.https://learnmech.com/design-and-fabrication-of-grass-cutter/

2.https://www.academia.edu/6414705/Design_and_development_of_grass_cutter_machine_using_dfma

3.https://www.youtube.com/watch?v=2kCJ_4OxHI8

4.https://www.youtube.com/watch?v=2kCJ_4OxHI8

5.https://www.google.com/search?channel=fs&client=ubuntu&q=Smart+solar+grass+cutter+robot+for+grass+trimming%22%2C+by+Ashish+kumar+chaudhari%2CYuvraj+Sahu%2CPramod+Kumar+Sahu.

6.https://www.google.com/search?channel=fs&client=ubuntu&q=%22Design+and+implementation+of+automatic+lawn+cutter%22+by+prof.Sheetal+Jagtap.

7.https://www.google.com/search?channel=fs&client=ubuntu&q=Technical+Solutions%2C+J.+Hammond+and+R.+Rafaels%2C+%E2%80%9CBuild+the+Lawn+Ranger%2C%E2%80%9D+Radio+Electronics%2C+June+1990%2C+pp.+31-49

8.https://www.google.com/search?channel=fs&client=ubuntu&q=Robert+Zondlo%2C+U.S.+Patent+5%2C461%2C292%2C+Remote+controlled+guidance+system+for+working+vehicle%2C+October+1995

9.https://www.youtube.com/watch?v=uUT1WJN_mxY