THANTHAI PERIYAR GOVERNMENT INSTITUTE OF TECHNOLOGY

Department of Mechanical Engineering

MINI PROJECT: **REPORT**

DESIGN AND FABRICATION OF SEMI AUTOMATED SOLAR GRASS CUTTER

Project Guide:

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SEMI AUTOMATED SOLAR GRASS CUTTER

ABSTRACT:

We present an Arduino-based automatic robotic system which is used for cutting grass or lawns, mostly healthy grass which needs to cut neatly like in a public park or a private garden. The purpose of this proposed project is to design a programmable automatic pattern design grass cutting robot with solar power which no longer requires time-consuming manual grass-cutting and that can be operated wirelessly using an Android Smartphone via Bluetooth from a safe distance which is capable of cutting the grass in indeed required shapes and patterns; the cutting blade can also be adjusted to maintain the different length of the grass. The main focus was to design a prototype that can work with a little or no Physical user interaction. The proposed work is accomplished by using an Arduino microcontroller, DC geared Motors, motor shield, relay module, DC battery, solar panel, and Bluetooth module. The grass-cutting robot system can be moved to the location in the lawn remotely where the user wants to cut the grass directly or in desired patterns. The user can press the desired pattern button from the mobile application, and the system will start cutting grass in the similar design such as a circle, spiral, and rectangle and continue pattern. Also, the main aim of this project is the formation of a grass cutter that relieves the user from mowing their own grasses and reduces environmental and noise pollution. The proposed system is designed as a lab- scale prototype to experimentally validate the efficiency, accuracy, and affordability of the systems. The experimental results prove that the proposed work has all in one capability (Simple and Pattern based grass cutting with mobile-application,), is very easy to use, and can be easily assembled in a simple hardware circuit. We note that the systems proposed can be implemented on a large scale under real conditions in the future, which will be useful in robotics applications and cutting grass in playing grounds such as cricket, football, and hockey, etc.

Keywords: Arduino , Bluetooth , Grass cutter.

TABLE OF CONTENT:

1. INTRODUCTION:

➢ A robot is a machine that can communicate with its physical environment and which can be controlled or programmed electronically to perform specialized tasks. All robots have features of a mechanical and adjustable structure under some form of control, and they mainly have three separated phases: understanding, processing, and action. Commonly, the understandings are done by the sensors mounted on the robot, the onboard micro- controller or processor do processing, and lastly, the operation is performed using motors, engines or with some other actuators. Intelligent robots have a vision and work accurately, using multiple degrees of coordinated action, do something like a living human, and learn from humans without making mistakes. Robots can be operated by different methods such as some of them can be controlled with gestures, some with mobile applications special remote and autonomously, etc. Grass cutter helps us cutting lawns at length; people can easily manage and beautify their gardens and lawns without any trouble. The grass is a beautiful gift from nature, which helps us to survive in various conditions, and so, the need to lessen their growth is essential to enhance the beauty and attractiveness of our environment.

➢ As humankind developed intellectually, grass cutting became an art. Grass cutting tradition starts with the use of hoes, machetes, and cutlasses, and later, advance technology and more reliable techniques of grass cutting were introduced and continuously improved.

➢ A robotic lawnmower is an autonomous robot which used to cut grass of lawns or parks, mostly healthy grass which needs to cut neatly like in a private garden or public park. The first lawn mower born in 1830 by Edwin Beard Budding , by having an idea from a cloth mill where a cutting barrel machine is used to trim clothes after production for a smooth finish. He noticed that a similar concept might be used to cut grass if the blade can be fixed in the wheel to rotate close to the lawns surface and then he designed a mower primarily to mow the grass on ample gardens and sports ground.

➤ In the late 1890s, motor-driven mowers arrived as lightweight petrol engines and became available in 1914, invented by "Ideal Power". Electric powered mowers and rotary grass cutting machines appeared in the era of 1920s to 1930s. An ideal grass cutter robot requires to set up a boundary wire that defines the area of grass to cut in the lawn. Robotic grass cutters are the second biggest category of domestic manufactured robots used by the end of 2000, and first commercial grass cutter was the "MowBot" that introduced and licensed in 1969 which shows many features of most popular grass movers of today's. The sales of the latest robotic lawn mower increased about 15 times more than traditional robots in 2012. With the evolution of smart phones, grass cutting robots have integrated with custom apps features to adjust scheduled mowing times, adjustments of the cutter and also manually control the grass cutter. Grass cutters have three types; Walk-Behind mower, Tow-Behind mower, and Riding mower.

➤ Pollution is human made and can be viewed in our own homes as well as in daily lives. Pollution is the primary concern with the conventional fuel and gas-powered lawn mowers. Riding and Motor-powered push grass cutters have a loud engine, which creates noise pollution and air pollution because of combustion in the engine. Traditional grass cutters are heavy machinery that requires a lot of strength and energy to operate. Along with motor-powered grass mowers, electrical lawn mowers are cannot be easily used in daily lives due to dangerous belts and motors , so the dream to cut grass cannot be efficiently fulfilled by the elders, younger, or disabled people. Therefore, human effort is another factor that needs to be reduced. Mowing the grass with a standard motor is disturbing, and no one takes satisfaction in it due to massive engines combustion, which creates much air pollution and required regular maintenance such as engine oil and greasing.

➤ Gas-powered lawn mowers are also not much efficient and responsible for air pollution due to the massive emission of gases, and mainly the price of fuel and gases are increasing rapidly. According to world energy report, we gain the energy of around 80% from fossil fuels like oil (36%), coal (23%) and natural gas (21%), 70% of Malaysian home citizens are using fuel-powered to cut grass in daily routine. That time is not far when all energy sources will be consumed so alternative sources can be utilized such as solar energy to avoid an energy crisis in the future. A solar panel contains cells and designed to produce electricity by capturing sunlight and does not make any pollution like fossil fuels and nuclear energy. Solar grass cutting robots are convenient to mow grass and cost-effective because of cordless electric mowers and cutter powered of solar cells that last a long time and have low running costs.

➤ To overcome this remote-control concept, controlling the grass cutting robot by using a Bluetooth Android mobile application along with Arduino is proposed. A Solar panel system is also deployed to make robot energy efficient. Besides these, Specific pattern drawing robots on paper and boards is also accomplished .Apart from the traditional grass cutting robot system, the term "internet of things" (IOT) is also essential for connecting robot with the internet to allow users to control grass cutter from anywhere and anytime. These wireless systems are contributing essential help to robot self- regulation systems by utilizing Wi-Fi and cloud computing mechanism.

2. MATERIALS AND METHOD:

For the simplicity of analysis, Figure 1 demonstrates the complete working mechanism and the features of the proposed automatic robot car whereas I/P and O/P represent the flow of the system as input and output. There are several modes of transmission and controlling of the grass cutter. Among that the first one is the arrow touch buttons with an android mobile application, which is specially designed for Android mobile and available and can be easily downloaded. In this system, when the user presses the corresponding touch button, a signal is transferred to the Arduino UNO that is attached to the car through the built-in mobile Bluetooth device. After receiving the following signal command, Arduino will check this signal with a predefined instruction that is programmed via coding and send the following signal to the motor module to move the wheels of the robot, make grass pattern, or relay to turn ON/OFF Cutter accordingly to the received signal. Also, Solar panel will charge the battery with solar rays to reduce the consumption of electricity.
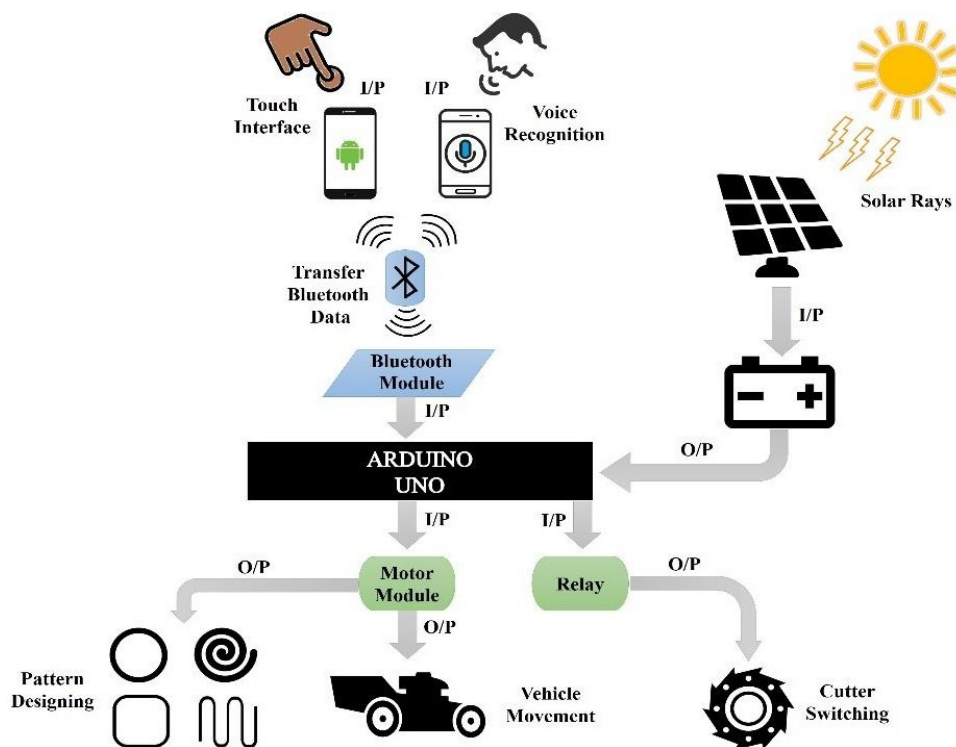

Figure 1

3. MATERIALS AND THEIR DETAILS:

Components and their specification are listed below in the Table: 1

Components	Specifications
Arduino UNO	28 pins; Operating voltage: 7–12V
Bluetooth ModuleHC-05	6 pins; Operating voltage: 3.3–5V; Transmission range: 100 m
Motor Driver	Operating voltage: 5V; Max power: 25W
Geared DC Motor / High speed DC Motor	Geared Motor (Operating voltage: 12V; Speed: 60 rpm), High speed Motor (Operating voltage: 12V)
DC Battery	Input Voltage: 12V; Capacity: 1.3AH; Battery type: Rechargeable
Solar Panel	Operating Voltage: 12V; Max. Power:20W
Android Mobile Application	Android compatible

Table: 1

3.1. Arduino UNO:

The Arduino Uno microcontroller board is generally based on the ATmega328 microcontroller's series and has a desktop, and web IDE (integrated development environment) to write, compile and uploads the programming languages codes to memory. Different sensors forward the observed data as an input to the microcontroller and send output to different devices such as motors, LED, relay module etc. It contains a total of 28 pins from which 14 digital input/output pins (six are PWM pins (pulse width modulation)) and six are analogs pins which used for interaction with the electronic components like LDR sensor, ultrasonic sensors, etc., 3 pins for grounding and other pins for 5V, 3.3V, VIN, RESET and AREF (analogue reference). Arduino microcontroller has 32 KB of storage memory, 2KB storage of SRAM (static random-access memory) and only 1 KB of EEPROM (electrically erasable programmable read-only memory). Arduino principally supports C/C++ programming language compiler (supports other languages like Python, java through libraries), macro-assemblers, and evaluation kits. Additionally, it has a USB connection jack for connecting with computer, a jack for external power supply. It is a 16 MHz ceramic resonator an ICSP (in-circuit serial programmer) header, a button to reset to factory settings. Its operating voltage 7 – 12 V with a limit up reset to 20V.

Figure: 2

3.2. Bluetooth Module HC-05:

The HC-05 Bluetooth module is designed for personal wireless serial connectivity and used in Master or Slave configuration, providing it with an excellent solution for wireless communication. This serial port Bluetooth module is fully adequate Bluetooth V2.0 + EDR 3 Mbps Modulation with 2.4 GHz radio transceiver and baseband. It contains total six pins; ENABLE pin to toggle within AT and Data command mode, VCC pin for giving voltage, Ground pin, TX-Transmitter and RX-receiver for sending and receiving serial data and lastly, a State pin for checking of Bluetooth pairing/un- pairing). Its operating voltage is 3.3–5V and transmitting range is up to 90m.

Figure: 3

3.3. Geared DC Motor with Encoder:

An encoder provides an electrical signal that is used to control speed and position. It turns the mechanical signal into an electrical which is managed by the control system to control special parameters of the application and make corrections if necessary. These parameters are defined by the type of application, which includes RPM, distance, speed, position between others. Cylindrical geared motor have six pins; Encoder A phase and B phase, Motor power supply Negative and Passive, Encoder power supply Negative and Passive.

A simple DC motor converts electrical energy into mechanical and have four basic types that are series-wound, shunt-wound, compound-wound, and permanent magnet motors. A DC motor contains an armature, a stator, a rotor and a commutator with brushes. The opposite polarity within the two magnetic fields of the motor causes it to run. DC motor is the most common type of motor used in many household appliances, such as cooling fans and shaving machines etc .It has only two wires; one for 12V VCC and the other one is for grounding.
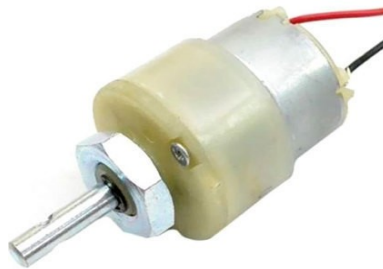

Figure: 4

3.4. RS775 DC MOTOR (High speed motor):

Used in numerous applications: this 12v to 24V torque gear motor perfectly fits for toys DIY, massage device, game device, game controller, cell phone etc. With metal material torque DC motor, lightweight, resistant abrasion and tough features, durable and reliable even you use it for long time Light and compact 12v to 24V DC motor, as good replacement for old or damaged gear motor. With low noise, high speed, high efficiency, low resistance features for this 1500 RPM DC motor. It is a high speed motor which is used to power the blades to cut through the grass.

Figure: 5

3.5. L298N Motor Module:

An L298N dual H-bridge motor controller is used to manage the direction and speed of one or two DC (direct currents) motors of up to 2A current each with a voltage between 5V to 35V. It has basically four input pins to receive the signal from the microcontroller and four output pins for the connection of the DC motors, two EN jumpers (Enable pins control the speed of DC motors).It has a built-in 5V regulator which is removed when the supply voltage is p to 12V.

Figure: 6

3.6. DC-Battery:

A battery transforms chemical energy into electrically a chemical reaction that is kept inside the battery and used to power other components such as bulb, fan, etc. A battery provides direct current (DC) electricity (electricity that flows only in one way and does not reflect). When a battery is giving electric power, red is for supplying DC voltage and black is for grounding.

Figure: 7

14

3.7. Solar Panel:

Solar panels absorb sun rays energy to generate DC electricity, and this electricity is supplied to the battery via regulator which assures the battery is charging correctly and not damaged. Photovoltaic modules contain the cells that absorb the solar rays, and that generates and provides solar electricity. AC appliances first need an inverter to convert the DC electricity into AC 220- 240V, but DC appliances can be powered from the battery directly.

Figure: 8

3.8. DC Relay Module:

Relay Driver (RD-1) is a totally programmable one channel logic controller is used to manage solid or mechanical state relays in DC and AC voltage power systems. It mainly works as a switch for electronics for on and off. It has 6 pins; VCC, GND, Input pin, normally open, normally closed and common pin.

Figure: 9

3.9. Blades:

Mower blades are the cutting components of lawn mowers. They are usually made of sturdy metals as they must be able to withstand high-speed contact with a variety of objects in addition to grass. The materials used (as well as size, thickness, and design of the blades) vary by manufacturer.

Figure: 10

3.10. Android Mobile Application:

An Android mobile application is application software developed in a computer programming language (C, C++, Java, etc.) which run on the Android platform. The application for controlling the grass cutting robot system is available and can be easily downloadable.

Figure: 11

4. DESIGN METHODOLOGY:

Figure 12, shows the circuit design of the grass cutter system, which is control by an android mobile application using Bluetooth. In this scenario, the robotic grass cutting system will move in the same direction as the user presses the arrow touch button or speaks the corresponding keyword. In this task, one Arduino UNO, an HC-05 Bluetooth module, an L298N motor module, geared DC motor with encoder, high speed DC motor, DC battery, solar panel, and a relay module were used. The RX pin of the HC-05 module is attached to the Arduino PIN D1/RX, TX to the D0/TX, Ground pin to the GND and VCC (voltage at the common collector) pin to the 5V pin of the Arduino. ENA and ENB pins of L292N motor module are connected to the digital pins A10, A5; IN1-4 pins to Arduino Pin 9, 8, 4, 3; 5V and GND pin to Arduino 5V and GND pins, 12V pins to Battery positive terminal. Further, OUT1 pin is attached to the negative terminals of LWF (Left wheel front) and LWB (Left wheel back), OUT2 pin of the motor module is connected to the positive terminals of the LWF and LWB motors. Similarly, OUT3 of the motor module is connected to negative terminals of RWF (Right wheel front) and RWB (Right wheel back), and OUT4 is connected to positive terminals of RWF and RWB. In this way, VCC, GND and IN terminal of relay driver is connected to Arduino 5V, GND and digital pin D7 and at last, NO (Normally open) pin to the positive terminal of Cutter, COM pin to the positive terminal of the battery and negative terminal of Cutter to negative terminal of battery. Positive and negative terminals of the solar panel are connected to +VE and –VE terminals of the battery.
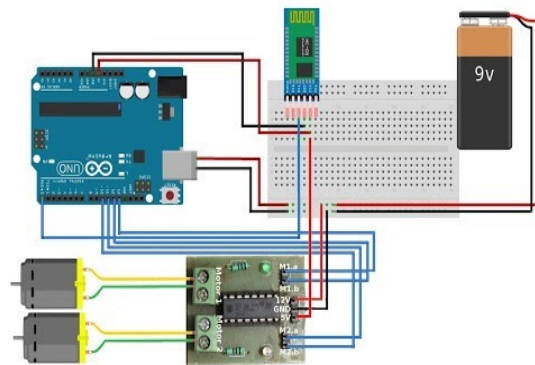

Figure: 12

5. WORKING:

The user presses the touch arrow buttons, the mobile application will recognize that keywords and a signal is sent to the Arduino. There are genuinely seven values Forward, Backward, Left, Right, Stop, OFF and ON for each function of the grass cutter. In simple words, the set of keywords are defined for the movement of the grass cutter in a specific way. If the received data by the application lies within these specified values, then the corresponding decision will be made. This decision value will be sent to the microcontroller, which then processes it to understand the keyword, and it will send a signal to move the robotic grass cutter accordingly. There is a total of two DC geared motors and high speed DC motors; both geared motors (600 RPM) for left back wheel, and for the right back wheel and high speed DC motor (6400 RPM) for the blade (cutter) is used in the construction of this grass cutter. The motors are controlled by the L298D motor shield and relay driver.
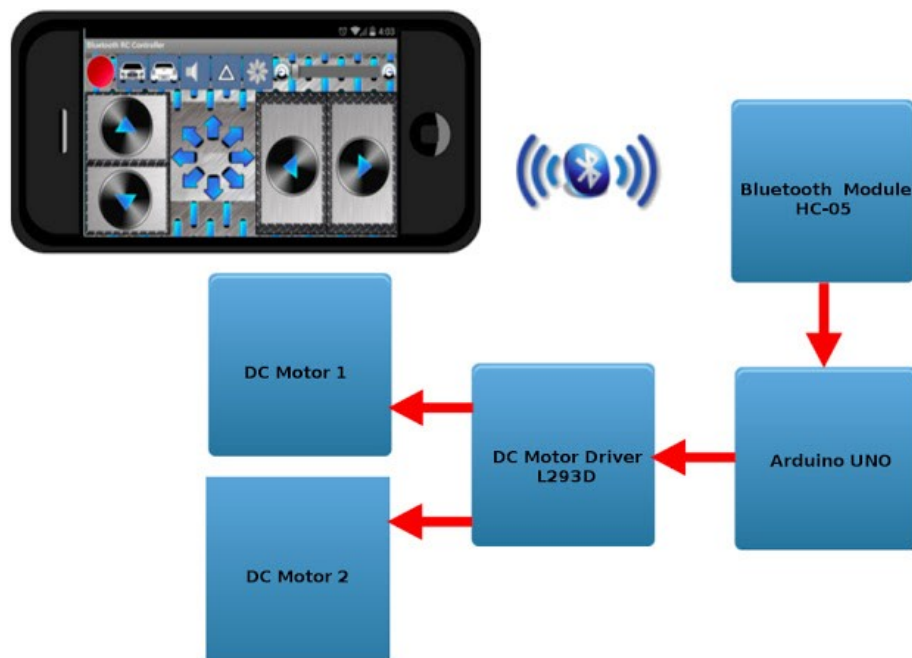

Figure: 13

6. COMPONENTS SPECIFICATION AND DIMENSION:

6.1. Robotic Wheels:

Robot Wheel is easy to mount, durable and cheap. These wheels have a 6mm hole for a shaft with the screw for fitting making it very easy to mount on motors.

➢ Long lasting.
➢ Excellent finish.
➢ Rustproof

6.2. Big Wheel:

➢ Wheel Diameter (mm): 100mm
➢ Wheel Width (mm): 44mm
➢ Shaft Diameter (mm): 6mm
➢ Load Capacity (Kg): 2Kg

6.3. Small Wheel:

➢ Shaft Diameter: 6 mm
➢ Wheel Diameter: 65mm
➢ Wheel Width: 40mm

6.4. Solar Panel Specification:

➢ Nominal Voltage: 12V
➢ Number of Cells: 36
➢ Maximum Power: 20W
➢ Materials: Mono crystalline silicon solar cells
➢ Encapsulated: PC film Lamination

➢ Temperature: 10℃ - 50℃
➢ Efficiency: 10.08%
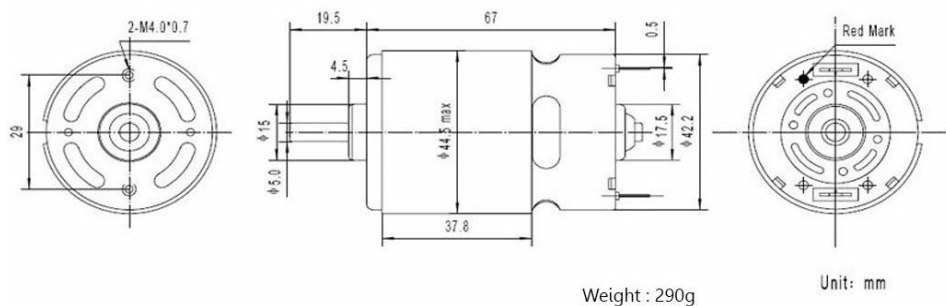➢ Size: 40x31cm

➢ Area: 1240 cm^2

6.5. DC motor Specification:

- Voltage: 12V
- Speed: 60 rpm
- Shaft Diameter: 6mm with internal hole
- Torque: 0.20 (N-m)
- No Load Current: 60mA (Max)
- Load Current: 300mA (Max)
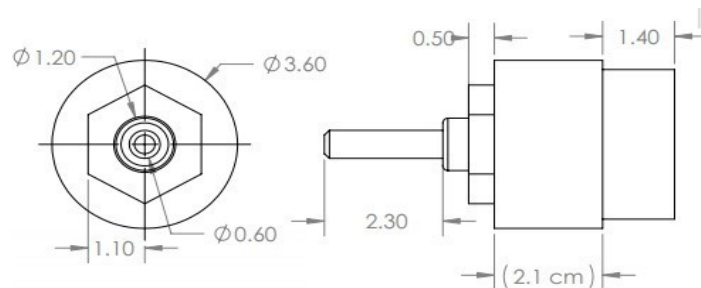
6.6. RS775 DC motor:

- Voltage: 6V-48V
- Speed: 15000 – 25000 rpm
- Torque: 0.3 – 1.30 Kg.cm
- Motor size: 42.2mm
- Motor Dia: 66.5mm

6.7. Wooden Frame:

- Length: 31cm
- Width: 30cm
- Breadth: 7cm

7. Design Calculation:

7.1. Motor selection:

  ➢ Voltage: 12v
  ➢ Current: 0.3A
  ➢ Power: 3W

7.2. Torque:

$$P = \frac{2\pi NT}{60}$$

$$T = \frac{3*60}{2*\pi*60}$$

$$T = 0.48\text{N-m}$$

Where,

P- Power in Watts
N- Speed in RPM
T- Torque in N-m

7.3. Shaft Diameter:

$$T = \frac{\pi*shear\ stress*d^3}{16}$$

$$0.48 = \frac{\pi*42*10^6*d^3}{16}$$

$$d = 0.004 \approx 6\text{mm}$$

Shaft Diameter (d) = 6 mm

7.4. Battery :

  Capacity: 12V, 1.3A. It can deliver 1.3Amps for 1 hour

We need,

  Total current required = (Motor 1) + (Motor 2) + (Arduino) + (Motor Driver)

  =>0.3+0.3+0.045+0.03=0.675 A

$$\frac{1.3}{0.675} = 1.9 \text{ hours}$$

With this battery capacity we can run the cutter machine approximately 2 hours

8. Arduino Coding:

<center>// Starting of Program</center>

```
int m1a = 9;
int m1b = 8;
int m2a = 4;
int m2b = 3;
int A = 10;
int B = 5;
char val;
void setup()
{
pinMode(m1a, OUTPUT);  // Digital pin 10 set as output Pin
pinMode(m1b, OUTPUT);  // Digital pin 11 set as output Pin
pinMode(m2a, OUTPUT);  // Digital pin 12 set as output Pin
pinMode(m2b, OUTPUT);
pinMode(A, OUTPUT);
pinMode(B, OUTPUT);
Serial.begin(9600);
}
void loop()
{
while (Serial.available() > 0)
{
val = Serial.read();
Serial.println(val);
}
if( val == 'F') // Forward
{
digitalWrite(m1a, HIGH);
digitalWrite(m1b, LOW);
analogWrite(A, 255);
digitalWrite(m2a, HIGH);
digitalWrite(m2b, LOW);
analogWrite(B, 255);
}
else if(val == 'B') // Backward
{
digitalWrite(m1a, LOW);
digitalWrite(m1b, HIGH);
analogWrite(A, 255);
digitalWrite(m2a, LOW);
digitalWrite(m2b, HIGH);
analogWrite(B, 255);
}
```

```
else if(val == 'L') //Left
{
digitalWrite(m1a, LOW);
digitalWrite(m1b, HIGH);
analogWrite(A, 200);
digitalWrite(m2a, HIGH);
digitalWrite(m2b, LOW);
analogWrite(B, 255);
}
else if(val == 'R') //Right
{
digitalWrite(m1a, HIGH);
digitalWrite(m1b, LOW);
analogWrite(A, 255);
digitalWrite(m2a, LOW);
digitalWrite(m2b, HIGH);
analogWrite(B, 200);
}
else if(val == 'S') //Stop
{
digitalWrite(m1a, LOW);
digitalWrite(m1b, LOW);
analogWrite(A, 0);
digitalWrite(m2a, LOW);
digitalWrite(m2b, LOW);
analogWrite(B, 0);
}
else if(val == 'I') //Forward Right
{
digitalWrite(m1a, HIGH);
digitalWrite(m1b, LOW);
analogWrite(A, 255);
digitalWrite(m2a, HIGH);
digitalWrite(m2b, LOW);
analogWrite(A, 200);
}
```

```
else if(val == 'J') //Backward Right
{
digitalWrite(m1a, LOW);
digitalWrite(m1b, HIGH);
analogWrite(A, 255);
digitalWrite(m2a, LOW);
digitalWrite(m2b, HIGH);
analogWrite(B, 200);
}
else if(val == 'G') //Forward Left
{
digitalWrite(m1a, HIGH);
digitalWrite(m1b, LOW);
analogWrite(A, 200);
digitalWrite(m2a, HIGH);
digitalWrite(m2b, LOW);
analogWrite(B, 255);
}
else if(val == 'H') //Backward Left
{
digitalWrite(m1a, LOW);
digitalWrite(m1b, HIGH);
analogWrite(A, 200);
digitalWrite(m2a, LOW);
digitalWrite(m2b, HIGH);
analogWrite(B, 255);
}
}
```
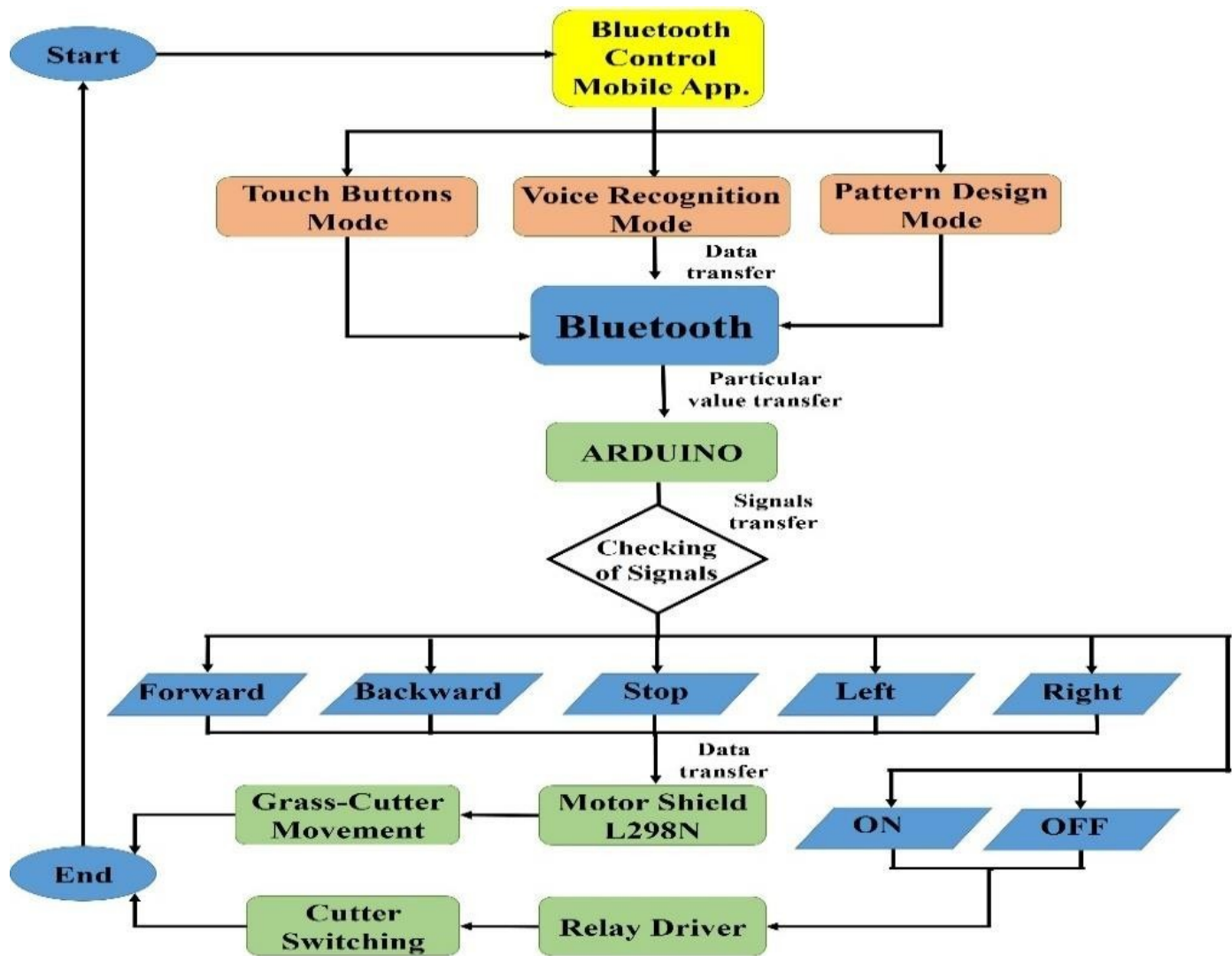
9. Block Diagram:

Figure: 11

10. Model Drafting:

SEMI AUTOMATED SOLAR GRASS CUTTER

310

400

Item Number	Parts Name	QUANTITY
1*	BODY	1
2*	WHEEL	4
3*	BLADE	1

75

Ø 105

Ø 2

165

	NAME	DATE
DRAWN		
CHECKED		
ENG APPR		
MGR APPR		

Solid Edge

TITLE
SEMI AUTOMATED SOLAR GRASS CUTTER

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN MILLIMETERS
ANGLES ±X.X°
2 PL ±X.XX 3 PL ±X.XXX

SIZE A4	DWG NO		REV

FILE NAME: MINI PROJECT

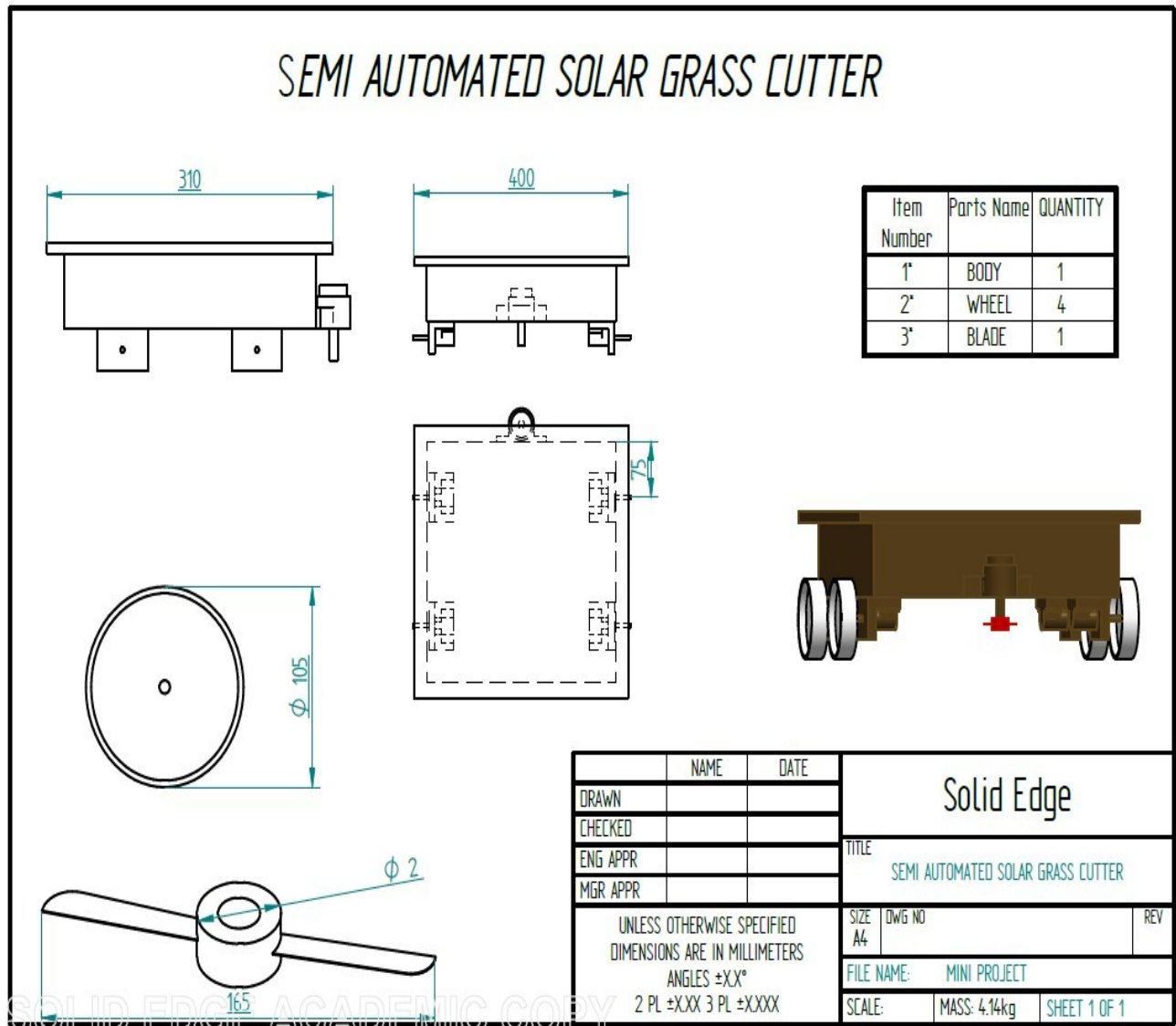SCALE: | MASS: 4.14kg | SHEET 1 OF 1

Figure: 12

11. ADVANTAGES:

- ✓ No fuel consumption
- ✓ Compact and portable
- ✓ Easy to move from one place to another
- ✓ Operating principle is simple
- ✓ Non skilled person also operate this machine
- ✓ Eco-friendly since it uses solar power to operate

12. CONCLUSIONS:

Our project entitled Fabrication of solar powered grass cutter is successfully completed and the results obtained are satisfactory. It will be easier for the people who are going to take the project for the further modifications. This project is more suitable for a common man as it is having much more advantages i.e., no fuel cost, no pollution and no fuel residue, less wear and tear because of less number of moving components and this can be operated by using solar energy. Manual work is removed by the implementation of Bluetooth control. The lawn mower can be further developed by implementing sensors so that any obstacles in the path can be sensed.

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