# ACKNOWLEDGEMENT

My endeavor stands incomplete without dedicating my gratitude to a few, who have contributed a lot towards the successful completion of my project work.

I am greatly indebted to our principal Shri.V.Showkthali, for providing the very excellent and powerful environment to lighten my young and energetic mind. I greatly obliged to HOD of the ECE Department who rendered valuable help during the period of project.

I would like to express my deep sense of gratitude to project guide Prof.Mrinalini .C.P, for the valuable guidance throughout the project.

I also take this opportunity to thank CERD(Centre For Engineering Research& Development)for providing us full financial assistance for the project Remote controlled solar green mower( SP81).Thoughts given by IRTC Mundur were also very valuable.

Gratitude is extended to all teaching and non teaching staff for their sincere directions imparted and co-operation in connection with the project.

Finally, I would like to express my heartful regards and thanks to my family members and all friends, whose support and inspiration had been strong pillars of support throughout my endeavor.

"Above all grace of almighty led me to finish this project."

# ABSTRACT

Remote controlled solar green mower is a system designed to cut grass. The system uses renewable energy sources, solar power so that it avoids pollution to environments. The system is designed to work with a remote control so that the mower can be controlled at a distance. The usual grass mowers are either operated by drivers or operators turning the vehicle in desired directions. But this grass mower can be controlled remotely from a distance of 100 meters. This helps to avoid possible hazards due to stones, thrown up during grass mowing. Also this can be used to reach remote areas for clearing ground without fearing snake bite or such personal hazard.

The system consists of three sections, the remote controlled section, vehicle and drive section, grass mower section. The remote control consists of a digital transmission and receiver module, which works with ASK modulation. The receiver is in the vehicle section. The maximum distance of transmission with this is 100 meters. The vehicle is driven by gear motors and the cutting section is fitted with an 18000 rpm dc motor for powerful cutting

The power supply required by the system is derived from solar energy. Two solar panels rated 10 watts are used for the purpose. The output voltage and current of solar panel will be changing continuously. To store the energy, a battery is required, which must be supplied with a regulated voltage. So the varying power from the solar panel is regulated using a dc to dc converter. In this project as a trial to study the behavior of the system a buck converter configuration is used. The system performance study is carried out to see the efficiency of the system.

.

# CONTENTS

# LIST OF FIGURES

**GOVERNMENT ENGINEERING COLLEGE**
**SREEKRISHNAPURAM**
**PALAKKAD-678633**

# CERTIFICATE

*Certified that this is the bonafide record of the project report on* ***REMOTE CONTROLLED SOLAR GREEN MOWER*** *done by* ***Karthik K Mayur****,* ***Krishnarjun A K, Renjith K R, TiljoT R*** *in partial fulfillment of the requirement for the award of the Degree of Bachelor of Technology of the University of Calicut during the years 2012-2013.*

**Project Guide**:
Prof.Mrinalini C.P.
Professor

**Co-ordinator:**
Prof.Mrinalini C.P.
Professor

**Head of the department:**

.

**GOVERNMENT ENGINEERING COLLEGE**
**SREEKRISHNAPURAM**
**PALAKKAD-678633**

# CERTIFICATE

*Certified that this is the bonafide record of the project report on* ***REMOTE CONTROLLED SOLAR GREEN MOWER*** *done by* ***Tiljo T R,*** *in partial fulfillment of the requirement for the award of the Degree of Bachelor of Technology of the University of Calicut during the years 2012-2013.*

| | |
|---|---|
| **Project Guide**: | **Co-ordinator:** |
| Prof.Mrinalini C.P. | Prof.Mrinalini C.P. |
| Professor | Professor |

**Head of the department:**

CHAPTER 1

# INTRODUCTION

Today's busy lifestyle demands that people make use of technology that will enable them to minimize effort. For this reason that the robotic lawn mowers have been sought after and easily accepted as a household "must-have". Another reason by which robotic grass cutter has became a necessity in today’s life is the unavailability of workers, who are ready to take up these kinds of jobs. It also ensures safety from stones, stick, wire, bones, toys, and possible snake bite that can cause personal hazard. These situations force us to depend on modern technology in agricultural field

Robotic green mower introduces robotics in agriculture based on green technology. The scarcity of energy can be minimized by using renewable energy resources. There are many renewable sources available, however solar energy can be easily used in our environment, thus we introduce solar energy to meet the necessary energy requirements. Also solar panels are commonly available in market.

The agricultural industry is behind other industries in using robots, because the sort of jobs involved in agriculture are not straight forward and many repetitive tasks are not exactly the same every time. However the main area of application of robots in agriculture is at the harvesting stage and robots are designed to replace human work.

One of the major problem that agricultural and these kinds of field’s faces is the unavailability of workers to work in this environment. The usage of Remote controlled green mowers helps to reduce the effort needed by workers, so the works can be effectively done and we can reduce labour cost. Thus cost of production can be minimized

Remote controlled solar green mower is eco-friendly equipment and it is free from fuels. This helps to reduce gaseous pollution. The conventional grass mowers are using gas oils and mains electricity, which is very expensive, Also gas and oil (diesel or petrol) pollute the environment. All these major problems can be solved by remote controlled solar green mower.

Remote controlled solar green mowers are designed to cut the grass in sizes which make it desirable as mulching material for the lawn. Upon decomposition, the cut grasses are returned to the soil and become a viable source of fertilizer for the lawn. It makes the reachability to remote areas possible. The hilly, terrain and dangerous areas which are difficult to be reached can be easily accessed using remote controlled green mowers

Remote controlled solar green mower is designed in a way that it has three sections. The major section which comprises of solar panels in order to get the required energy for green mower operation. Renewable energy resource, solar energy which is free from pollution and solves the problem of energy scarcity is used. The electric power developed is proportional to the intensity of light incident on the panel. The corresponding voltage is regulated by means of buck regulators and stored in Pb-acid battery.

The second section includes the vehicle part and cutting section. With the provided remote control we can move the vehicle in different directions. Remote control operates at radio frequencies. Instructions are given through the switches on the remote control and transmitted to the vehicle. Signal received at the receiver of the vehicle is decoded if it matches with the encoding done at the transmitter section. Decoded data are given to the Atmega8 microcontroller. The Atmega8 is programmed to control the motor driver and cutting section. The motor driver has the capability of controlling two motors independently.

Motor driver controls the direction of rotatory motion of the motor. It can be either in the clockwise or anti clockwise direction. Forward motion is carried out by the clockwise rotation of both left and right motors. Likewise the reverse motion is done by the anti clockwise rotation of both left and right motors. Left motion occurs by the clockwise rotation of left motor only. Right motion occurs by the clockwise rotation of right motors only. Likewise the cutting motor also can be controlled.

CHAPTER 2

# SYSTEM OVERVIEW

## 2.1 MOTIVATION

Remote controlled solar green mower introduces robotics in agriculture based on green technology. The scarcity of energy can be minimized by using renewable energy resources. There are many renewable sources available, however solar energy can be easily used in our environment, thus we introduce solar energy to meet the necessary energy requirements. Solar panels are readily available in market.

Presently used equipments in agriculture field consume lot of nonrenewable energy resources (petrol, diesel). They causes pollution by emitting hazardous gasses like carbon dioxide, carbon monoxide etc. By using solar power as the main energy source, the problem of energy scarcity can be resolved. They are environment friendly thus it doesn't cause any environment pollution.

Labour cost and unavailability of workers are the major problems in today's agricultural fields. By using Robotic mowers the effort of the work can be reduced and hence we can solve the above problems.

In our lawn, there are areas with dense grass and also there are areas which are unreachable by workers because of broken glasses, wastes, snakes, etc. By using robotic green mower we can reach to these kinds of areas without any harm or danger to workers.

## 2.2 NEED ANALYSIS

1. What is Remote Controlled Solar Green Mower?

Ans. It is a environment friendly remote controlled equipment, designed to cut the grasses, which uses solar energy as a power source.

2.What are the application expected?

Ans. Aim is to level the over grown grass in play grounds.

3. What is the importance of this project?

Ans. It aims at a move towards green technology. It solves the problems like unavailability of workers, high labour cost and unreachability to remote areas.

4. What are the advantages of robotic green mower over currently available green mowers?

Ans. Remote controlled solar green mower uses solar energy as power source, hence reduces pollution. It is operated by using remote control, which provides operators safety.

5. How will be the total product structure looks like?

Ans. The main part is remote controlled vehicle with cutting section infront of it. The solar panel is setup at outside the vehicle for power requirements.

6. What is the power requirement for grass mowing?

Ans. The total power required is the sum of power required for driving motor, grass cutting motor and the electronic circuitry is, P = 50 W

6. How many solar panels should be exposed to sun light to meet these power requirements?

Ans. Two 10 W solar panel should be exposed for 6 hours 30minutes (calculation included in the design).

7. What are the specifications needed for the motor used?

Ans. The grass cutting motor require high initial torque and speed to cut the grasses, to meet these capabilities we use self excited dc motor with speed 18000 rpm. In the case of vehicle driving section dc gear motor with 12V, 30 rpm, met all design specifications (calculation shown in design).

8. How much distance we can control the vehicle and what type of transmission is sufficient for this?

Ans. RF 434 transmitter receiver module, which provides 100 meter range of operation is used. ASK (amplitude shift keying) modulation is sufficient for this, because the data transmitted is not complex and the error probability in the working environment is less.

## 2.3 WISH SPECIFICATIONS

- Adjustable cutting shaft height.
- Grass cutting at a speed of 300cm²/s
- Automatic tracking of Sun by Solar Panel.
- Large distance of Operation.

## 2.4 SPECIFICATION

- Mass of vehicle : 6.5 Kg
- Battery used :5 Ah,12V Pb acid
- Charging time of battery : 6 hour
- Working time of grass cutter : 2 hour
- Velocity : 15c m/s
- Range of operation : 100-150 meters
- Total power required :50 W

## 2.5 TIME PLAN

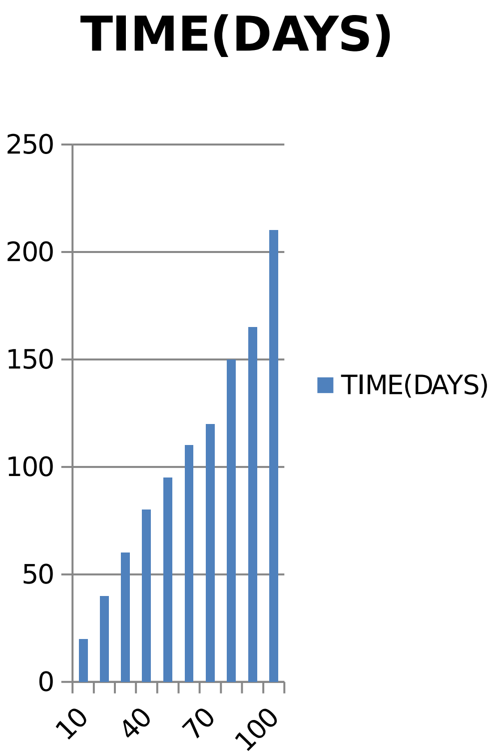
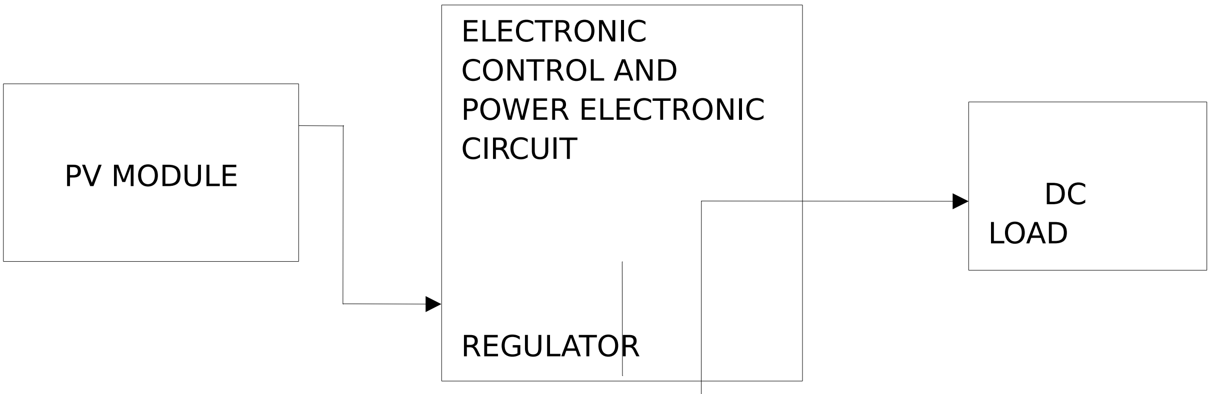



Figure.1

| | |
|---|---|
| Selection of topic | 09/08/2012 |
| Discussion with guide | 10/08/2012 |
| Idea presentation | 12/08/2012 |
| Preparing questions and answers about project | 16/08/2012 |
| Collected data about solar panel and motor from books and internet | 20/08/2012 |
| First level presentation | 18/10/2012 |
| Study of motor and converter design | 19/10/2012 |
| Intermediate level presentation | 19/11/2012 |

| | |
|---|---|
| Components purchasing | 10/1/2013 |
| Circuit making and PCB design | 1/2/2013 |
| Vehicle structure deign and making | 15/3/2013 |
| System integration | 25/3/2013 |
| Report making | 27/3/2013 |
| Final presentation | 1/4/2013 |

## 2.6 BLOCK DIAGRAMS



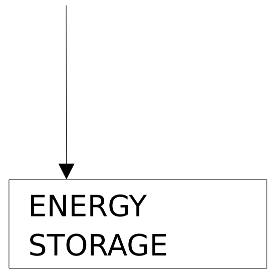
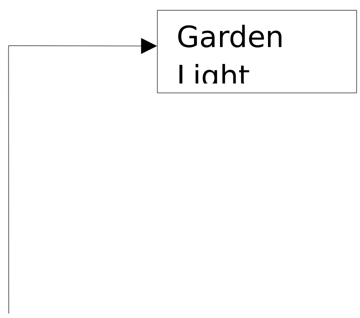



Fig.2 General energy flow diagram



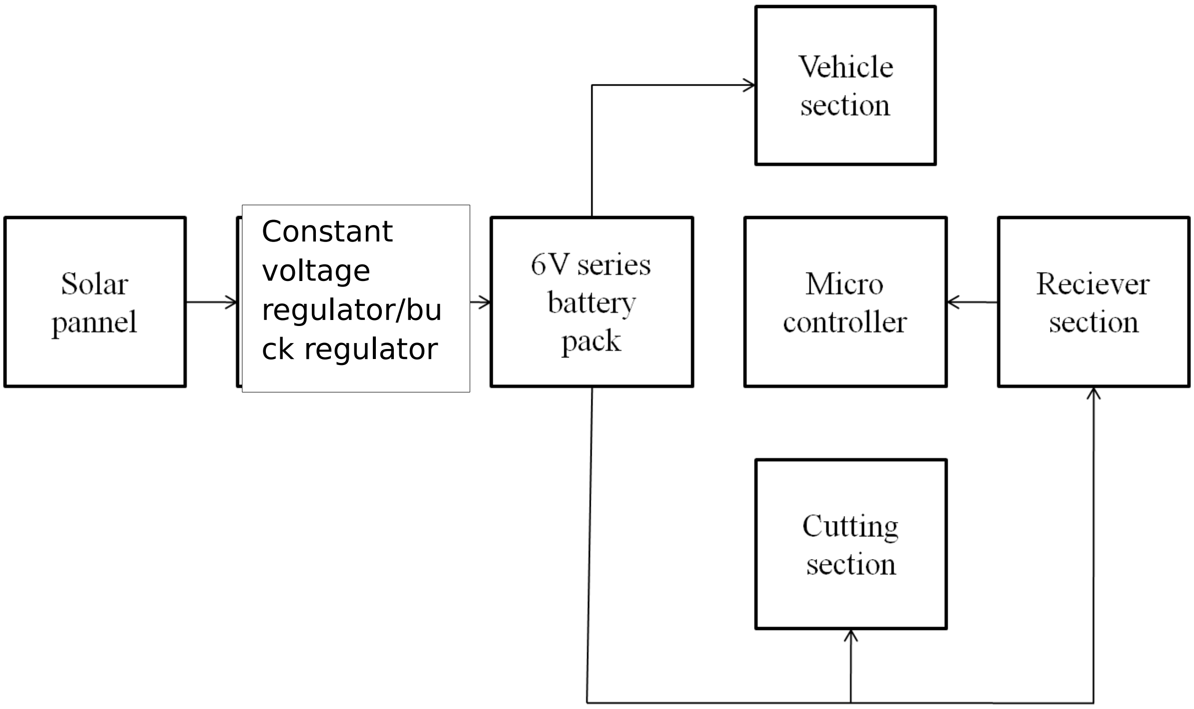



Fig.3 System block diagram

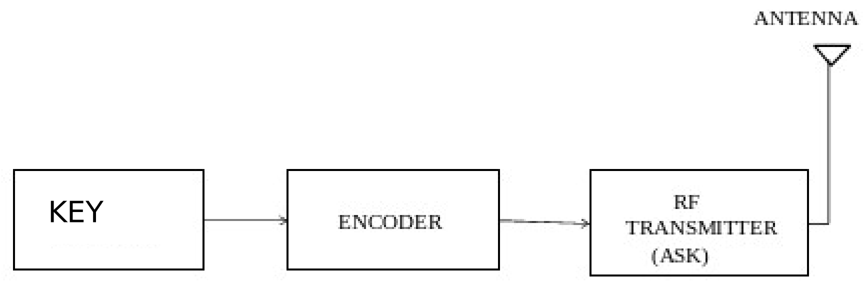



Fig.4 Remote control

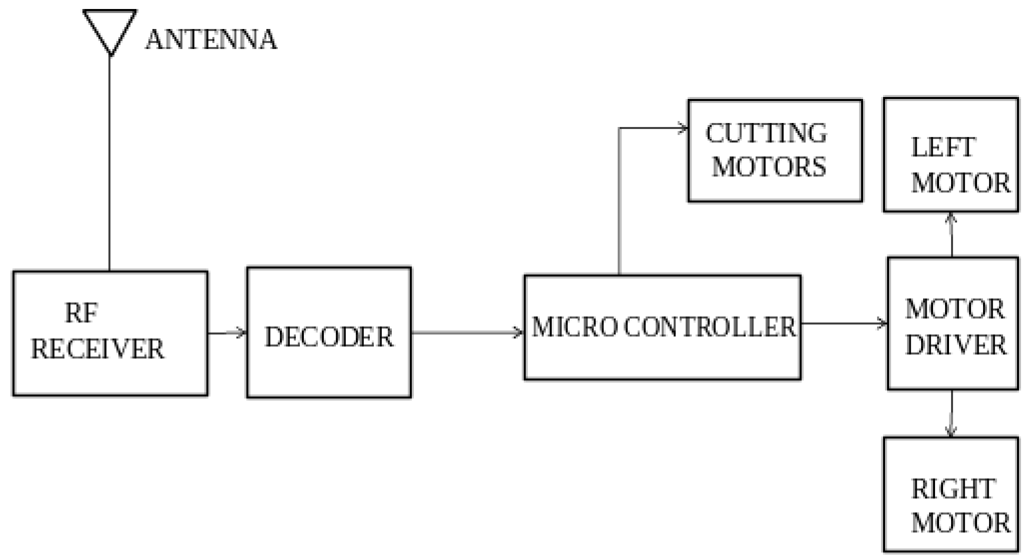



Fig.5: Vehicle drive & Cutting section control

# BLOCK DIAGRAM DESCRIPTION

The remote controlled green mower mainly consists of three sections, power supply section, remote control section and vehicle driving and cutting section.

## POWER SUPPLY

The solar energy is used as power source, the generated solar energy by solar panel is regulated by means of buck regulator and is stored in a Pb-acid battery.

### Solar Panel

Solar panel is the power generating centre. It is a photovoltaic module where a number of solar cells are electrically connected to each other and mounted in a single structure. These modules are connected serially or parallel to get the required output. By connecting panels in parallel the current adds up while voltage remains constant. Solar cells are formed of silicon wafers. When light is incident on it the barrier between the p-n junctions of the silicon wafer breaks and current begins to flow. This panel should be properly mounted to allow maximum intensity of light to strike the surface. Solar panel can be adjusted manually according to the intensity of sun light

### Buck Converter

The power output of the solar panel will be highly varying depending on the availability of sunlight. To control this highly varying dc we use a dc-dc buck converter. Here we are using LM2576 series of regulators to convert the solar panel output voltage into a fixed voltage. The regulator circuits of this series are capable of driving a 3.0A load with excellent line and load regulation. The LM 2576 converter is a switch-mode power supply, its efficiency is significantly higher in comparison with popular three-terminal linear regulators especially with higher input voltages. In many cases, the power dissipated is very low so that no heat sink is so required or its size could be reduced dramatically.

## Battery Bank

Battery bank of the system is used for storing the solar energy regulated by the buck regulator. A 5 AH 12V Pb-acid battery is used for storing charge. The Pb-acid battery is a oldest type of rechargeable battery. Despite having a very low energy to weight ratio and low energy to volume ratio, their ability to supply high surge currents means that the cells maintain a relatively large power to weight ratio. These features along with their low cost make it as good choice.

## Garden light

A LDR circuit is used to work the vehicle as a garden light during night time. Its working is based on the property of decreasing resistance of LDR while exposing to light. Here LDR is placed across the terminals of the transistor (BC547) and is properly biased, so when light falls, transistor turns on and under no light condition it turns off. By taking the output across the collector and placing there a light source, a Garden light can be implemented.

## REMOTE CONTROL

Remote control of the vehicle consists of five push buttons and a on/off switch. One of the push button is used to control the cutting motor and remaining push buttons for controlling motion of the vehicle.

## Encoder

For the remote control, the serial data transmission is used. So we need to convert the input data in the parallel form into the serial data. The encoder IC can be used for this purpose. Since, we require 12 bit data transmission, HT12E encoder IC is implemented in the circuit. These 12 bits are divided into 8 address bits and 4 data bits. It is active low IC.

HT12E are paired with 2^12 series of decoders for use in remote control system applications. The chosen pair of encoder/decoder should have same number of addresses and data format.

HT12E has a transmission (TE) enable pin which is active low. When a trigger signal is received on TE pin, the programmed address, data are transmitted together via an RF transmission medium. HT12E begins a four word transmission cycle upon receipt of a transmission enable. This cycle is repeated as long as TE is kept low. As soon as TE returns to high, the encoder completes its final cycle and then stops.

### Transmitter Module

Serial data transmission can be made possible by an RF module. A434 RF module which transmits the data from the encoder at a frequency of 434 MHz has been used. Its efficient transmission is possible within the range of 20 meters with the help of an antenna. ASK modulation is used for transmission of data. The transmission occurs at the rate of 1 Kbps-10Kbps.

## VEHICLE AND CUTTING SECTION

The encoded data from RF transmitter is received and decoded, these information is used to control vehicle and cutting part in the vehicle.

### Receiver Module

The transmitted data has to be received correctly for that receiver module A434 performs two functions reception and demodulation. The reception unit receives the data transmitted from the transmitter module, while the other unit demodulates the received data and separates the unwanted data. Then only the received data is sent to the decoder. ASK modulation is used for transmission of data. The transmission occurs at rate of 1kbps-10kbps.

### Decoder

Decoder and encoder functions in pair. HT12D has been implemented in the circuit. In the receiver decoder compares the address received with that of encoder. It converts serial data in to parallel data. These parallel data's are given to the Atmega8 and then to motor driver ICs for further operations

HT12D belongs to 2^12 series decoders. The serial input data is compared with the local addresses three times continuously. The input data code is decoded when no error or unmatched codes are found. A valid transmission is indicated by a high signal at VT pin. HT 12d is capable of decoding 12 bits, of which 8 are address bits & 4 are data bits. The data on 4 bit latch type output pins remain unchanged until new one is received.

## Motor Driver

Parallel data decoded by the decoder is given to the microcontroller and its output is used as an input to motor driver. The motor driver used here is L293D IC. It can control two motors independently. The operations of two motors can be controlled by input logic at ports 2&7 and 10&15. Input logic 00 or 11 will stop the corresponding motor logic 01 & logic10 will rotate it in clockwise and anticlockwise directions respectively. Thus depending on the signals generated at the transmission end, the motors can be rotated in desired direction. The L293D is quadruple high-current half-H driver. The L293D is designed to provide bidirectional drive currents of up to 1A and voltages from 4.5V to 36 V. It is an active low IC. This device is designed to drive inductive loads such as relays, solenoids, dc and bipolar stepping motors.

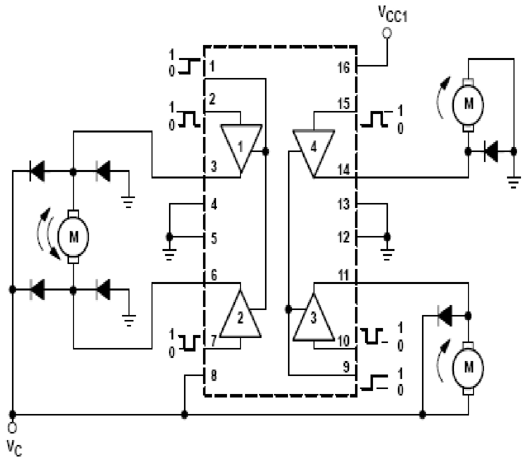



Fig 6. Block diagram of L293D

## Driving Motors

Four DC motors operating at 12V, 30 rpm are used. Two motors are used for controlling right side tyres and other two for left side tyres. As left and right motors rotates in clockwise direction, the vehicle moves in the forward direction. For right motion, only the right motors are made to rotate in the clockwise direction. For left motion, only the left motor is allowed to rotate in clockwise direction. When both motor rotates in anticlockwise direction, the vehicle moves in the backward direction

## Cutting Motor

A 12V 18000 rpm dc motor is used for cutting purpose, It is placed infront of the vehicle, and the height of cutting motor can be adjusted manually.

## Microcontroller

Atmega8 is used as the microcontroller for the remote controlled green mower. It consists of three ports and has 28 pins out of which 23 pins can be used as input output pins, 512 Bytes of EEPROM, Its low cost and can be programmed using C language. Port B is used as input and C and D Ports as output for cutting and driving motors respectively. The clock frequency of atmega8 is set as 16 MHz.

# CHAPTER 3

# SYSTEM DESIGN

## 3.1 DESIGN OF VEHICLE

### Specification of vehicle

<u>Weight of the Vehicle</u>

Mass of cutting motor = 0.065 Kg

Mass of driving motors = 0.085 ×4 Kg

= 0.34 Kg

Mass of battery = 1.5 Kg

Mass of Tyres = 0.5 Kg

Mass of Vehicle frame = 4 Kg

TOTAL MASS = (0.065+0.34+1.5+0.5+4)

= 6.405 kg

Torque (M) =Force × Perpendicular distance

= Force × Radius of the tyre

= 6.405 ×9.8×0.05

= 2.96 Nm

<u>Speed</u>

Speed of the vehicle = Revolution per second × 2Π × Radius of tyre

Assumption: Minimum speed of vehicle needed for cutting is 0.15 m/s

Radius of tyre = 0.0 5 m

RPS × (2 × Π × 0.05) = 0.15 m/s

RPS = 0.15 / (0.10 × Π)

= 0.48

So, RPM (ω) = 0.48 × 60

= 28.8

Hence choosing four 12 V, 30 rpm dc gear motor for driving the structure

Power

Power is the product of force multiplied by distance per unit time, in the case of rotational motor, the analogus calculation for power is the product of torque multiplied by the rotational distance per unit time

$$P = M \times \omega$$

P is the mechanical rotational power, M is the Torque and ω is the angular velocity.

In calculating rotational power it is necessary to convert velocity to units of rad/sec

$\Omega$ rad/sec = $\omega$ rpm × (2×Π/60)

$\Omega$ rad/sec = 30 × (2×Π/60)

= 3.14 rad/sec

So, Power = M × Ω

= 2.96 × 3.14

= 9.29W

Hence, Total power required for driving is 9.29 W

Cutting motor

We need to use high speed dc motor for proper cutting of grasses. A 12V, 18000 rpm dc motor can be used for this purpose.

The power needed for cutting = Current drawn by motor × voltage

Maximum current rating of cutting motor = 2.5 A

Hence, Power = 12 V × 2.5 A

= 30 W

**Total power needed for remote controlled solar green mower= 9.29+30 = 39.29 Watt**

## 3.2 DESIGN OF SOLAR PANNEL BASED CHARGER CIRCUIT

Battery capacity needed

Total power requirement = 39.29 watts

If a 12 V battery issued, The current requirement is = 39.29/12

= 3.27 A

Therefore, battery capacity for 1 hour = 3.27 Ah ≈ 5Ah

Then, Battery capacity needed by the system = 12 V × 5Ah

= 60WH

Battery could supply 60 W for 1 Hour.

Exposing time of solar panel

using 2, 10 Watt Solar panel with efficiency of 45%

exposing time ( considering system loss ) for charging 60Wh battery

= 60 / (2 * 10 * 0.45)

= 6 hour 30 minutes

**So, The solar panel must be exposed for 6 Hours and 30 minutes for the complete charging of the battery.**

## 3.3 DESIGN OF BUCK REGULATOR

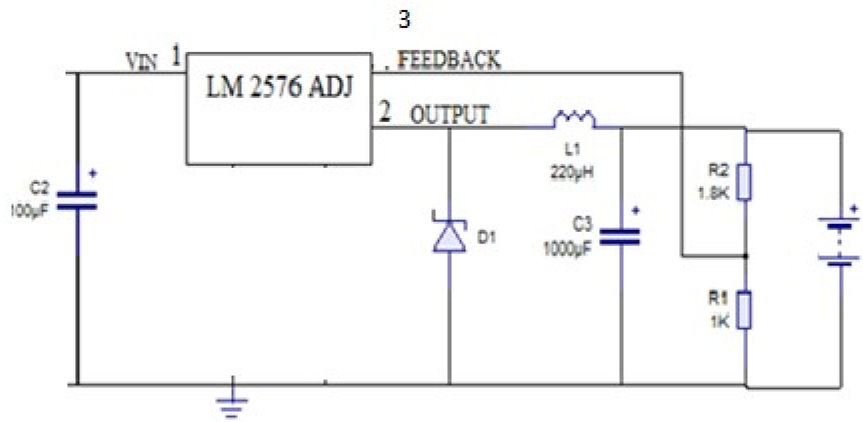



Fig.7 Buck regulator

Input voltage to the buck regulator, Vin =20 V

Output voltage of the Buck Regulator is adjusted using the relation.

$$Vout = Vref\ (1+ R2/R1)$$

Vref = 5 V for a adjustable regulator

We want 14V regulated output for charging 12v lead acid battery. Hence Vout =14 V

Then,

$$14 = 5\ (1+R2/R1)$$

Choose R1 = 1K

Hence, R2 = 1.8K

**Input Capacitor Selection (C2)**

To prevent large voltage transients from appearing at the input and for stable operation of the converter, electrolytic bypass capacitor is needed between the input pin Vin and ground pin Gnd. This capacitor should have a low ESR (Equivalent Series Resistance) value. A 100 µF electrolytic capacitor provides sufficient bypassing.

**Inductor Selection (L1)**

The inductor Volt x microsecond [V x µs] constant can be calculated as
E x T = (Vin – Vout) × (Vout /Vin) x 10 ^6 / F

The inductor chosen must be rated for a switching frequency (F) of 52 KHz.

Hence, E x T= (20 – 14) x (14/20) x 1000 /52 = 80.76 [V x µs] ,This E x T constant is a measure of the energy handling capability of an inductor and is dependent upon the type of core, the core area, the number of turns, and the duty cycle.

The maximum load current of the regulator is 1.3 A.

Hence, from the Figure 25(appendix) the inductance region intersected by the E x T value 80.76 and the maximum load current value 1.3A on the horizontal axis is L220.

From the inductor code L220 select an appropriate inductor value 220µh using Table 2 (appendix).

**Output Capacitor Selection (C3)**

For stable operation, the capacitor must satisfy the

$$C3 \geq 13{,}300 \times \text{Vin (max)} / (\text{Vout} \times L)$$

$$\geq 13{,}300 \times 20 / (14 \times 220) = 86.36\ \mu F$$

To achieve an acceptable ripple voltage, select C3 =100 µF electrolytic capacitor.

CHAPTER 4

# SOFTWARE DESIGN

## 4.1 LANGUAGE

### C language

It is the most popular computer language used. It is a robust language whose rich set of built in- functions and operators can be used to write any complex program. The C combines the capabilities of a assembly language with the futures of a high level language. Program written in C are efficient and fast. There are only 32 Key words and its strength lies in its built in-functions. C is a highly portable language.

## 4.2 ALGORITHM

Step 1: Start

Step 2: Initialize port C and D as output ports and ports B as input port.

Step 3: scan the input ports.

Step 4: Check whether the cutting switch is pressed if so drive all cutting motors in forward direction.

Step 5: Check whether the left switch is pressed if so drive left motors in reverse direction and right motors in forward direction.

Step 6: Check whether the right switch is pressed if so drive left motor in forward direction and right motors in reverse direction.

Step 7: Check whether both left and right switches are pressed if so then rotate all the four driving motor in forward direction.

Step 8: Check whether the reverse switch is pressed if so rotate all driving motors in reverse direction.

Step 9: Go to step3.

Step 10: Stop

## 4.3 FLOWCHART

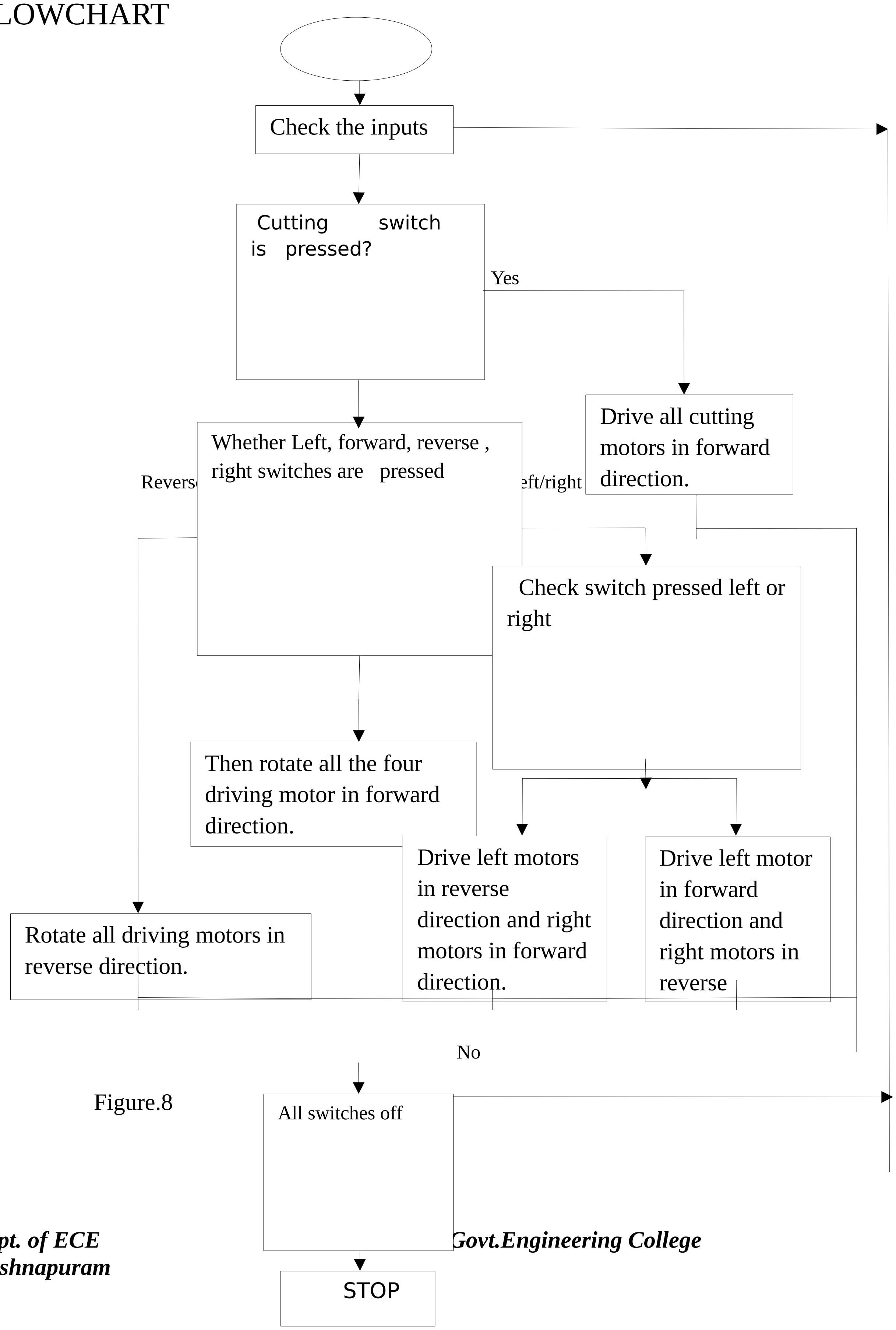



Figure.8

## 4.4 PROGRAM

```
 #include <avr/io.h>
#define sbi(x,y) x |= _BV(y)
#define cbi(x,y) x &= ~(_BV(y))
int main()
{
DDRD=0xFF;
DDRB=0x00;
DDRC=0xFF;
PORTC=0xFF;
PORTB=0x00;
PORTD=0x00;
while(1)
{
if(!is_high(PINB,PB0) && !is_high(PINB,PB1) && !is_high(PINB,PB2) && !
is_high(PINB,PB3))
{
cbi(PORTD,PD0);
cbi(PORTD,PD1);
cbi(PORTD,PD6);
cbi(PORTD,PD7);
cbi(PORTC,PC3);
cbi(PORTC,PC4);
 }
 if(is_high(PINB,PB0) && !is_high(PINB,PB1) && !is_high(PINB,PB2) && !
is_high(PINB,PB3))
{
cbi(PORTD,PD0);
cbi(PORTD,PD1);
cbi(PORTD,PD6);
cbi(PORTD,PD7);
sbi(PORTC,PC3);
cbi(PORTC,PC4);
 }
if(!is_high(PINB,PB0) && is_high(PINB,PB1) && is_high(PINB,PB2) && !
is_high(PINB,PB3))
{
sbi(PORTD,PD0);
cbi(PORTD,PD1);
sbi(PORTD,PD6);
cbi(PORTD,PD7);
cbi(PORTC,PC3);
cbi(PORTC,PC4);
 }
```

```
 if(is_high(PINB,PB0) && is_high(PINB,PB1) && is_high(PINB,PB2) && !
is_high(PINB,PB3))
{
sbi(PORTD,PD0);
cbi(PORTD,PD1);
sbi(PORTD,PD6);
cbi(PORTD,PD7);
sbi(PORTC,PC3);
cbi(PORTC,PC4);
}
 if(!is_high(PINB,PB0) && is_high(PINB,PB1) && !is_high(PINB,PB2) && !
is_high(PINB,PB3))
{
sbi(PORTD,PD0);
cbi(PORTD,PD1);
cbi(PORTD,PD6);
sbi(PORTD,PD7);
cbi(PORTC,PC3);
cbi(PORTC,PC4);
}
 if(is_high(PINB,PB0) && is_high(PINB,PB1) && !is_high(PINB,PB2) && !
is_high(PINB,PB3))
{
sbi(PORTD,PD0);
cbi(PORTD,PD1);
cbi(PORTD,PD6);
sbi(PORTD,PD7);
sbi(PORTC,PC3);
cbi(PORTC,PC4);
}
 if(!is_high(PINB,PB0) && !is_high(PINB,PB1) && is_high(PINB,PB2) && !
is_high(PINB,PB3))
{
cbi(PORTD,PD0);
sbi(PORTD,PD1);
sbi(PORTD,PD6);
cbi(PORTD,PD7);
cbi(PORTC,PC3);
cbi(PORTC,PC4);
}
 if(is_high(PINB,PB0) && !is_high(PINB,PB1) && is_high(PINB,PB2) && !
is_high(PINB,PB3))
{
cbi(PORTD,PD0);
sbi(PORTD,PD1);
sbi(PORTD,PD6);
cbi(PORTD,PD7);
sbi(PORTC,PC3);
```

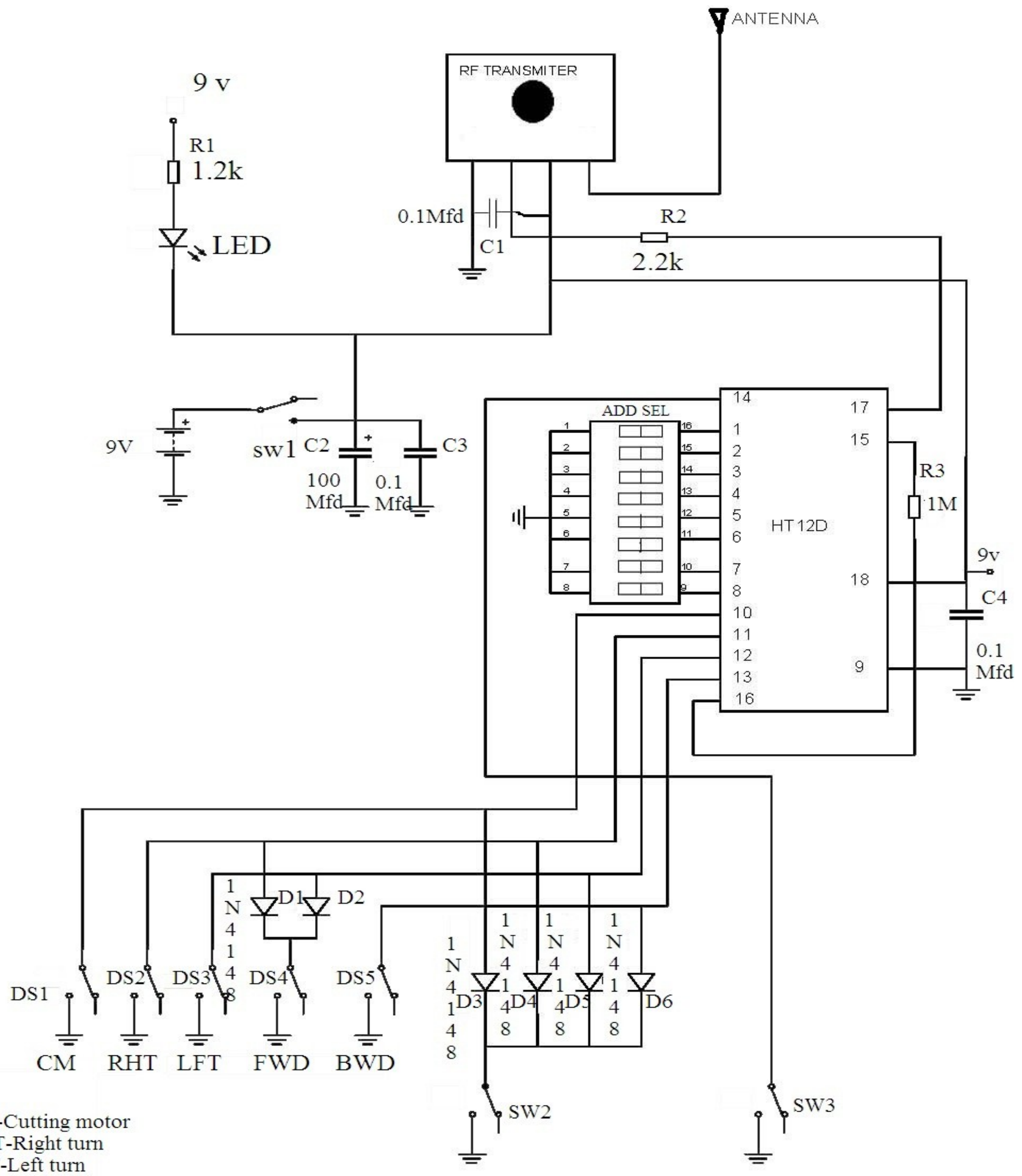
```
cbi(PORTC,PC4);
}
 if(!is_high(PINB,PB0) && !is_high(PINB,PB1) && !is_high(PINB,PB2) &&
is_high(PINB,PB3))

{
cbi(PORTD,PD0);
sbi(PORTD,PD1);
cbi(PORTD,PD6);
sbi(PORTD,PD7);
cbi(PORTC,PC3);
cbi(PORTC,PC4);
}
 if(is_high(PINB,PB0) && !is_high(PINB,PB1) && !is_high(PINB,PB2) &&
is_high(PINB,PB3))
{
cbi(PORTD,PD0);
sbi(PORTD,PD1);
cbi(PORTD,PD6);
sbi(PORTD,PD7);
sbi(PORTC,PC3);
cbi(PORTC,PC4);
}
}
return 0;
}
```

# CHAPTER 5

# SYSTEM INTEGRATION

## 5.1 COMPLETE CIRCUIT DIAGRAM




CM-Cutting motor
RHT-Right turn
LFT-Left turn
FWD-Forward
BWD-Backward

Fig.9 Transmitter

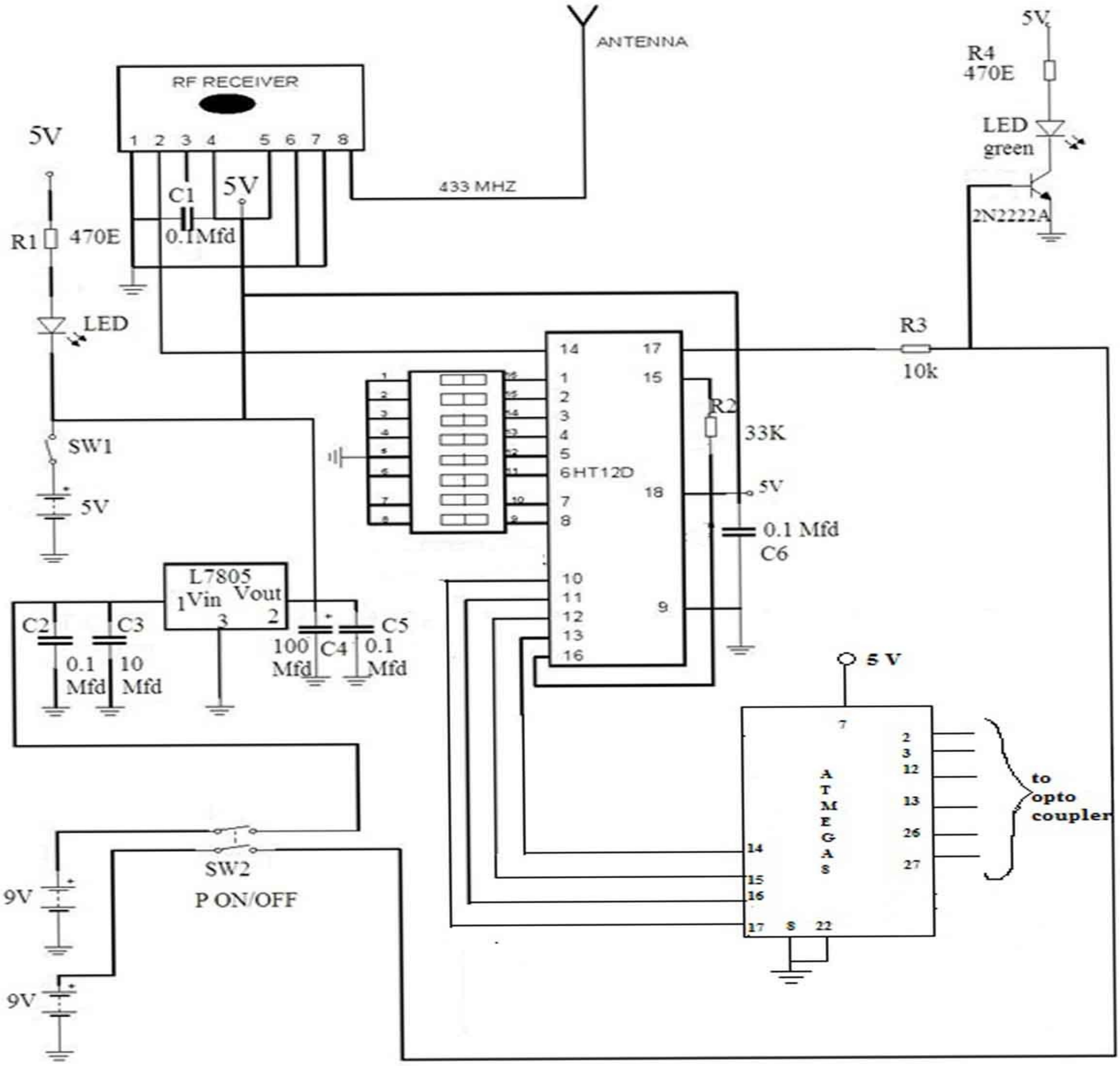



Fig. 10 Receiver

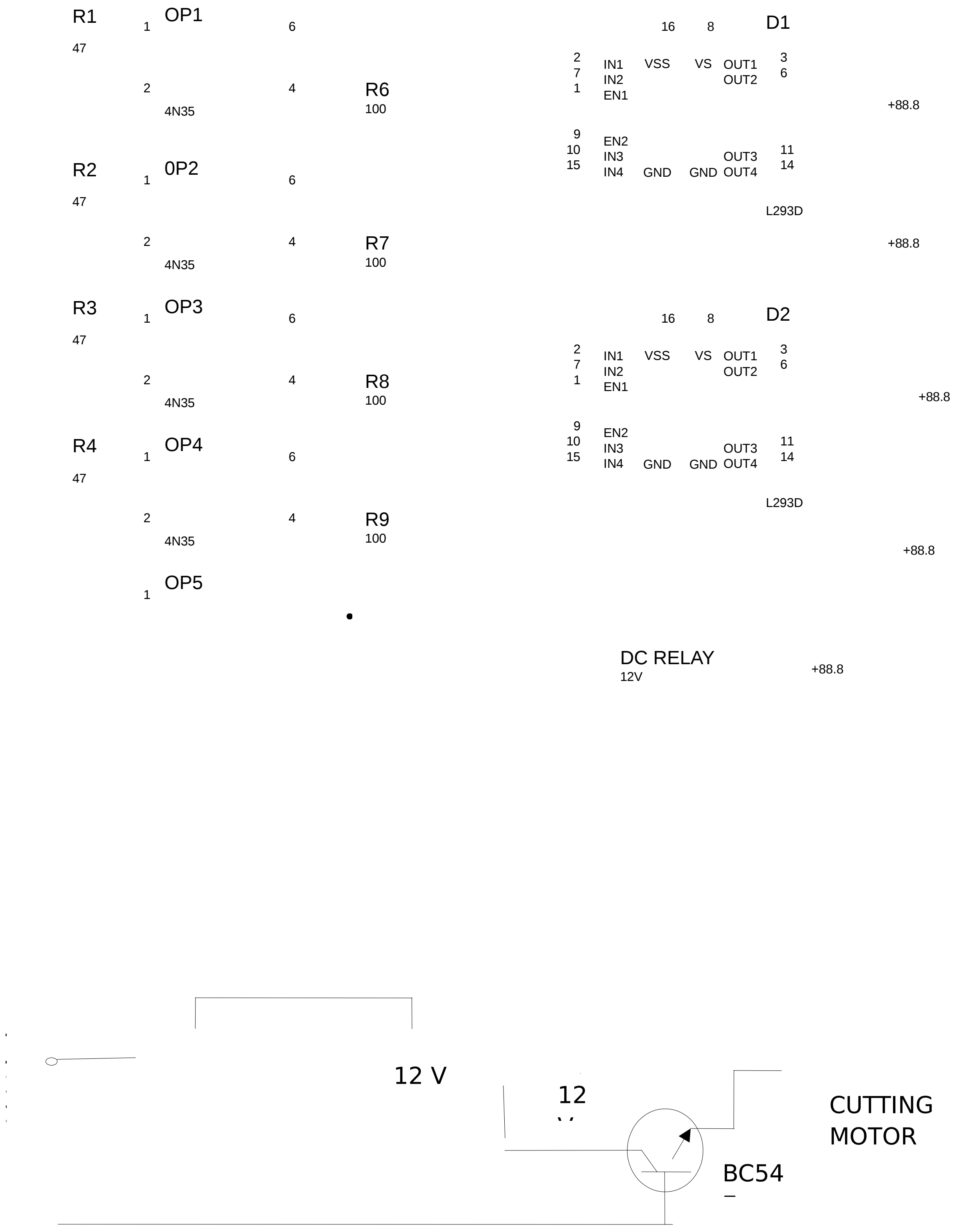

R1
47
OP1
4N35
R2
47
0P2
4N35
R3
47
OP3
4N35
R4
47
OP4
4N35
OP5
R6
100
R7
100
R8
100
R9
100
D1
L293D
IN1
IN2
EN1
EN2
IN3
IN4
VSS
VS
GND
OUT1
OUT2
OUT3
OUT4
D2
L293D
+88.8
DC RELAY
12V
12 V
CUTTING
MOTOR
BC54

Fig. 11 Motor section

FROM ATMEGA8

•

## 5.2 PCB LAYOUT

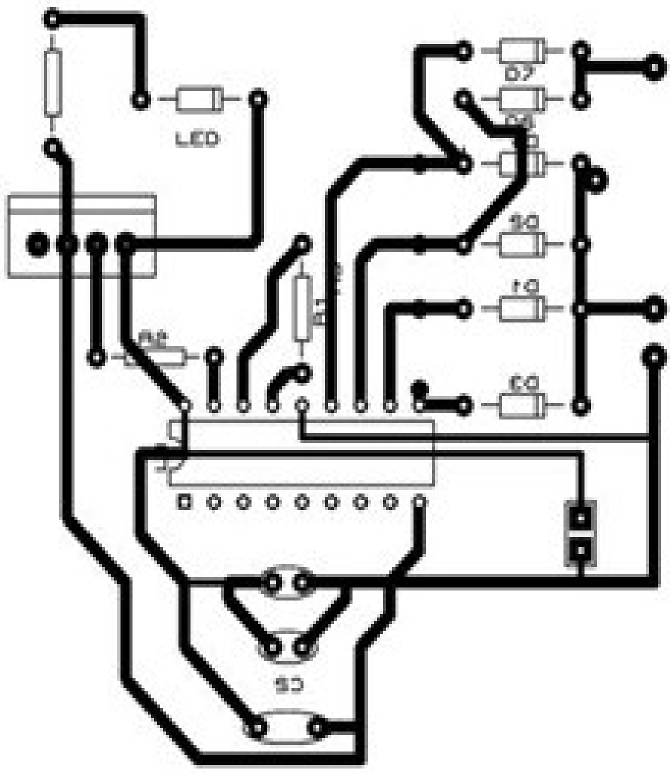



Fig.12 Transmitter PCB layout

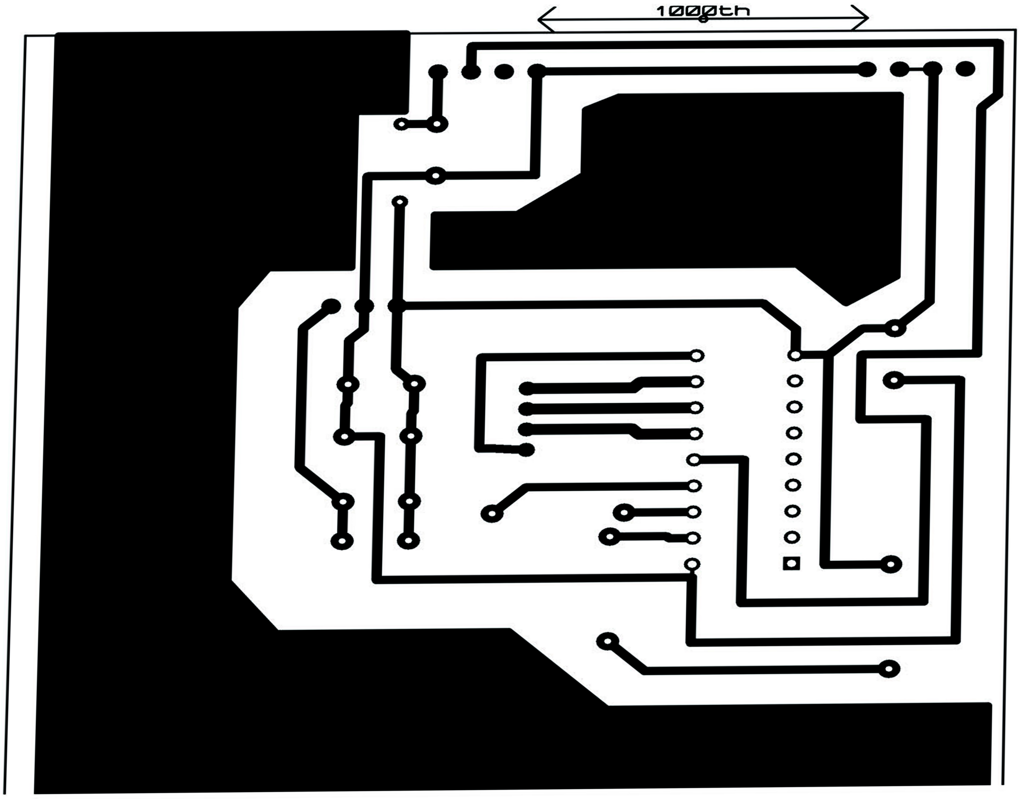



Fig.13 Receiver PCB layout

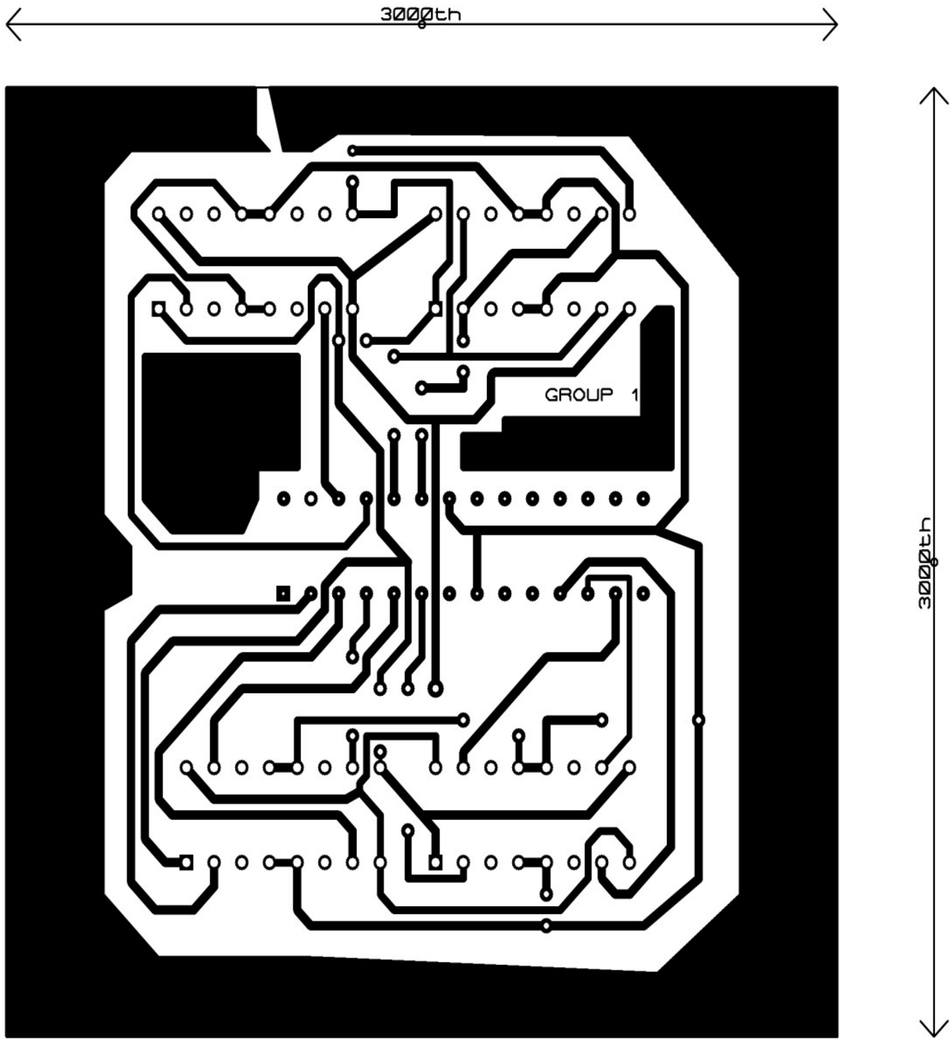
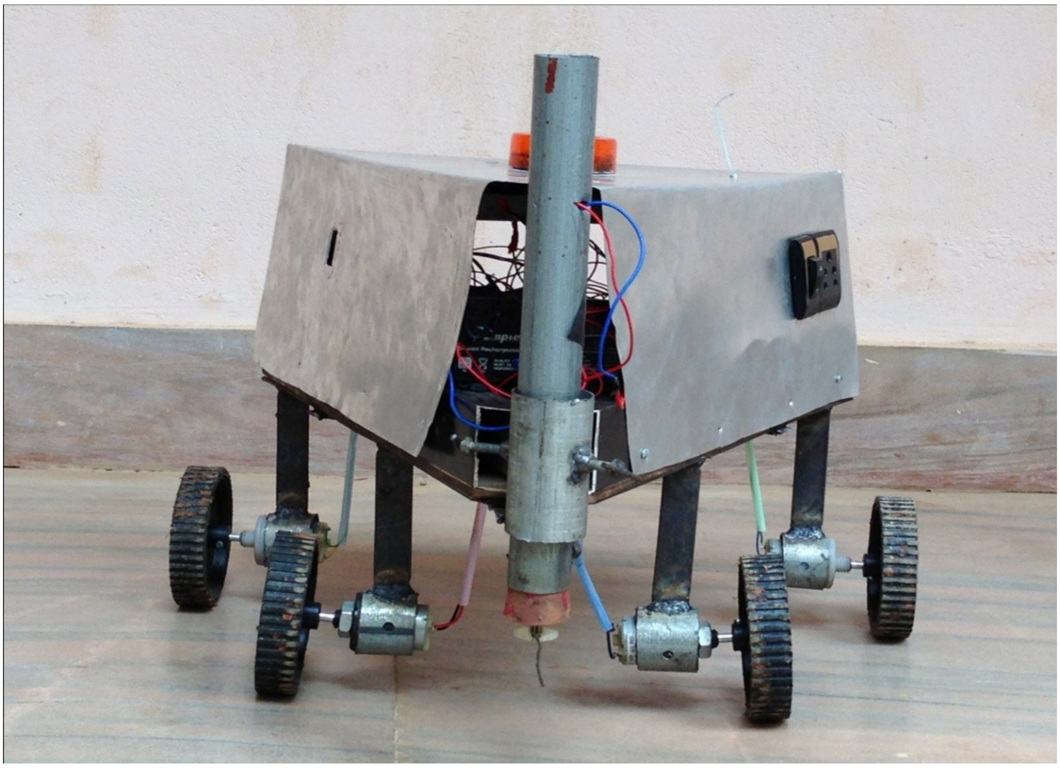
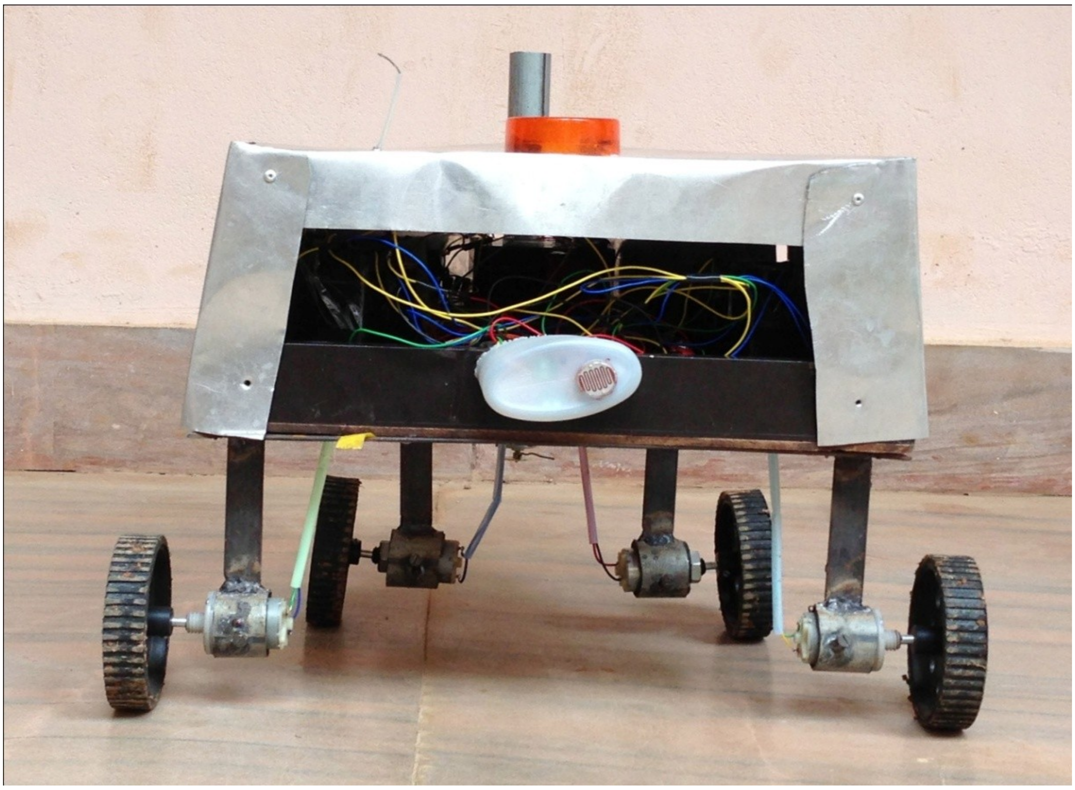
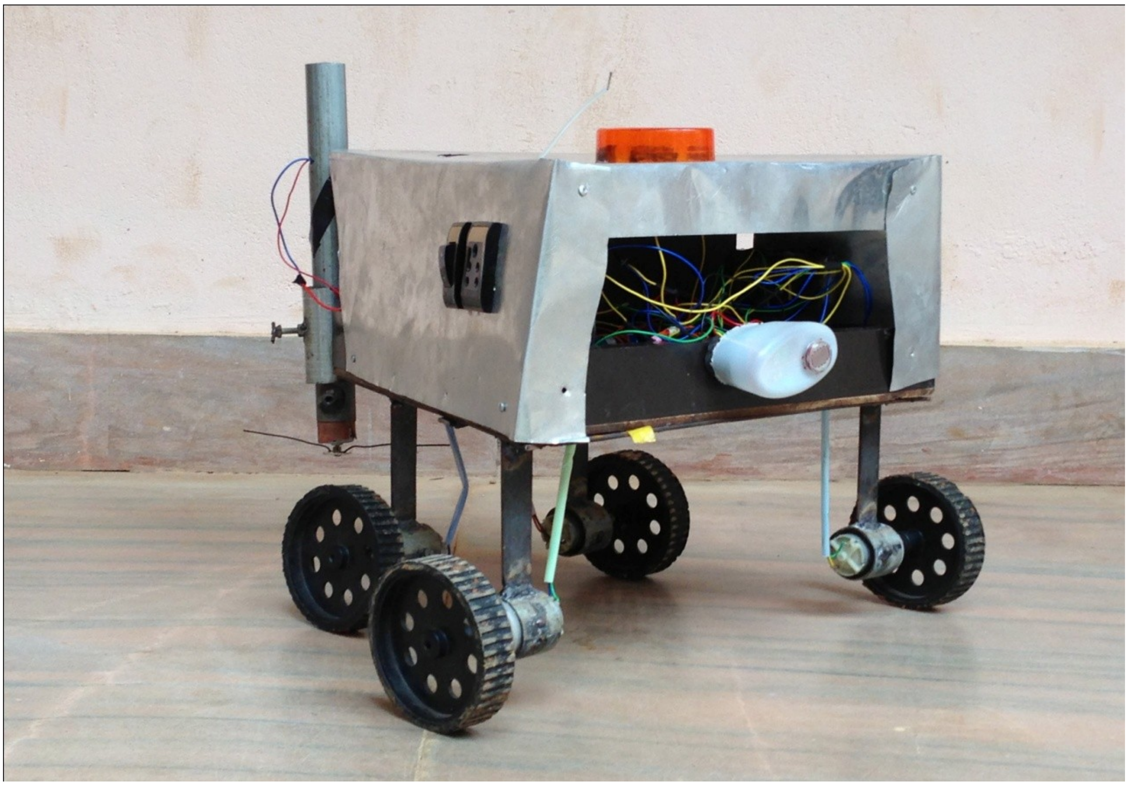



Fig14. Motor & microcontroller section PCB

## 5.3 PRODUCT PHOTOGRAPHS







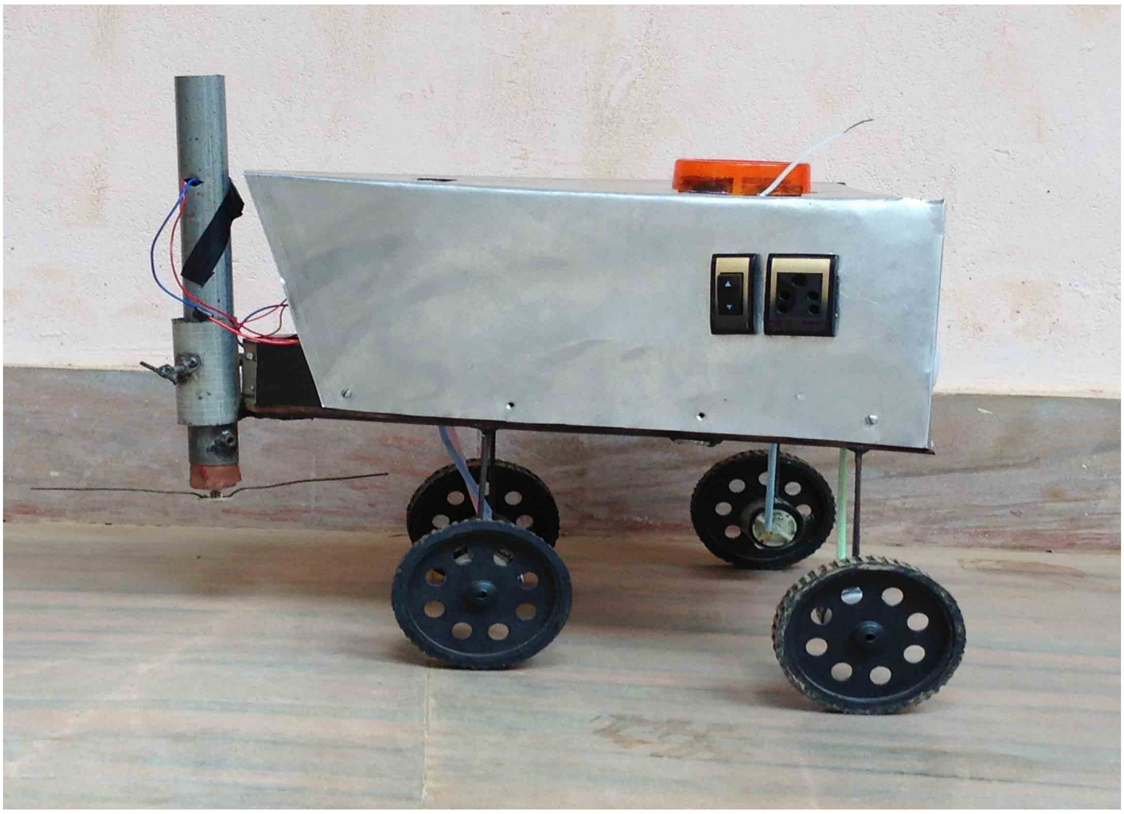


Figure 15 GREEN MOWER

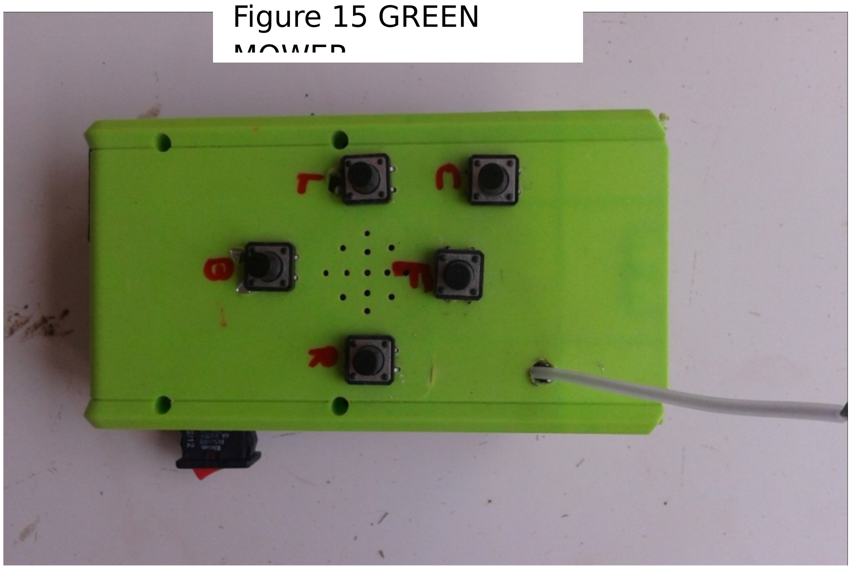



Figure 16 .REMOTE CONTROL

Figure .17. SOLAR PANEL

## 5.4 OPEATING SEQUENCE OF INSTRUMENTS

1. Charge the battery using solar panel
2. Turn on Power
3. Move the vehicle to desired directions
4. Power on the cutting motor
5. After cutting switch off the cutting motors
6. Return the vehicle to the charging section

CHAPTER 6

# CONCLUSION

## 6.1 RESULTS

The system had achieved the requirements, using the system most of the grasses are mowed. Grass within a range of around 2m.sq was mowed in a minute of time. Mowing grasses during the movement of vehicle is not so accurately achieved. Accuracy of solar panel is not so consistent along the day time but this is minimized by tilting the angle of the panel. Above 6 Hrs was needed for the complete charging of the battery.

### 6.1.1 SYSTEM EFFICIENCY

System efficiency is the measure of how much efficiently the system works. The efficiency of the Remote controlled solar green mower depends on the product of Photovoltaic module efficiency and battery pack efficiency.

PV MODULE EFFICIENCY

The average voltage and current readings from the solar panel over a period of one week at particular time intervals (9:30 am to 3pm at regular intervals of 30 minutes), are plotted and is shown in figure 18.

The efficiency of solar panel = $\dfrac{peak\ power}{instantaneous\ radiation \times PV\ module\ area}$

From the I-V graph, figure 18,

Peak voltage =20.4 V

Peak current =1.1 A

Hence, Peak power = 20.4 × 1.1

= 22.4 W

Instantaneous radiation measured =800 lumens

Total area of PV module = 1562.4 $cm^2$

= 0.15624$m^2$

Therefore, PV module efficiency = $\dfrac{22.4}{800 \times 0.15624}$

= 17.9%

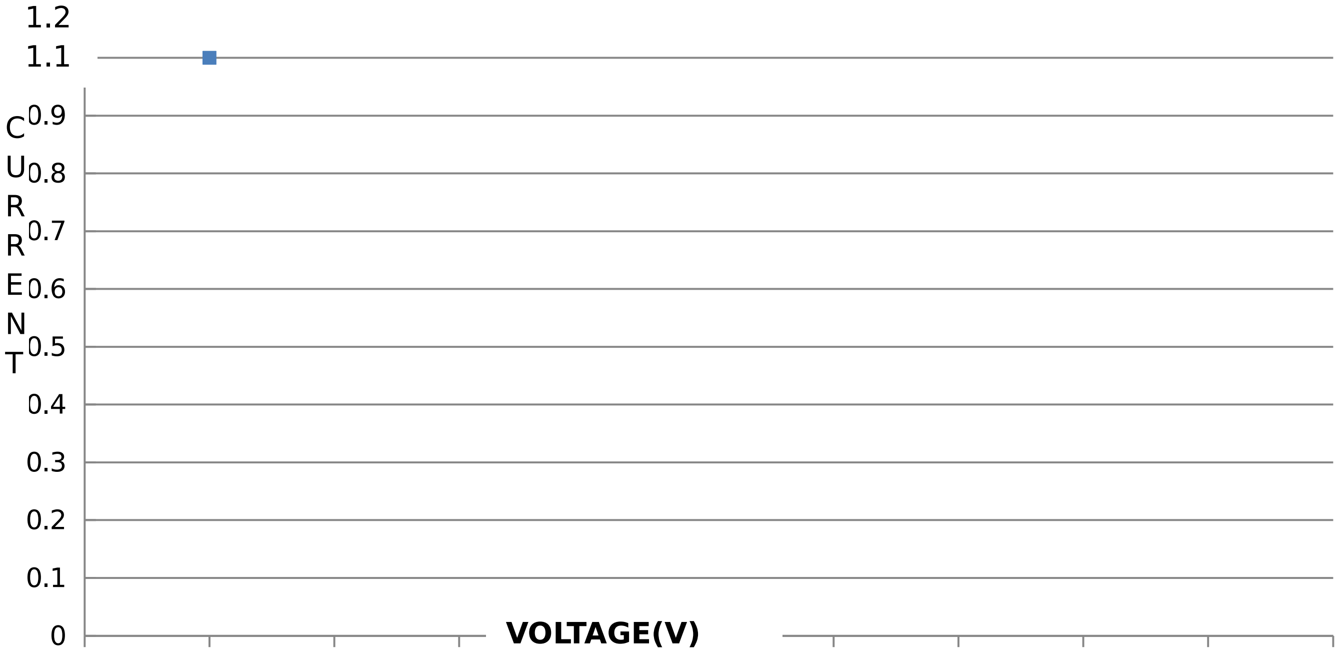



Fig. 18 voltage current characteristics of photo voltaic module

BATTERY EFFICIENCY

Battery Efficiency $= \frac{Energy\ output}{Energy\ input} \times 100$

Here energy = Voltage × Current × time

Average current discharged through battery to load = 3.4A

Voltage across the battery = 12V

Time taken for discharging = 1Hour 48 minutes

Output Power = 12× 3.4× 1.8

= 73.44WH

Average current used for charging = 1A

Voltage across the battery =14V

Time taken for charging = 6Hour 38 minutes

Input power = 92.96 WH

Therefore efficiency $= \frac{73.44}{92.26} \times 100$

= 79.60%

System Efficiency = PV module efficiency ×Battery efficiency

= 0.796 ×0.179 ×100

= 14.3%

**The overall system efficiency of remote controlled solar green mower is 14.3%**

## 6.2 ERROR ANALYSIS

1. Range of transmission was 20m & by using an antenna of co-axial and 50 ohm, range extended to 100m.

2. Using regulator circuit of ‘lm2576’ we got only 5v.we varied the feedback resistances of the circuit and got a voltage of 14.88v.

3. Using a solar panel of 10W, 20V we got only 600mA.but for the charging of battery 800mA is required, so we used two solar panels for the current requirement.

4. The voltage regulator provided a variable current output. So we replaced the regulator IC by lm317 & we got constant current output.

5. We initially selected IR frequency for transmission. But it is short range and low penetration capacity. So we chose RF frequency.

# REFERENCE

- www.engineersgarage.com
- www.ikalogic.com
- www.datasheet.com
- www.fairchild.com
- www.summittechnology.co.in
- www.holtek.com

# APPENDIX