AUTONOMOUS MOBILE ROBOT

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BALLOON BURSTING AND LINE FOLLOWING ROBOT

PROJECT REPORT

FALL – 15

DEPARTMENT OF MECHATRONICS ENGINEERING

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A special credit goes to our fellows who helped us out in completing the project, where they all exchanged their own interesting ideas, thoughts and made it possible to complete our project with all accurate information. We would like to wish thank our parents for their personal support or attention who inspired me to go my own way. At last, I would like to thank ALLAH who made all the things possible for us till the end.

ABSTRACT

The main goal is to design and develop a mobile robot. A mobile robot is an automatic machine that is capable of locomotion. Mobile robots have the capability to move around in their environment and are not fixed to one physical location. This robot could detect a balloon, determine its color, burst them and plan the path towards them by following a provided path or line. Such a robot will be able to determine its location from the start point to the goal point. The robot is able to sense any obstacles place between its start and goal point.

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CHAPTER 1: INTRODUCTION

1. Introduction

Robotics has proven to be a helping hand for humans in various fields of life. Every day the research in robotics takes this field a step further into the human world. From tasks that are harmful to humans to the performing simple tasks at much greater pace, robotics is helping humanity at its best. The need of the hour is to take a step further and to train the future engineer to be familiar and acquainted with the field before they go out into the practical world.

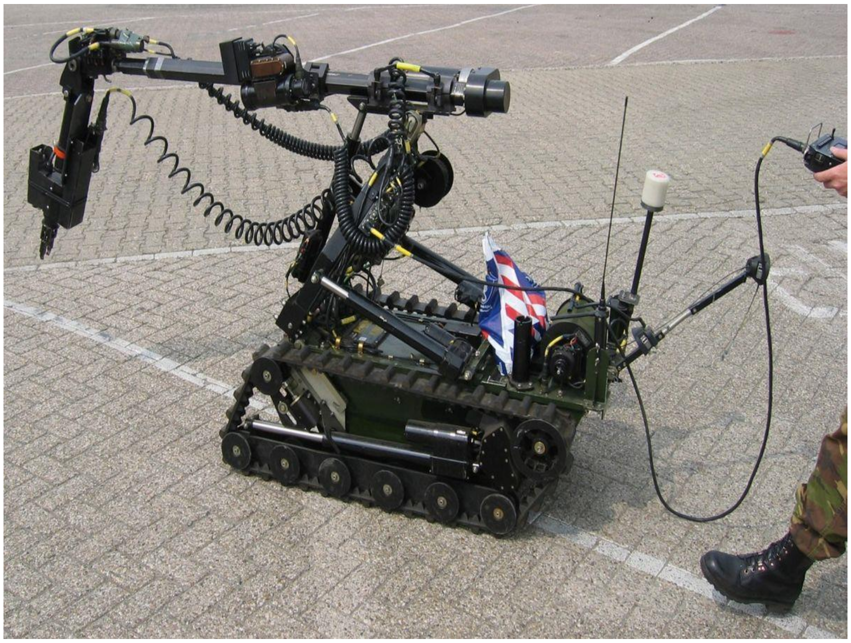
Robotics is the fortunate invention. Robots all have some kind of mechanical construction, a frame, form or shape designed to achieve a particular task. For example, a robot designed to travel across heavy dirt or mud, might use caterpillar tracks. The mechanical aspect is mostly the creator's solution to completing the assigned task and dealing with the physics of the environment around it.

Robots have electrical components which power and control the machinery. For example, the robot with caterpillar tracks would need some kind of power to move the tracker treads. That power comes in the form of electricity, which will have to travel through a wire and originate from a battery, a basic electrical circuit. Even gas powered machines that get their power mainly from gas still require an electric current to start the gas using process which is why most gas powered machines like cars, have batteries. The electrical aspect of robots is used for movement (through motors), sensing (where electrical signals are used to measure things like heat, sound, position, and energy status) and operation (robots need some level of electrical energy supplied to their motors and sensors in order to activate and perform basic operations).

All robots contain some level of computer programming code. A program is how a robot decides when or how to do something. Programs are the core essence of a robot, it could have excellent mechanical and electrical construction, but if its program is poorly constructed its performance will be very poor or it may not perform at all. There are three different types of robotic programs: remote control, artificial intelligence and hybrid. A robot with remote control programming has a pre-existing set of commands that it will only perform if and when it receives a signal from a control source, typically a human being with a remote control. It is perhaps more appropriate to view devices controlled primarily by human commands as falling in the discipline of automation rather than robotics. Robots that use artificial intelligence interact with their environment on their own without a control source, and can determine reactions to objects and problems they encounter using their pre-existing programming. Hybrid is a form of programming that incorporates both AI and RC functions.

Types of mobile Robot

Remote Operated



Autonomous robots

In this regard our task is to design an efficient robot that should be capable of following the line and sense different colored patches. This project has a great importance in our Engineering as it gives us exposure to various segments that could help make us great Mechatronics Engineers.

2. Objective

To reach the enemy balloon, pop it and complete the arena during it which it had to do by following the path and distinguishing between friendly and enemy balloons.

3. Design Criteria

The following were the criteria provided for the bots.

- The whole robot (including mounted sensors) must fit within 1 cubic foot.
- The weight of the robot must not exceed 9kg.
- The robot should be autonomous.
- Any type of battery is allowed provided it must not exceed 24V
- The robot should be strong enough to carry a payload of up to 1 kg with stability.
- The robot must be capable of line tracking.
- The robot must be self-made from discrete components.
- The robot must be capable of distinguishing color balloons as enemy or friendly ones using color sensing.

4. Design cycle

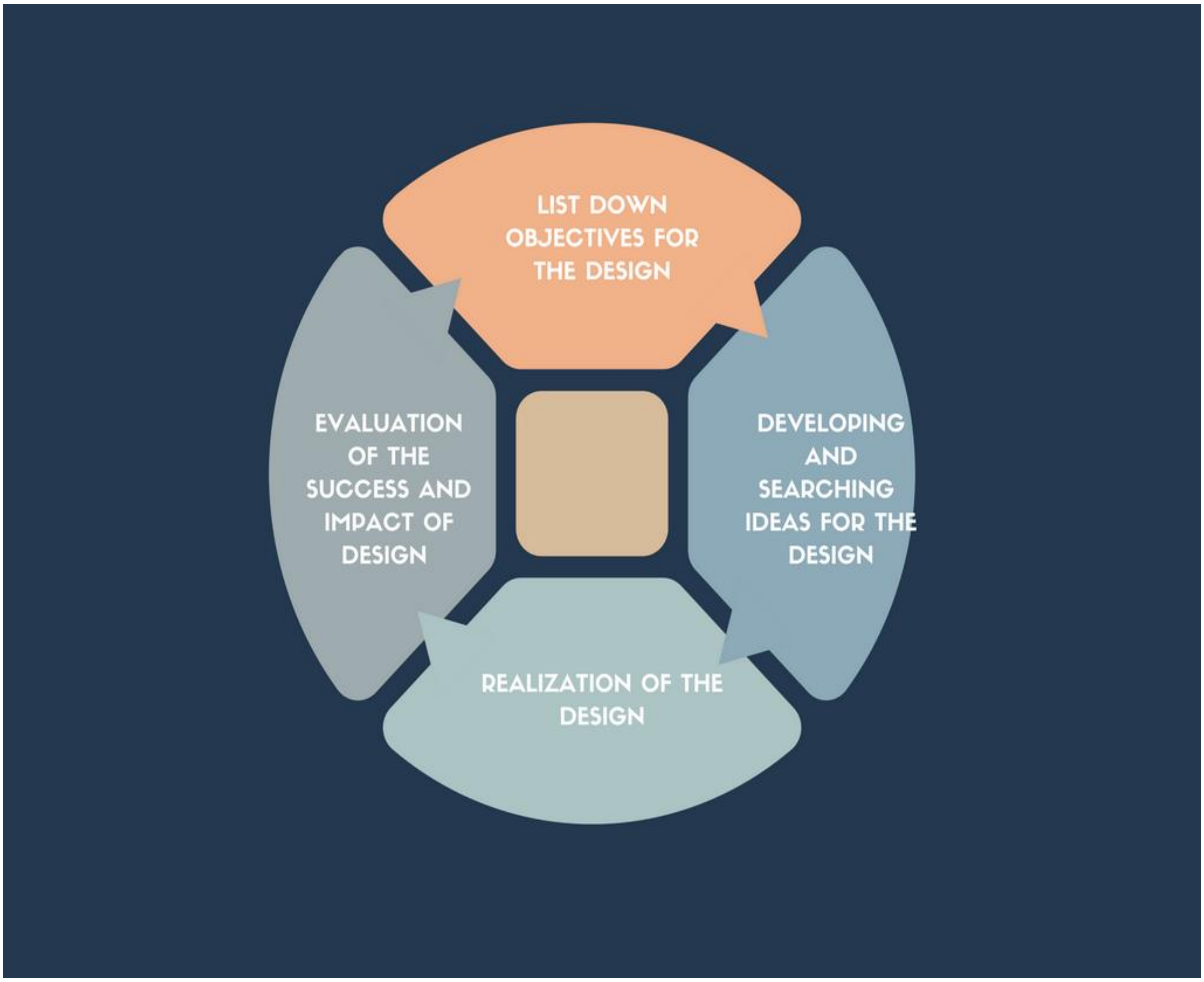
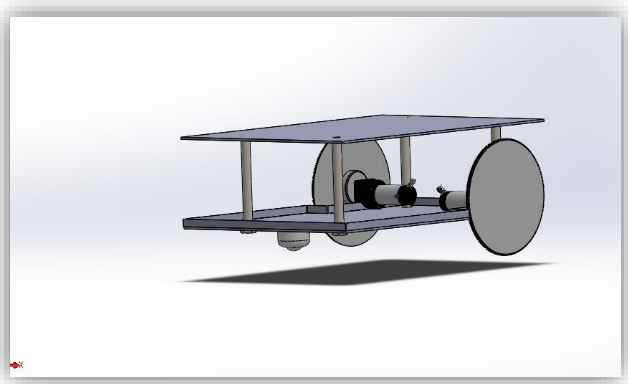


Figure 1.1: showing the cycle that we had to undergo in order to achieve our design

Chapter 2: Main Design

1. Mechanical Design

Our body was made up of Aluminum Sheet, bended at 90 degrees from all of the edges. Following are the views of Solid works.



Fig; 1.2 Isometric view of the robot

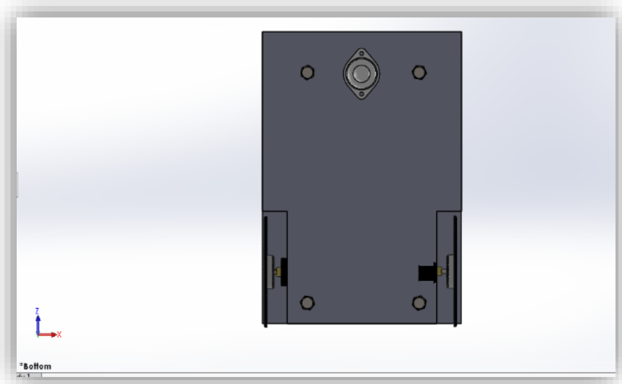


Fig 1.3 Bottom view

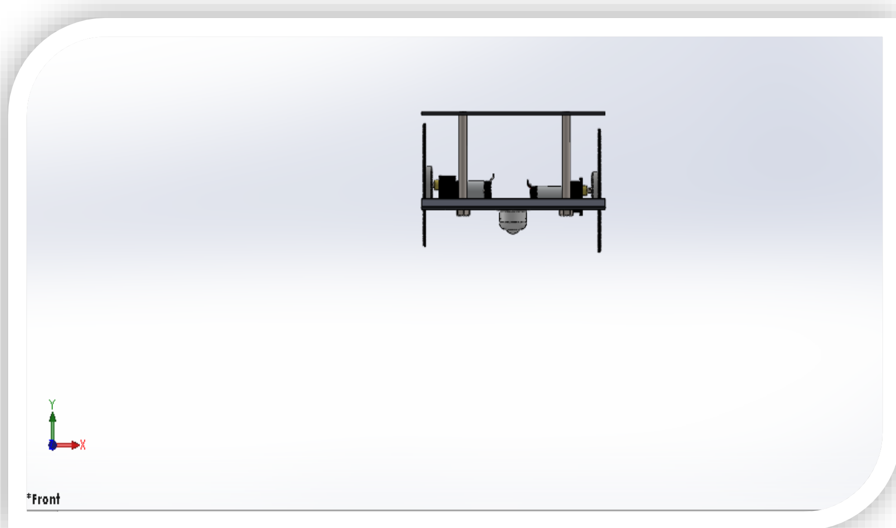


Fig 1.4 Front view

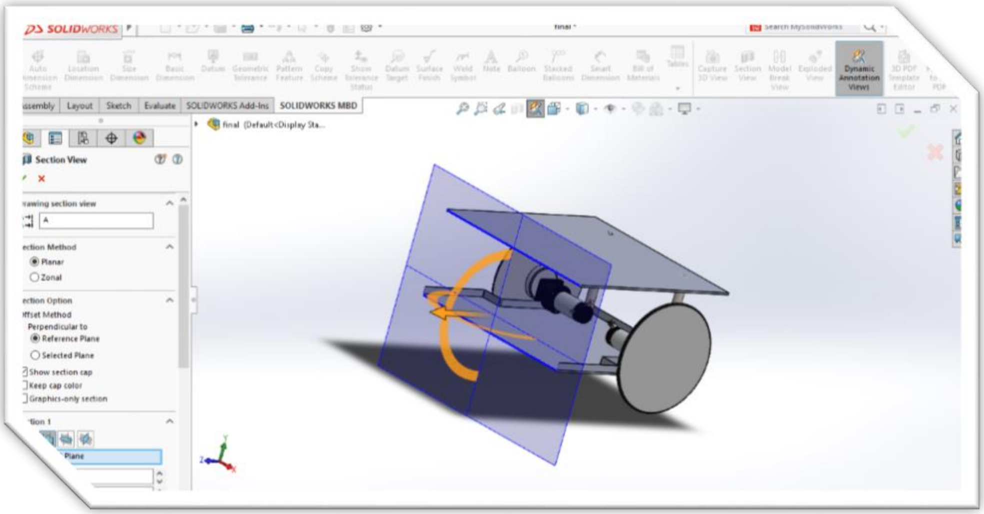


Fig 1.5 Cross sectioned views

Dynamic details include all the properties involved in the motion of the robot, for example

Area of cross section

X- Centroids values

Y- Centroid values

Z- Centroid values

Moment of inertia on all 3 planes

Centre of action of mass

Volume

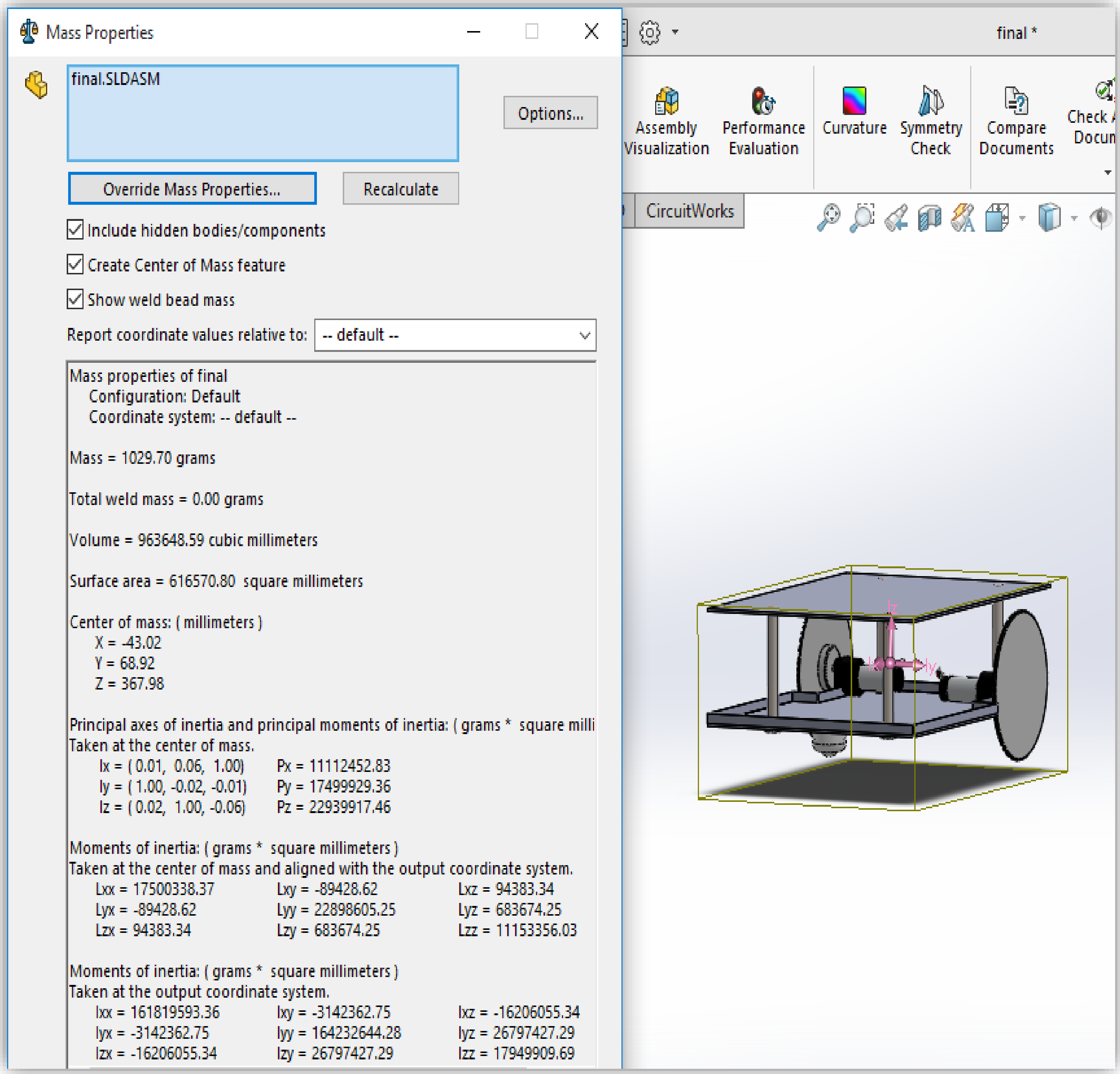


Fig 1.6 Dynamic details of our robot

Later Curvature Analysis was done, it distinguished all the points which were planer and which one was curved

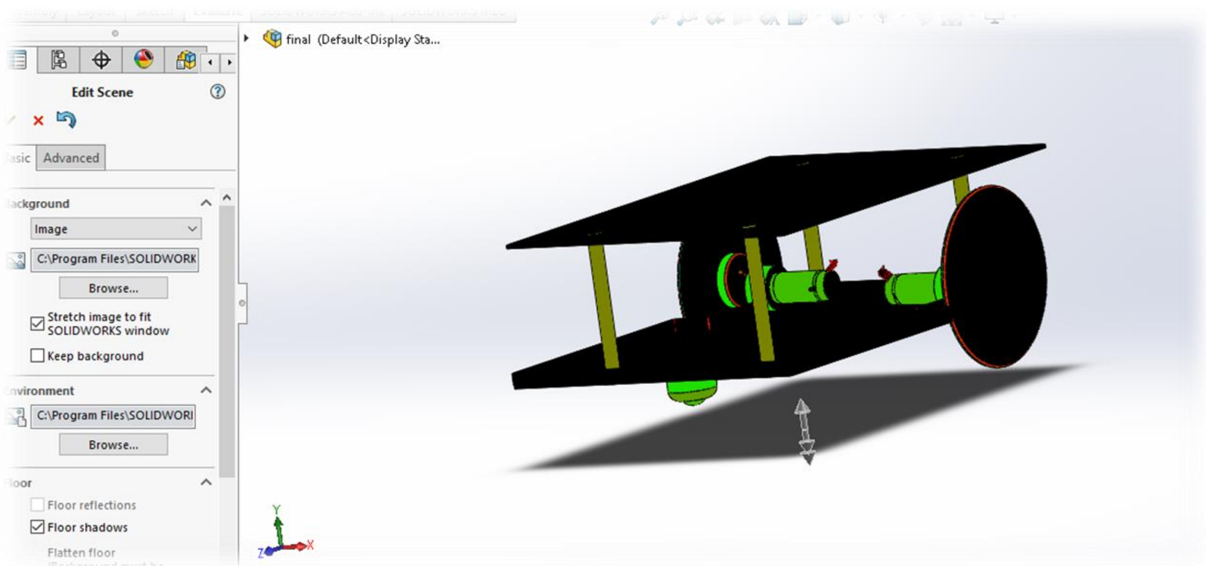


Fig 1.7 Complete Curvature Analysis

2. Weights and Torque Calculations

We first assume that robot base must not exceed the weight of 9 kg according to the competition criterion. So, our first assumption is m=6 kg which must passed through the center of the body as weight. Second assumption is the robot should move with the speed of 48in /sec (1.2192m/s). In designing, we must assure that the whole weight of the body appear to be acting at the center of the body downwards So, according to free body diagram

F=ma

For ‘a’, we again make assumption that body must accelerate 1.2192 m in one second (m/s2)

So a= 1.2192

So F=8(1.2192)

F=9.7536

Torque calculation

T= r x f

R= radius of tire

We had to use 4 inch diameter tire as this is the only size available in market.

T=r x f= 0.0508 * 9.7536 = 0.49548 Nm = 4.9966kgcm or 5kgcm ± 10%

3. Drive Selection with Reason

We selected simple two wheel drive as the drive mechanism for our robot. The reason of our choice was that we noticed that the Air Tech competition was based on control, and most importantly it was based on speed. For this we took the inspiration from **MICROMOUSE BOTS**, whom all are based upon Direct Drive Based System**.** In our observation, simple two speed drive was our best option. It was efficient and cost effective as compared to its alternatives, like chain drive and while it gave much more unneeded torque, it was also expensive and also had a greater number of mechanical parts which could act as sources for failure simply by getting stuck.

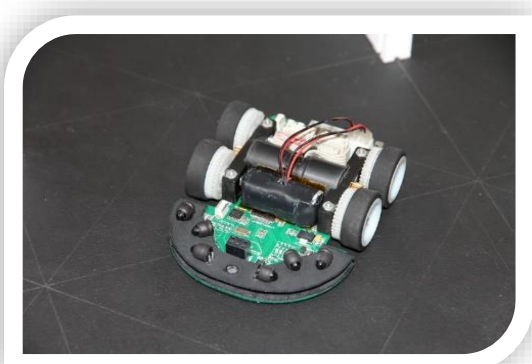


Fig 3.1: micromouse robot

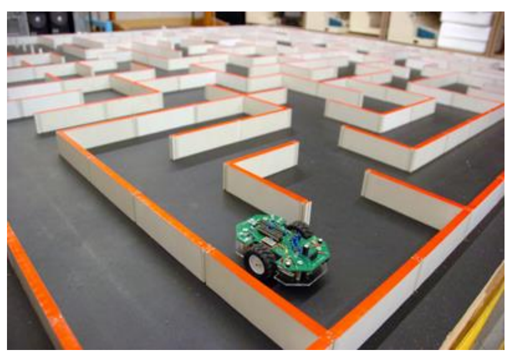


Fig 3.1: micromouse robot in action

4. Motor and Tire Selection

The selection of motors was directly concerned with the motor available in the market so first we searched the motor which was operated at 12V and had Encoder in it. By careful searching, we came to the results that the motors with built-in encoders are available in following specs:

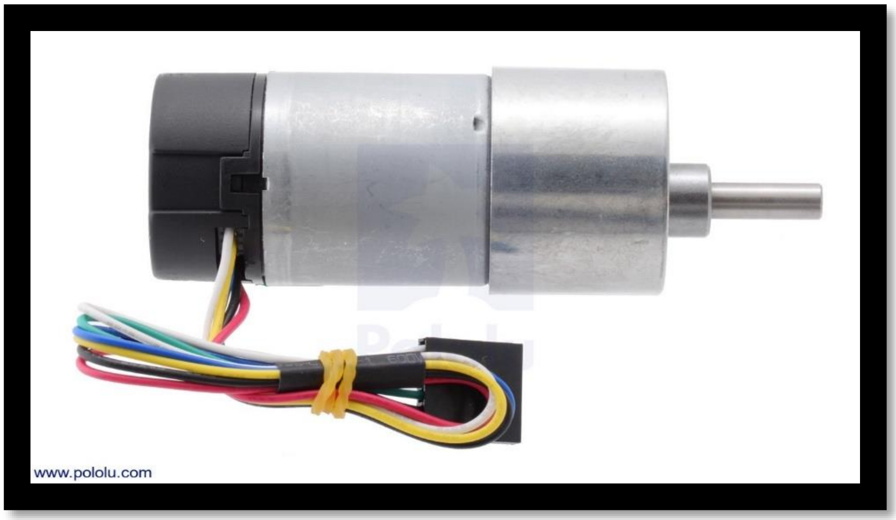


Fig 2.2 Motors

Pololu 12V, 350 RPM, 8 kg-cm, 30:1 Gear Motor w / Encoder
Pololu 12V, 500 RPM, 5 kg-cm, 19:1 Gear Motor w / Encoder
Pololu 12V, 20 RPM, 12 kg-cm, 50:1 Gear Motor w / Encoder
Pololu 12V, 10 RPM, 16 kg-cm, 100:1 Gear Motor w / Encoder

Our required motor will be one of the above.

Now, our required RPM is = 1.1292/0.0508=229.18RPm (from above assumptions).

Hence, motor 1 will be the best choice for our requirement

The only tires available in the market were the 4 inch diameter tires. The alternative was to machine them separately which won't have been cost or time effective especially when the ones available in the market were really good already for our use.

5. Material Selection

Another decision that should be made in the outline stage is the decision for the material of the frame. The material ought to have a decent imperviousness to consumption, have a high quality to weight proportion and should be reasonable.

Steel:

High quality steel is a kind of compound steel that gives better mechanical properties or more prominent imperviousness to consumption than carbon steel. HS steels fluctuate from different steels in that they are not made to meet a particular compound organization but instead to particular mechanical properties. They have carbon content between 0.05–0.25% to hold formability and weld capacity.

Advantages of steel:

- The preferences of high quality steel are the cost and the way that it is normally utilized, so there is much information of it.
- It is impervious to erosion and considerably more grounded and harder than normal carbon steel
- It is malleable and profoundly formable and weld-able.

Disadvantages:

The major disadvantage of steel is the low strength to weight. High Weight

Aluminum:

The flexibility of the metal takes into consideration a few plans that can supplement the exterior of the structure they are introduced around. By using different mixes of its profitable properties, for example, quality, gentility, erosion resistance, recyclability and formability, aluminum is being utilized in a constantly expanding number of utilizations. Aluminum has a superior quality to weight proportion than steel and is generally accessible.

Advantages of Aluminum:

- The fundamental favorable position is that aluminum segments don't rust as effortlessly as iron.
- It has better quality to weight proportion and has a smooth radiant surface because of its atomic structure.
- It has both elements that are looks and quality.

Disadvantages:

- It is significantly more costly that steel.
- The downside of aluminum is that it is anodic to most other basic amalgams, making it helpless against erosion.
- It is restricted to certain geometric elements utilizing practical procedures.
- It is grating to tooling.
- It is hard to weld.
- It is inclined to serious spring back.

Glass-fiber reinforced plastic:

The most commonly used composite for marine vehicles is glass-fiber reinforced plastic (GFRP).Fiber Reinforced Polymer (FRP) composites are utilized as a part of a wide assortment of uses. Their mechanical properties give exceptional advantages to the item they are shaped into. FRP composite materials have prevalent mechanical properties including:

- Impact resistance
- Strength
- Stiffness
- Flexibility
- Ability to carry loads

Advantages of GFRP/CFRP:

GFRP is modest concerning different composites and has a high quality to weight proportion. Carbon fiber fortify composites (CFRP) are around 3 times more costly than GFRP, however have a substantially higher tractable modulus than GFRP.

Mechanical strength:

Fiberglass is so solid and hardened for its weight, it can out-perform most different materials including steel, aluminum and timber.

High impact strength:

Rather than most metals, fiberglass does not change shape notwithstanding when it is burst.

Resilience and Formability:

Fiberglass items have a hard complete and can be formed to any coveted shape.

Chemical resistance and Corrosion resistance:

Fiberglass is negligibly receptive, making it perfect as a defensive covering for surfaces where concoction spillages may happen and fiberglass does not rust away and it can be utilized to make durable structures.

Anti-magnetic, no sparks:

Making it super safe for the power business, fiberglass has no attractive field and opposes electrical flashes.

Low maintenance:

Once introduced, fiberglass items require negligible support.

Long life:

Fiberglass items are worked to last and have high imperviousness to exhaustion. It has indicated incredible strength.

Disadvantages:

- Higher beginning cost contrasted with a customary solid deck. The unit cost of FRP materials is regularly more costly than traditional materials.
- Limited FRP encounter inside the development business.

Acrylic:

Advantages:

Acrylic is cell-thrown acrylic sheets made to demanding gauges of furniture and frill. It is comprised of lightweight, unbending thermoplastic material that has commonly the breakage resistance of standard window sheet glass. It is profoundly impervious to climate conditions. It is appropriate for most utilitarian applications.

Structural Strength Property:

Acrylic Sheets utilized are not as unbending as glass or metals. In spite of the fact that the elasticity of Acrylic sheets utilized is 10,000 psi (69 Mpa) at room temperature (ASTM D638), stretch crazing can be brought on by consistent loads underneath this esteem.

Insulation:

Acrylic has numerous attractive electrical properties and consistent open air presentation has little impact on these properties. It is a decent separator with surface resistivity higher than that of generally plastics.

Thermal Property:

The thermal conductivity of a material-its capacity to lead warmth is known as the k-Factor. The k-Factor is an inalienable property of the material and is free of its thickness and of the surroundings to which it is uncovered. The k-Factor of Acrylic sheets is: 1.3 B.T.U. or, on the other hand 0.19 W (hour) (sq. ft.) (°F/inch) m.K

Disadvantages:

Acrylic is an ignitable thermoplastic. Safeguards ought to be taken to shield the material from flares and high warmth sources. Acrylic for the most part consumes quickly to consummation if not doused. The surface of plastic is not as hard as that of glass. Consequently, sensible care ought to be practiced in dealing with and cleaning Acrylic.

For Our Robot we use the Following Material

- 2mm Aluminum sheet for base frame because it has high strength to weight ratio as compared to steel and acrylic
- 1.5mm Steel sheet for mounts because it has more strength as compared to aluminum and resistive to bending
- 3mm Acrylic sheet for upper base.

6. Dimensioning

Area: 10x9 in

Height: 7 in

7. Sensor Placements

IR Sensor Array: Attached to the front of the base plate
Color Sensor 1: 1 inch away towards the right hand side of caster wheel
Color Sensor 2: 1 inch away towards the left hand side of caster wheel

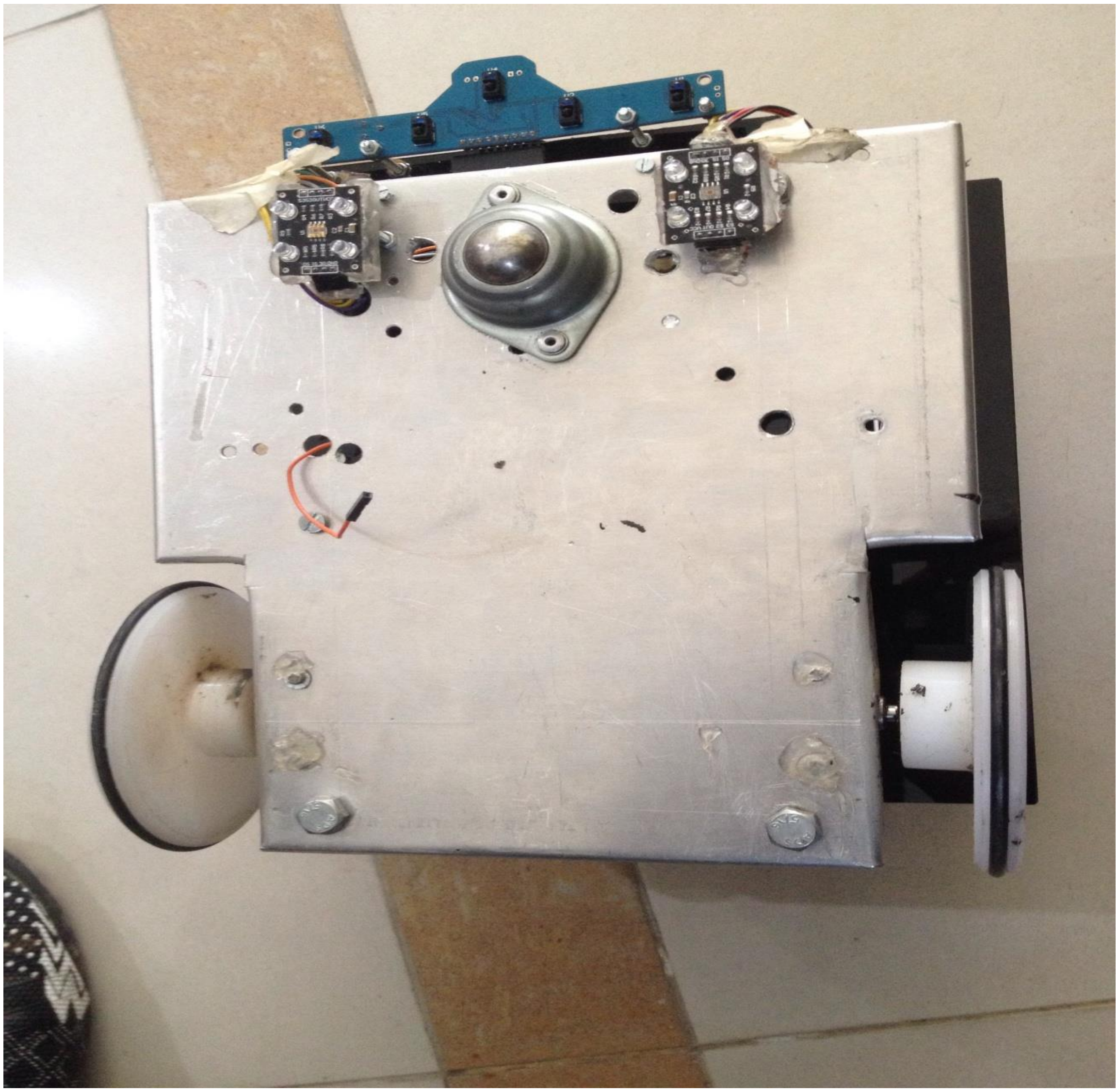


Fig: 7.1: bottom view of our robot showing sensor and wheel placement

8. Working Methodology

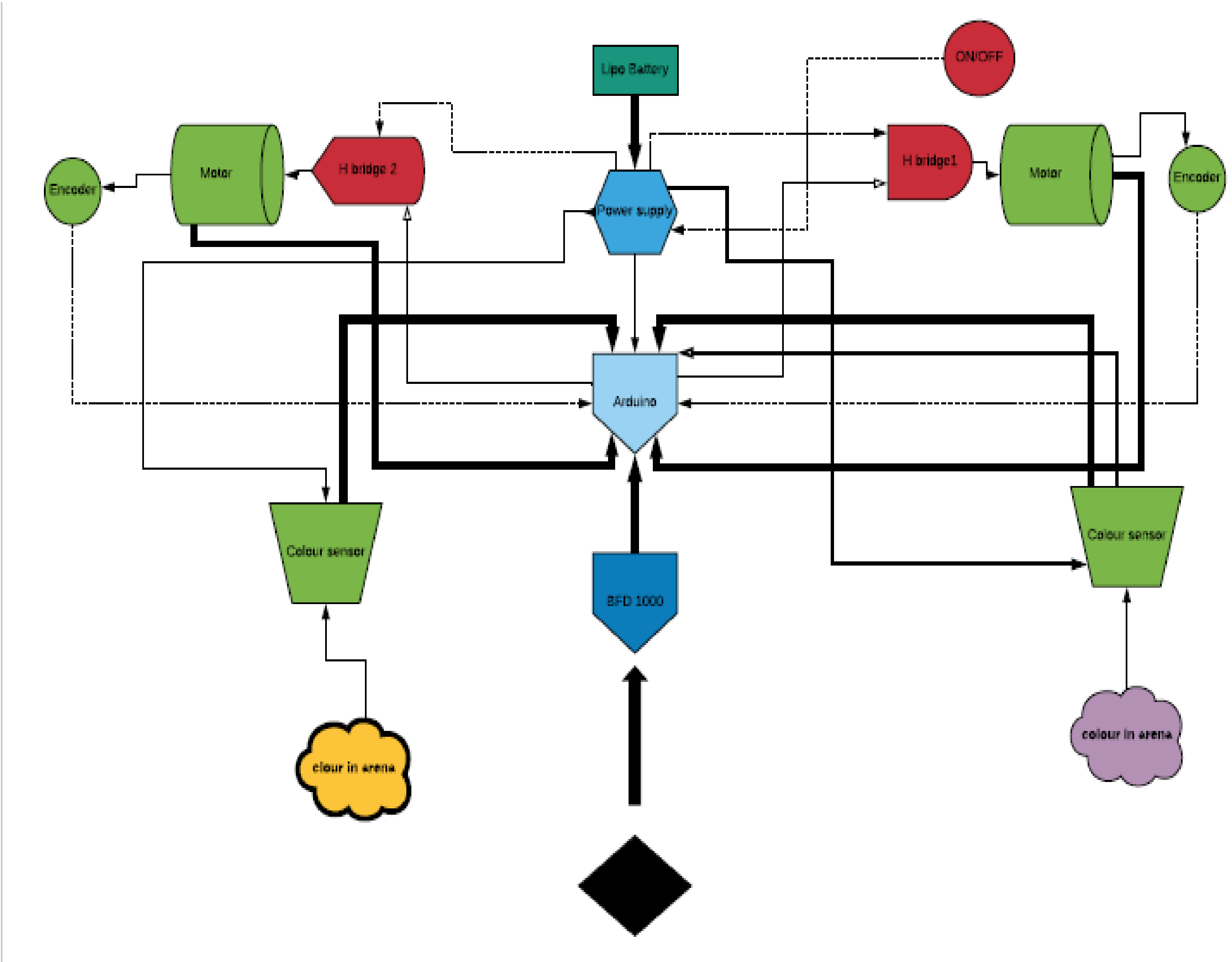


Figure 8.1: flowchart for the robot's working

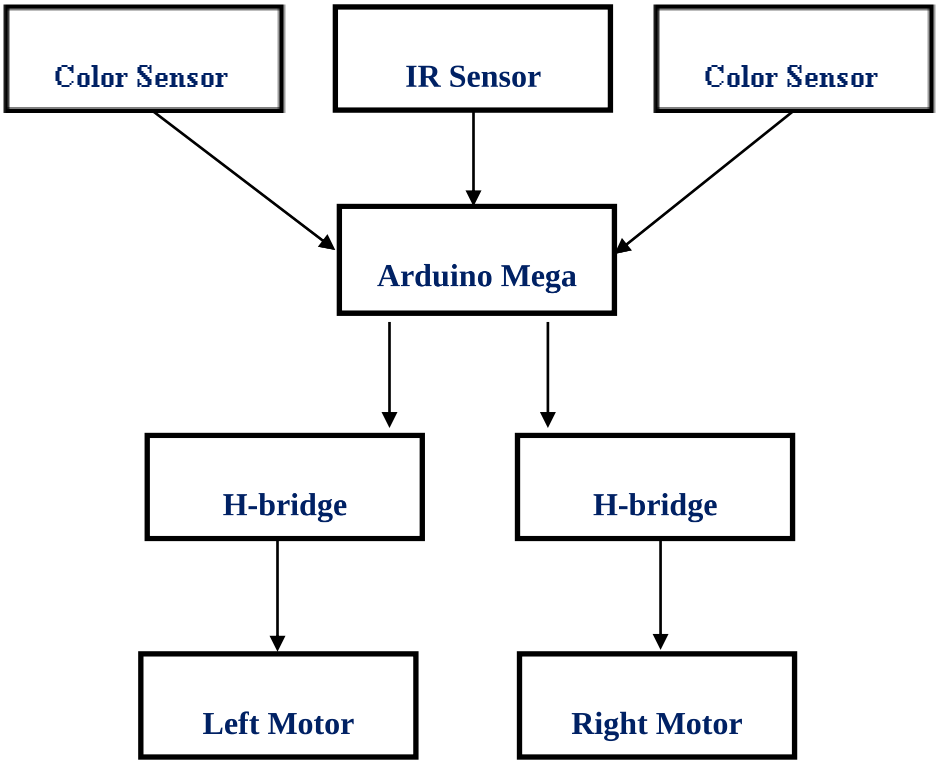


Fig 8.2: block diagram of our robot’s working hardware

CHAPTER 3: ELECTRIC DESIGN

1. Circuit Design Criteria

The overall criterion for designing any electrical circuitry for this project was that the use of ready-made module was prohibited. Other than that, we were free to use components as we deemed to accomplish our required outputs. For example, we were not allowed to use H-bridge Ics, so instead the criterion for the H-bridge we needed to make **was t**hat it must have a current rating of at least 10A.

2. Circuitry

<u>H-bridge schematics</u>

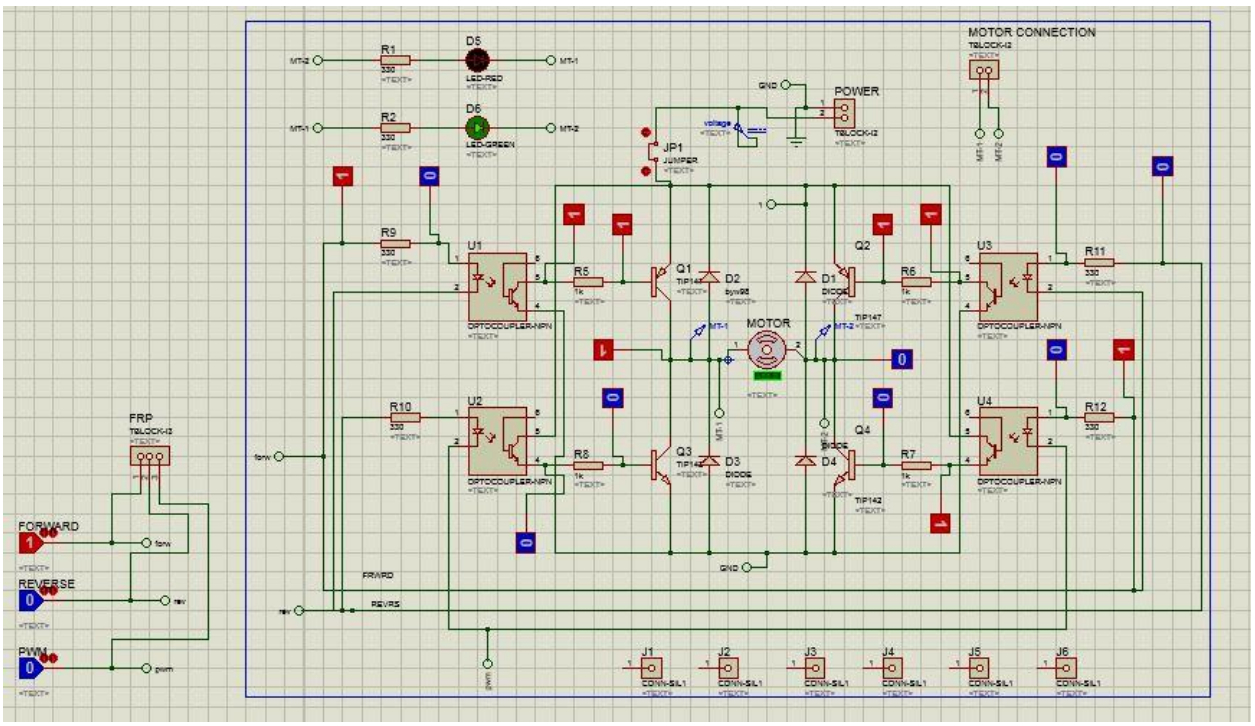


Figure 3.1: h-bridge schematics

Color sensing system

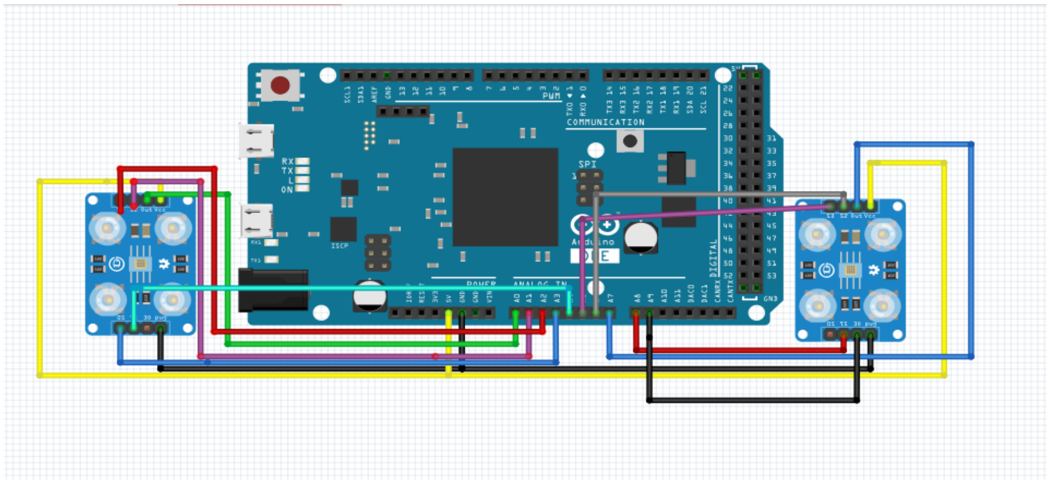


Figure 3.2: color sensing system

3. Mother Board

One Of The biggest problems on moving robots is wires and loose connection therefore we Chose to make a discrete motherboard module , that eliminated The hussle Of wire , We uses Special Type of connector which has Simple male and female wires with fixed Connectors.

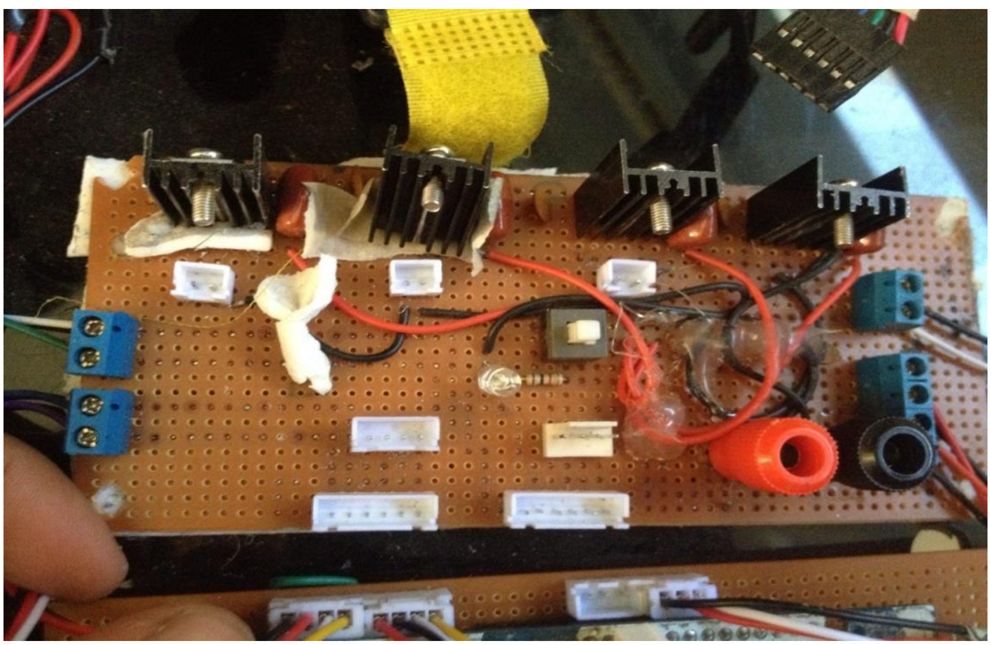


Fig 4.1: motherboard

4. H-Bridge Selection and Ratings of Developed H Bridge

We selected a design for H-bridge that used BJTs switching and Optocouplers for protection. It can be argued here that BJTs are slow for switching. However, we needed a circuit that could sustain drawing of current as high as 10 Amps and MOSFETs may be good for fast speed switching but they can’t sustain that much high current. Optocouplers were used so that unidirectional flow can be maintained and the circuitry can be protected in case any kind of accidental scenario may occur.

5. Power requirements

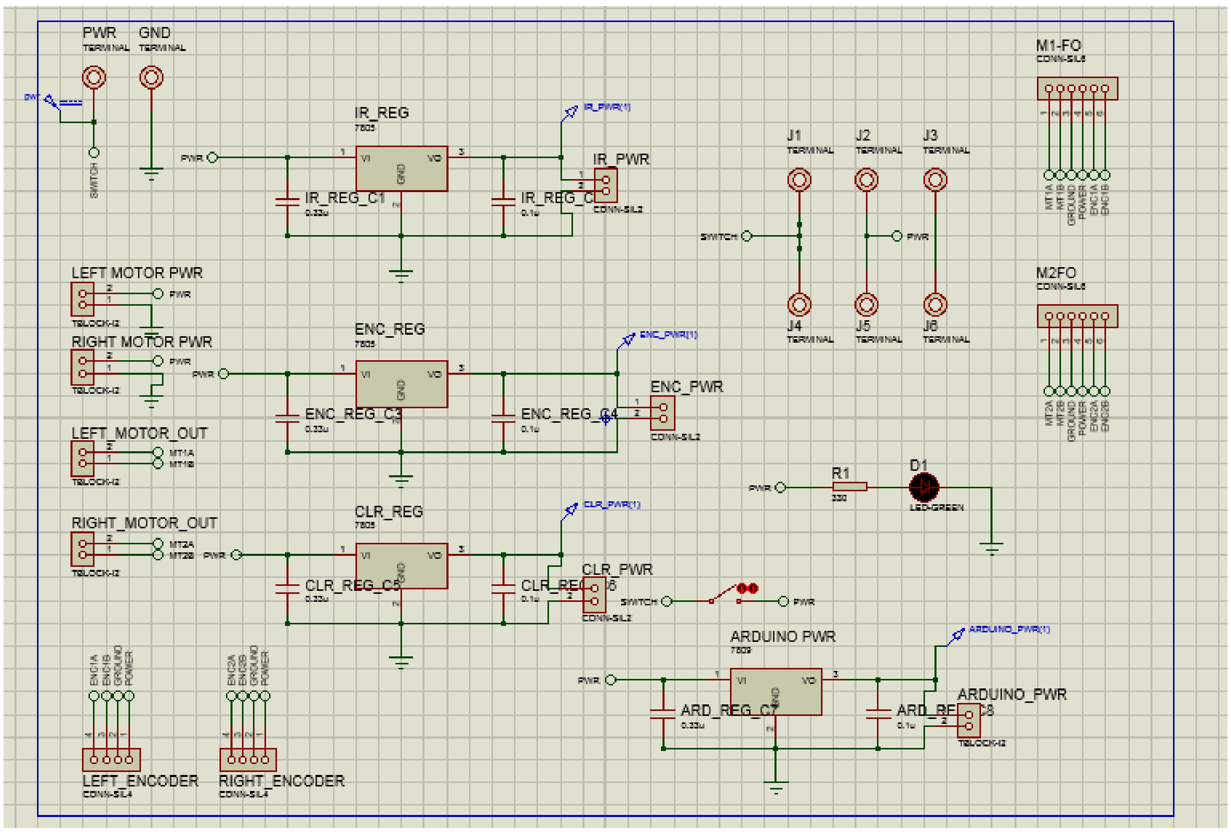


Figure 5.1: Power board

For calculating power requirement, following are to be kept in mind

Motor Current each (6±10% At full / Stall current)

Power Supply Rating (2 A in our Case)

Modules power consumption (500Ma) Total in our case

So our robot has almost 15 amp of current consumption at full load. Now, if we assume that the robot consumes 10 amp (35pprox.) current at full load and we also know that current is linearly related to torque. So,

16kgcm (2 motors)/10= 18/x

X=11amps ; So, battery has to provide 11amp of current

6. Power Justification for Battery Selection

Now, we already had a Li-Po battery of 12 V 5000mAh which we were using for our quad copter. Here,

Battery Life = Battery Capacity in Milli amps per hour / Load Current in Mill amps * 0.70

Battery Life = 5000/ 11000 * 0.70

Battery life = 0.315 hours =31min 5 sec (Approx)

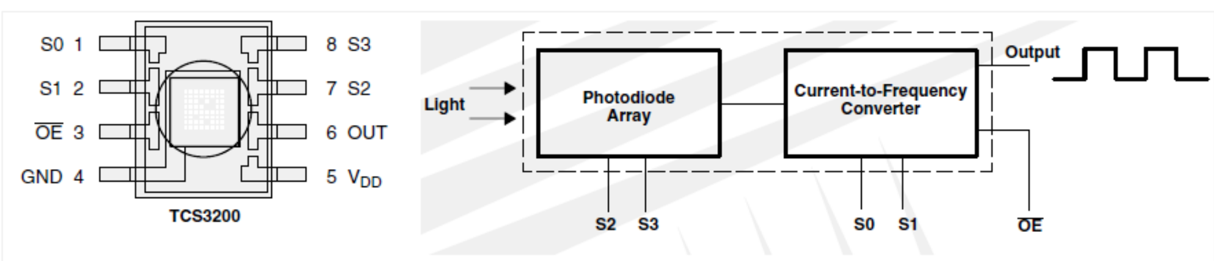
So, our batter was giving at least half an hour of work time which seemed good enough to us. Therefore, we decided to use this battery.

7. Sensors and Board

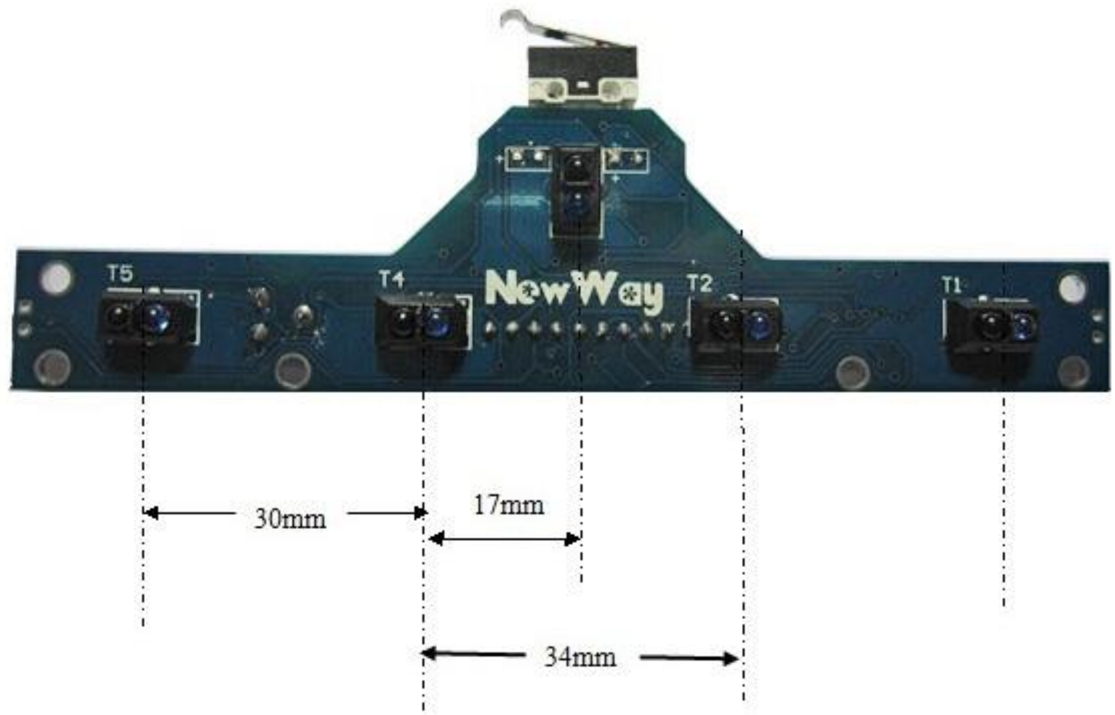
We selected an IR sensor array (bfd1000) and two color sensor (tcs 3200) for our sensing needs.

BFD-1000	TCS-3200
5 in One Sensor Array	Widely available
Digital output	Cost effective
Easy to Interface	Easy to Interface
Cost effective (Rs.650/-)	Small Size
Indication LEDS for Debugging	
Sensor are positioned in a way that it can differentiate between T and cross	

Pin diagram for TCS 3200



Pin info for BFD 1000



Connections:

VCC5 + 5 Volts DC Power
GND -- Ground
SS1**,** SS2 -- Leftmost two downward-looking sensors (T1 and T2 in photo, right)
SS3 -- Center Sensor, optimized for seeing horizontal lines that are crossed if moving ahead.
SS4**,5** -- The next 2 Sensors on the right (top view) and T4 and T5 in photo, right)
Near **--** The Forward-looking IR LED and Sensor on separate wires. NOTE: aim them to converge 1 to 2 inches ahead. They are just held by their leads, and you may want to create some "Front Panel" on your robot with a couple of holes for these to fit through.
CLP -- The Micro-switch on the front, usually used as a physical "bump" sensor.

Tech Specs for Arduino Due

Microcontroller	AT91SAM3X8E
Operating Voltage	3.3V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-16V
Digital I/O Pins	54 (of which 12 provide PWM output)
Analog Input Pins	12
Analog Output Pins	2 (DAC)
Total DC Output Current on all I/O lines	130 mA
DC Current for 3.3V Pin	800 mA
DC Current for 5V Pin	800 mA
Flash Memory	512 KB all available for the user applications
SRAM	96 KB (two banks: 64KB and 32KB)
Clock Speed	84 MHz
Length	101.52 mm
Width	53.3 mm
Weight	36 g

CHAPTER 4: SOFTWARE DEVELOPMENT

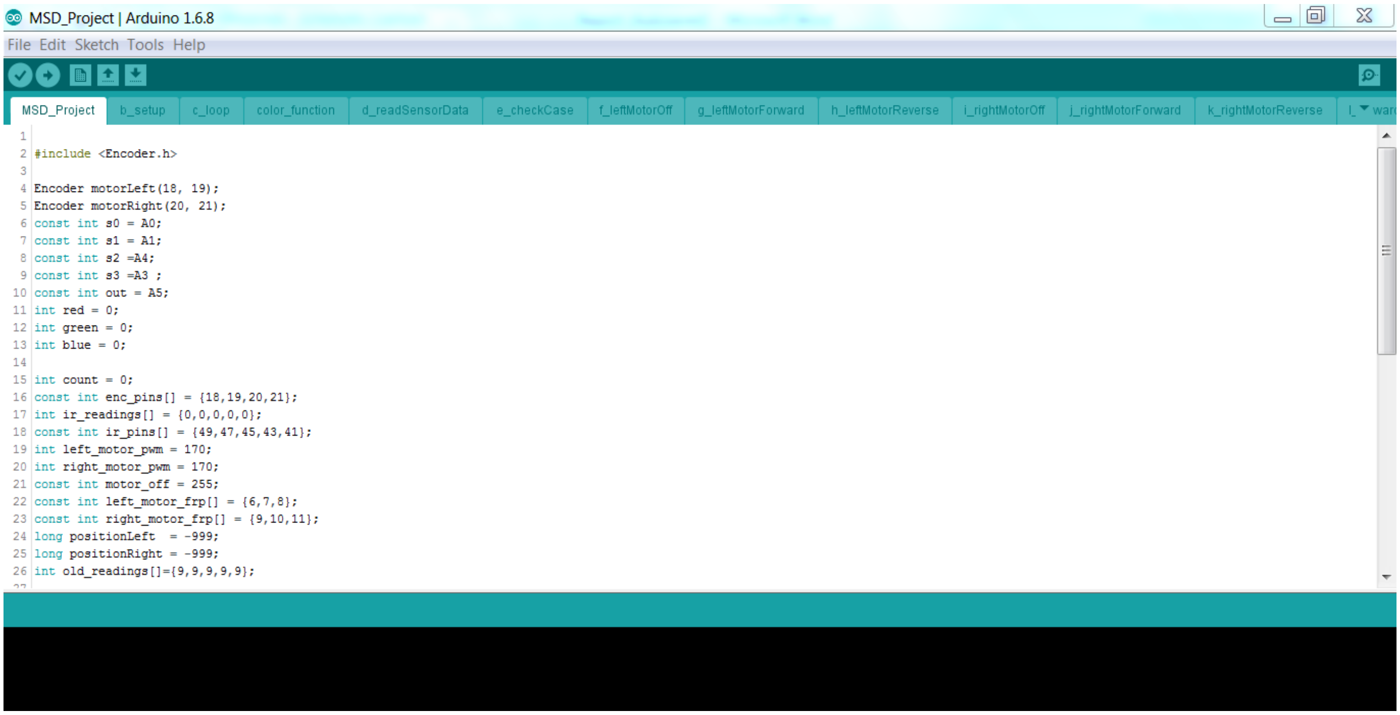


Figure: 4.1: screenshot of our main code window

Main code window:

#include <Encoder.h>

Encoder motorLeft(18, 19); // creating an instance of the encoder object

Encoder motorRight(20, 21);

const int s0 = A0;

const int s1 = A1;

const int s2 =A4;

const int s3 =A3 ;

const int out = A5;

```
int red = 0;

int green = 0;

int blue = 0;

int count = 0;

const int enc_pins[] = {18,19,20,21};   //Declaring the pins for the encoder

int ir_readings[] = {0,0,0,0,0};  // The readings given by the IR sensor are stored here

const int ir_pins[] = {49,47,45,43,41}; // Here we declare the pins used by the IR sensor

int left_motor_pwm = 170; // Here we are setting the how fast the left motor spins

int right_motor_pwm = 170;

const int motor_off = 255;

const int left_motor_frp[] = {6,7,8}; // The pins used by the left Hbridge

const int right_motor_frp[] = {9,10,11}; //The pins used by the right Hbridge

long positionLeft  = -999;  // Initializing encoder variable

long positionRight = -999;

int old_readings[]={9,9,9,9,9};

void readSensorData();

void printSensorReadings();

void checkCase();

void leftMotorOff();

void leftMotorForward();

void leftMotorReverse();

void rightMotorOff();

void rightMotorForward();

void rightMotorReverse();
```

```
void forward();

void turnRight();

void turnLeft();

void uTurn();

void hardLeft();

void hardRight();

void checkHardCase();

void displayEncoderReadings();

void color();
```

Setup function code:

```
void setup() {

  Serial.begin(9600);

  pinMode(s0, OUTPUT);

  pinMode(s1, OUTPUT);

  pinMode(s2, OUTPUT);

  pinMode(s3, OUTPUT);

  pinMode(out, INPUT);


  digitalWrite(s0, HIGH);

  digitalWrite(s1, HIGH);

count = 0;

for(int i=0;i<5;i++) //Setting the encoder pins as output
```

```
{
  pinMode(ir_pins[i], INPUT);
}

for(int i=0;i<3;i++) // Setting the encoder pins as output
{
  pinMode(left_motor_frp[i], OUTPUT);
  pinMode(right_motor_frp[i], OUTPUT);
}

for(int i=0;i<4;i++) // Setting encoder pins as input
{
  pinMode(enc_pins[i], INPUT);
}
  while(ir_readings[0]!=1 && ir_readings[1]!=1 && ir_readings[2]!=0 && ir_readings[3]!=1
&& ir_readings[4]!=1) // Condition for the robot to only move if is on top of the line
  {
  }
}
```

Loop function code:

```
void loop()
{
 if (green < red && green < blue)
  {
```

```
    if (green<= 10 && red <=10 && blue <= 10){
     Serial.println("WHILE");
  }
  else
  {
    while(ir_readings[0]!=1 && ir_readings[1]!=1 && ir_readings[2]!=0 && ir_readings[3]!=1 
&& ir_readings[4]!=1)
   {
   hardLeft();
   }
  }


  }
 readSensorData();
 printSensorReadings();
 checkCase();
}
```

Chapter 5: Project Management (How it was done)

The management of this project was carried out by dividing the project into stages so that we can make sure that the project is going efficiently within the timeline. Our timeline consisted of 4 quadrants that are as follows.

Late October 2017: Research and Analysis

During this quadrant, half of our time, researched online to check for the different approaches to making of various robots and meanwhile the rest of the members checked the previous designs from senior students and inquired them about any possible problems/faults they had to face and how they avoided them.

First half of November 2017: Brainstorming for ideas and creating a design

During this time the entire team put together their various ideas and suggestions so as to check which one would be most efficient and then combining them to form the most efficient design/approach

Second half of November 2017: Prototyping & Testing

This quadrant took all of our time in the making of circuit boards (H-bridges and motherboards) and then re-making of the iterations of those boards after their previous versions burnt out during testing. Overall, this part was the most tedious of them all.

Start of December till Air Tech: Calibration & Finalizing

After we finally had our working robot, we used all the remaining time in tweaking our codes and sensors to get the perfect coverage of the arena because the sensors had to be calibrated again and again due to the various changing environmental conditions

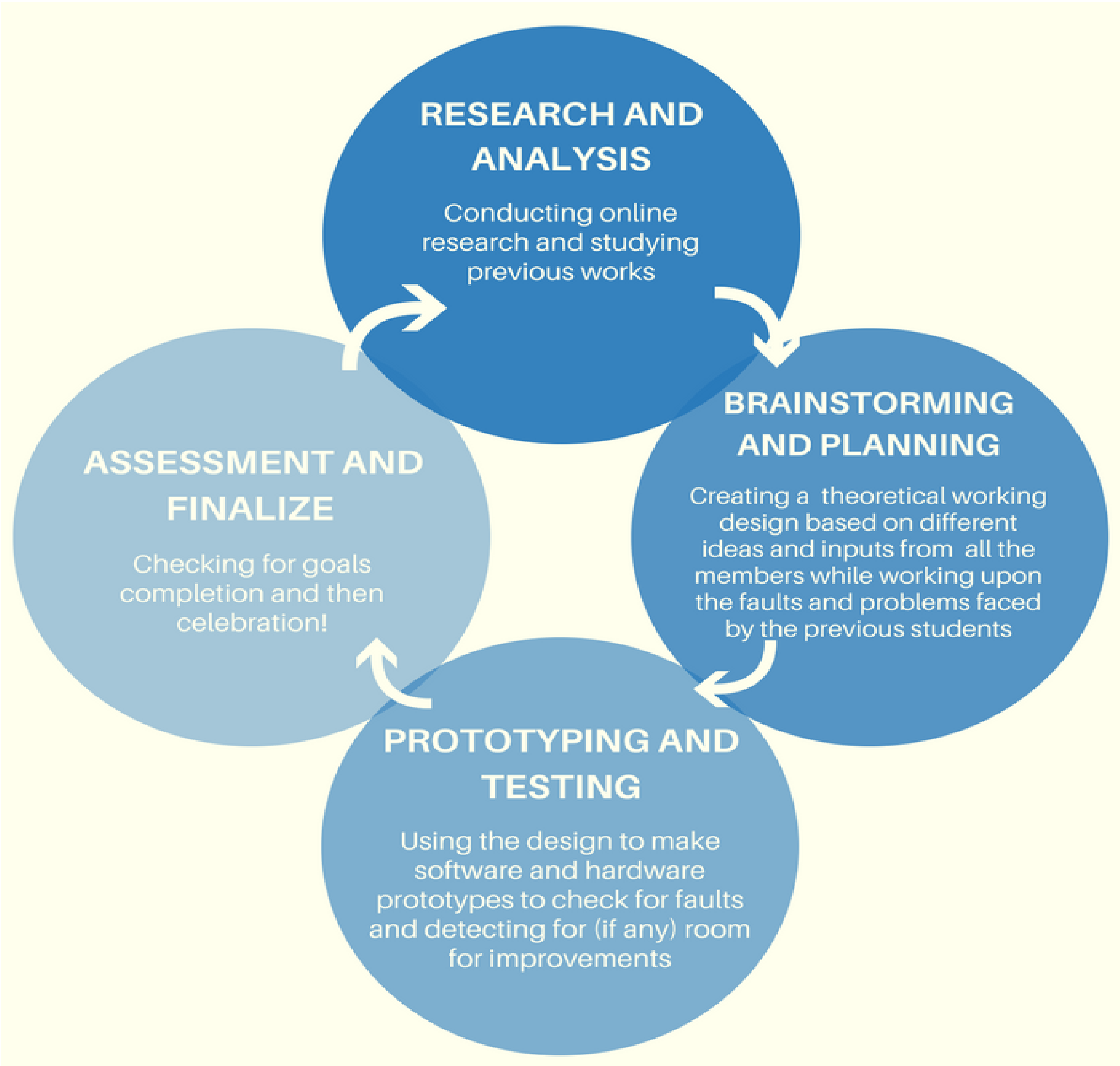


Figure 4.1: showing our project management flowchart

CHAPTER 6: BUDGET REPORT

Our estimated cost/budget was as follows

TABLE NO. 1

Item name	Cost (Rs.)
Fee by Khradiya	10000
Arduino Due	3000
H-bridge	5000
Arduino Mega	800
Line tracking sensors	3000
Motors	7000
Material for body	5000
Color sensors	2500
Power supply	300
Motherboard	100
Battery	3200
Castor wheels	600
Miscellaneous	2000
Total	42,500

Our actual cost/budget was as follows

TABLE NO 1

Item name	Cost (Rs.)
Arduino Due	2100
H-bridge	7000
Line tracking + Color sensors	1800
Motors	6000
Material for body	3000
Power supply	300
Motherboard	100
Battery	3200
Miscellaneous	2000
Total	25,500

CONCLUSION

Finally, we were able to complete our robot within the given timeline and used much less budget than we had previously estimated. We concluded the following From the Project

- A system must have a sound Base Mechanically
- A Project must be done For The Learning Purpose
- Work Must be divided equally in group on Individuals
- Safety of Persons and electronics of the system must be The first priority

In the end we were able to achieve majority of the objectives specified in project objectives. However we were unable to complete some tasks due to the

- Unaligned Chassis
- Low quality Components
- Color of the tapes was not detectable by analogue sensors.
- Low quality binding tapes were used instead of vinyl tapes which caused reflection.
- Availability of arena

According to the theme the category of competition was indigenous, means that we had to design and fabricated the chassis and the components by ourselves. So overall the project was very beneficial from learning point of view. We learned to analyze and design mechanical chassis. Different circuits for the motor driver were studied on basis of their current ratings, availably of components, cost and efficiency.

Above all the essence of this project apart from technical learning was team spirit and risk management. We learnt a lot of things which will help while going thorough FYP phase.

LESSON LEARNED (INDIVIDUAL)

Usama Zafar (Group Leader)

Being the group leader for this project, I learned a lot about project management and teamwork that was provided due to the cooperation of my team members. All this experience increased my cooperation and public handling skills. Going to Purchase the items such as material increased my knowledge about the material handling and I learned how to design a Robot assembly. However, perhaps the biggest lesson I learnt in this project was that “How you get results matters”, it’s easy to just pay an outsider to make your projects for you or simply buy a ready-made project from previous students. But then one can never learn about designing, trouble shooting and most of all teamwork. I needed to learn how to collaborate, delegate, and most of all trust my team members. The best way to deal with this is through helping and empowering teammates by building them up and supplying them with the tools, information, and resources they need to perform. From CAD designing to the simulations and then self-fabricating the whole robot, I learned how to select the material for the robot. All the dynamic aspects were applied to the robot. Learned how to interface the color sensor TCS3200 and other line tracking sensors.

Syed Muhammad Hamza

A lesson to be remembered that I learnt working on this project was to NEVER dive blindly into the project. I saw too many groups do exactly that and then encountered problems they hadn’t even imagined which were causing too much of a hindrance in their project. After selecting your project, one must understand the complexity of the processes, he/she wants to automate well in advance and then plan accordingly. That can help in avoiding a ton of problems. Another lesson that’s worth mentioning is: “Over-test the robot to ensure it handles exceptions properly”. It is easy to start celebrating once your robot successfully completes a task for the first time. However, the real work begins in the testing phase to ensure the robot handles exceptions properly. There’s notdhing worse than believing you have successfully deployed your robot only to realize a week later that it fails when it’s run on a new arenabecause the paint on the surface of this arena is a bit brighter than the previous one. To ensure sustainability, give the robot instructions on what to do in case of errors or unexpected conditions. Finally, check, double check, and triple check that the process runs in all scenario types before signing off on a successful implementation.

Usama Hamayun Ghouri

In my experience with this project, treads are trickier than they may seem. I have seen more success with four wheeled systems than treaded systems. For treaded systems to work the treads must have a good internal suspension. Also, I should mention treaded vehicles without good suspension can tip over backwards when climbing over relatively short obstacles. That's why, wheeled systems are my preference. Another point to be mentioned about the topic on wheels is that caster wheels are always seen as something to be disliked and avoided. Yes, if not used correctly they can be nuisance. But if you select the right kind of casters, provide them with enough lubrication and attach them at the right position according to weight distribution, there is no reason they would act as a problem but instead they would easily become your own advantage. Another thing I learnt was to NEVER skimp on the motors you use. I saw projects fail because the motors were too junky and didn't work, or generated too much electrical noise, or were too weak. Better motors are more expensive, but well worth it. Also, choose motors well suited for the task at hand - Does the robot need to move fast or slow and what kind of payload (how heavy) does it need to carry?

Muhammad Moiz

A lesson to be learned for me was about electric system noises; the typical solution for them is isolation. An optoisolator is usually used in this situation. Optoisolators offer great isolation but have the disadvantage of taking up extra space and some can be expensive. Another disadvantage is that some of these digital out optoisolators draw a lot of current. Remember optoisolators can also be used for transmitting analog as well as digital signals.Some optoisolators are designed specifically with feedback paths for handling analog signals so be careful when choosing an optoisolator. Another thing to be remembered about connectors (key parts for easy connecting and disconnecting of components) is to use locking connectors. They may take up more space and be more expensive - but they are a god send. In the end, I would highly recommend adding ability for the system to check its battery voltage. If you have an A/D port open you can use that. It saves having to pull out a voltmeter every time. Or you can also just use the battery voltage checking module which is cheap and readily available in the local market.