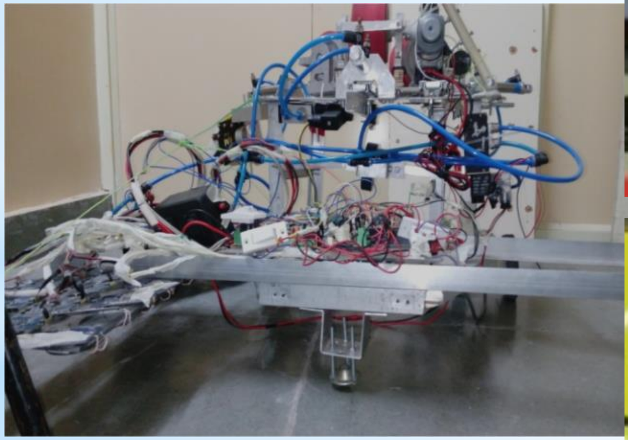
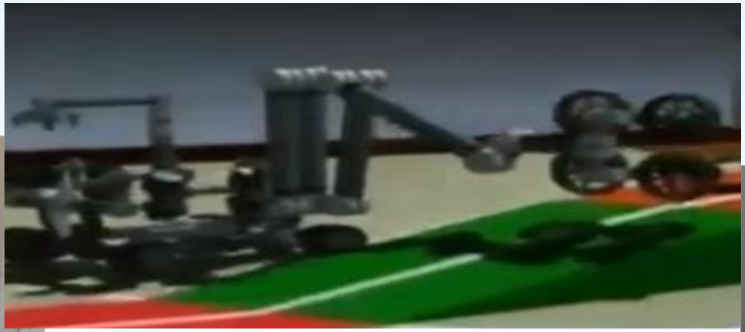
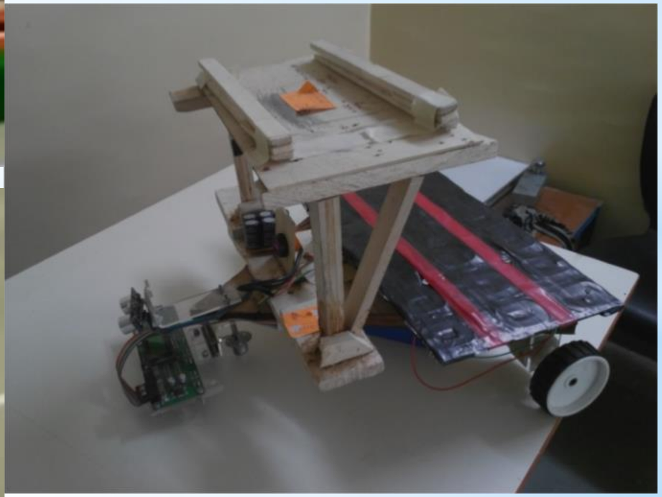
DESIGN OF HYBRID ROBOT WHICH DRIVES ECO ROBOT THROUGH AN INDIRECT ENERGY SOURCE.







PROJECT TEAM

- Group Members:
  - Sanjuksha. Sanjay. Nirgude
  - Kiran. Sanjay. Patil
  - Shivani. Nilkanth. Patil
  - Rahul. B. Wagh

- Group Guide: Prof. Sanjay. Matekar

Problem Statement

- Eco Robot departs from "Eco Robot Start Zone" .
- It runs along 3 zones; "3 slopes and hills", "River" and "Down hill", then aims for "Wind Turbine Station" by receiving driving energy from Hybrid Robot.
- Later the hybrid robot has to climb a pole.

Dimensional and other parameters description

- Maximum weight of both robots is 40kg.
- Maximum voltage of power source is 24 V DC.
- Maximum pressure of compressed air power is 6 bars.
- Dimensions of Eco Robot must be minimum 400mm in length, height and breadth each.
- Dimensions of Hybrid Robot must be maximum 1000mm in length, height and breadth each.

METHODOLOGY AND SCOPE OF PROJECT

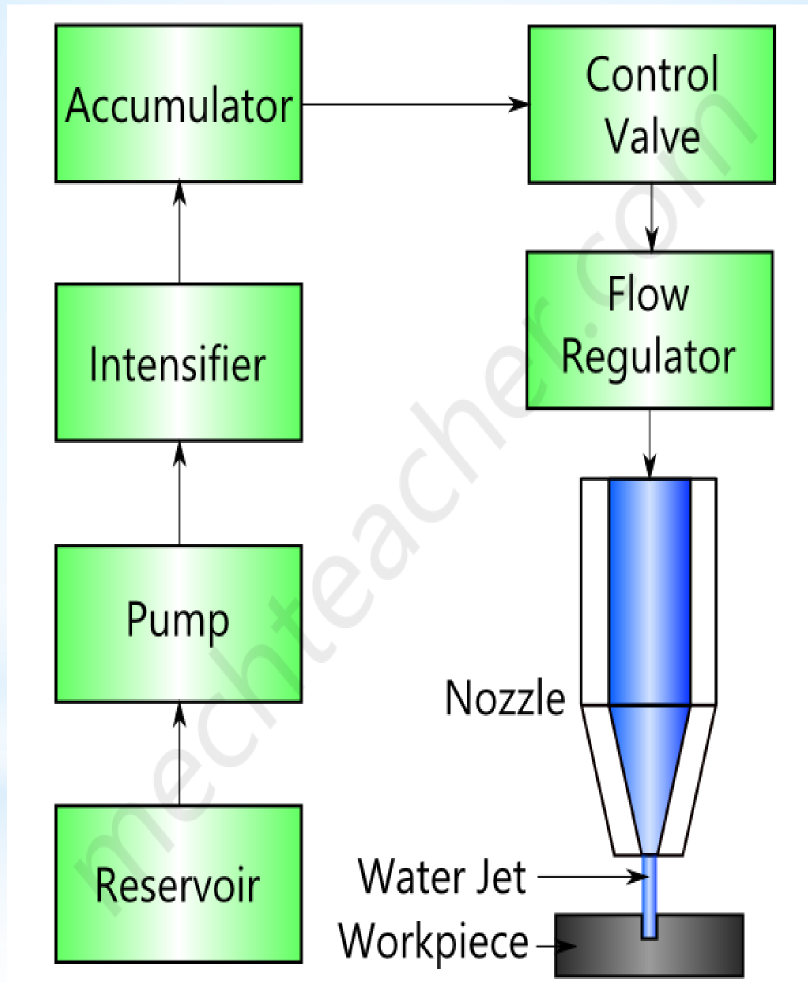
- METHODLOGY:
  - Study of Robots.
  - Design of robots.
  - Analysis of designed robots.
  - Manufacturing of robots.
  - Testing of robots.
  - Modifications(If necessary)
  - Final testing.

- SCOPE:
  - Study of chassis design.
  - Study of wheel dynamics.
  - Study of various types of motors and its torque calculations.
  - Design of various mechanisms on Catia.
  - Study and Practices of different type of Manufacturing process like water jet cutting and laser cutting.

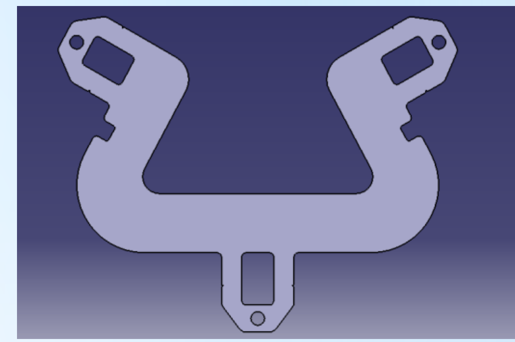
Literature study for Hybrid Bot

- Mecanum wheels.
- Traction wheels.
- Electronic architecture.
- Advanced manufacturing process like water jet cutting and laser cutting.

An Introduction to Water jet cutting



Apparatus for water jet machining



Base plate for pole climbing mechanism which is manufactured under water jet cutting.

Decisions for Design of Hybrid Robot

- Mechanism for driving Eco-robot: Energy transmission through wireless charging of capacitor.
- Mechanism for pole climbing of hybrid- robot: Principal of 3- jaw chuck.
- Selection of speed and torque for motors.
- Selection of wheels : Traction wheels are preferred.
- Manufacturing process used : Water jet cutting
- Coding for pole climbing mechanism.

Energy transmission through wireless charging of capacitor.

* 24 Transmitters are used to transfer power.
* Transmitters are grouped together and 12 groups of transmitters are fit on hybrid robot side.
* Each group of transmitter is connects to DC step down connector. This converter gets 12 V 8 A on the input side and provides 5V 2 A on output side to two transmitters. These transmitters are connected in parallel to each other so that each transmitter gets 5V 1A supply. This energy is wirelessly transmitted to receiver where it gets 5V 0.4A energy.
* The 12V 8A is provided by lithium polymer battery which is kept on hybrid root.

Speed calculations for motors (Navigation)

Assumptions are as follows:

- Diameter of wheel = 0.107 m.
- Distance to be covered (s) = 7 m.
- Time for covering the distance (t) = 5 sec.
- Initial velocity (u) = 0 m/s.

From Calculation

- $a = 0.56\ m / s^2$
- v = 2.8 m/s
- N = 449.776 rpm ≈ 500 rpm

Torque calculations for motors (Navigation)

- Assumptions are as follows:
- Mass of the load (m) = 15 kg
- Coefficient of friction (μ) = 0.2

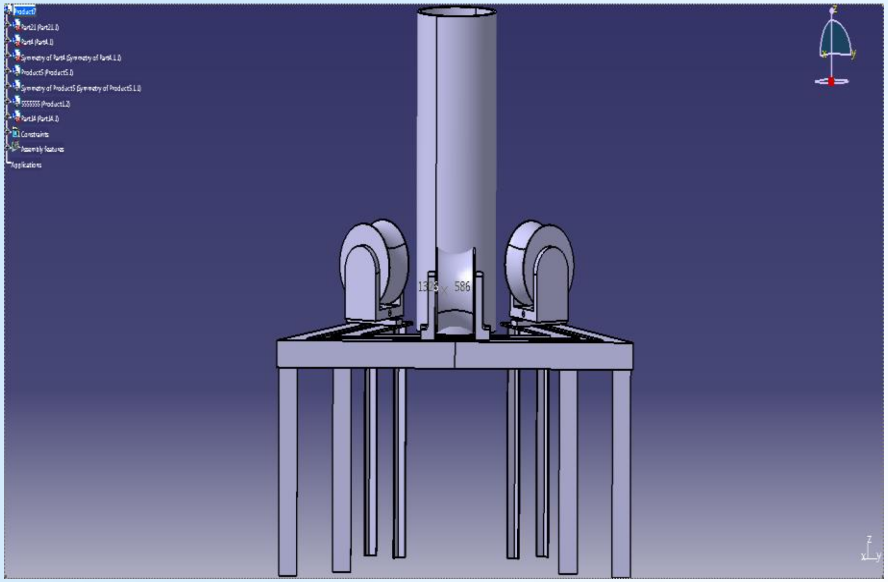
- Frictional Force (F_r) = μ * m * g = 29. 43 N
- Force required (F) = m * a = 8.4 N
- Total Force (F_T) = F + F_r = 37.53 N

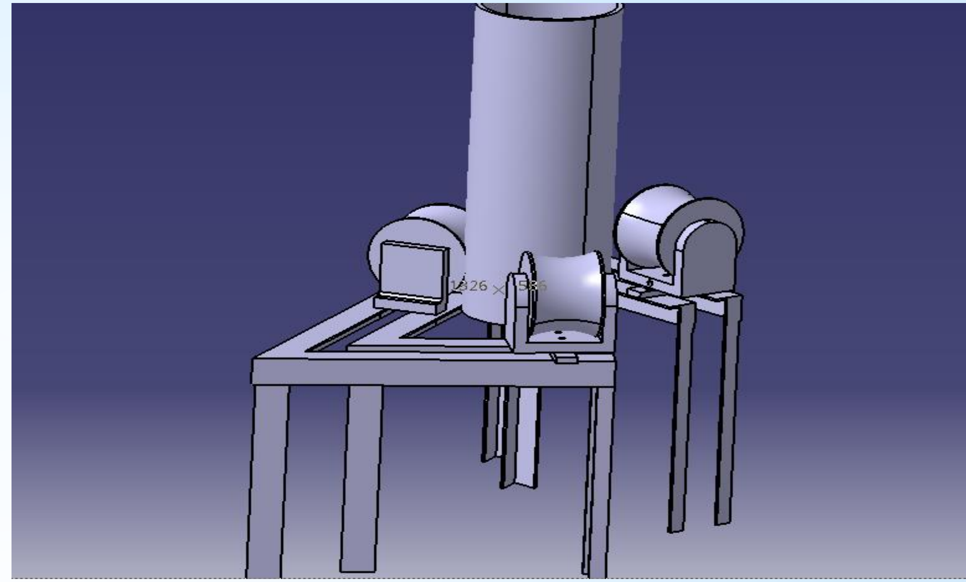
Torque (Ʈ) = F_T * (D/2)

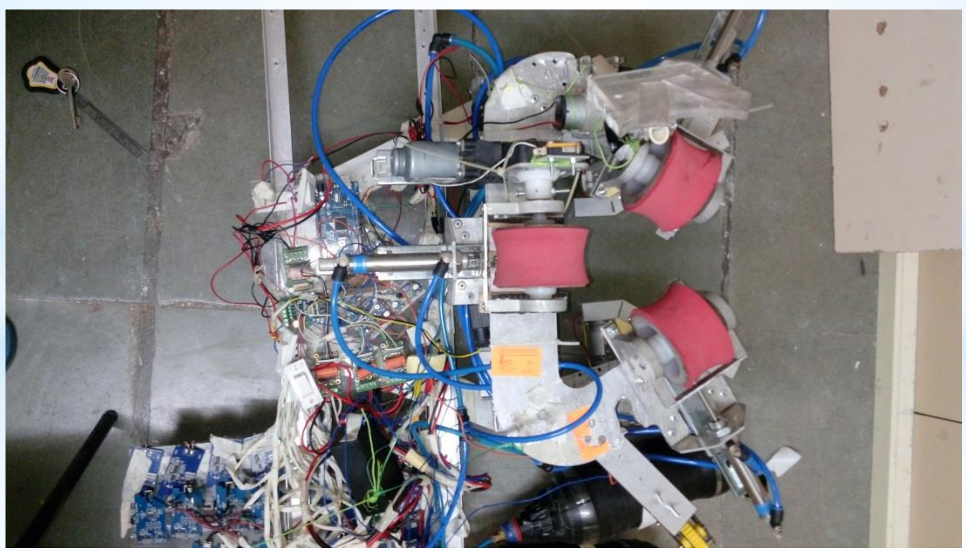
Ʈ = 2.0239 Nm= 20.638 kgfcm

Ʈ ≈ 30 kgfcm

Pole climbing mechanism







Speed calculations for motors(Pole climbing)

Assumptions are as follows:

- Diameter of wheel = 0.07 m.
- Distance to be covered (s) = 2.5 m.
- Time for covering the distance (t) = 6 sec.
- Initial velocity (u) = 0 m/s.

From Calculation

- a = 0.138 m / s^2
- v = 0.833 m/s
- N = 227.36 rpm ≈ 300 rpm

Torque calculations for motors (pole climbing)

Assumptions are as follows:

- Mass of the load (m) = 15 kg
- Coefficient of friction (μ) = 0.2
- Acceleration (a) = 0.1388 + 9.81 = 9.9488 m/s

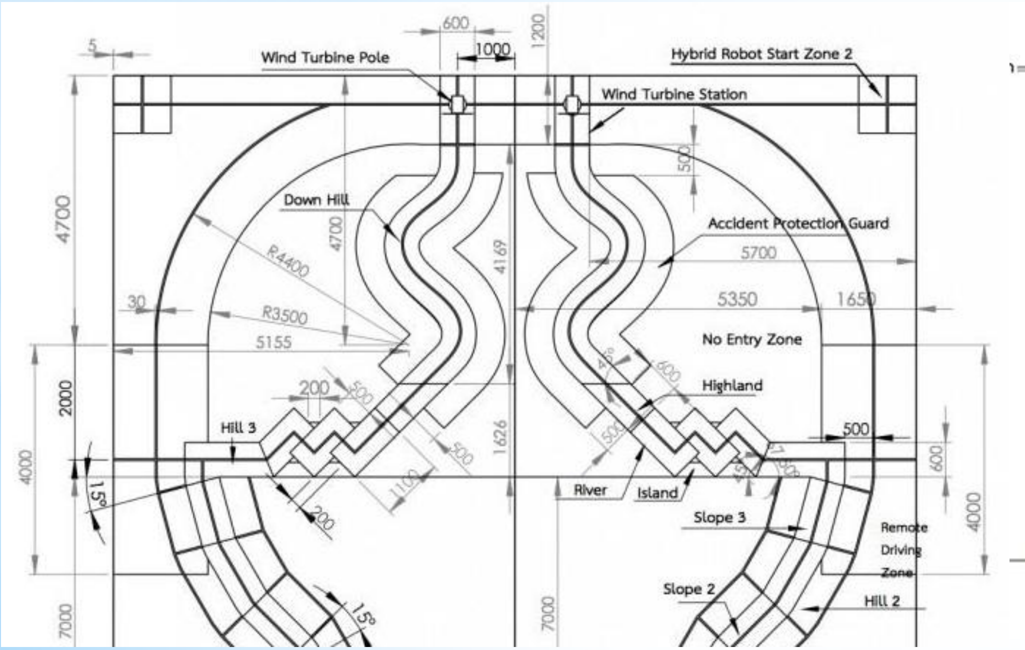
From Calculation

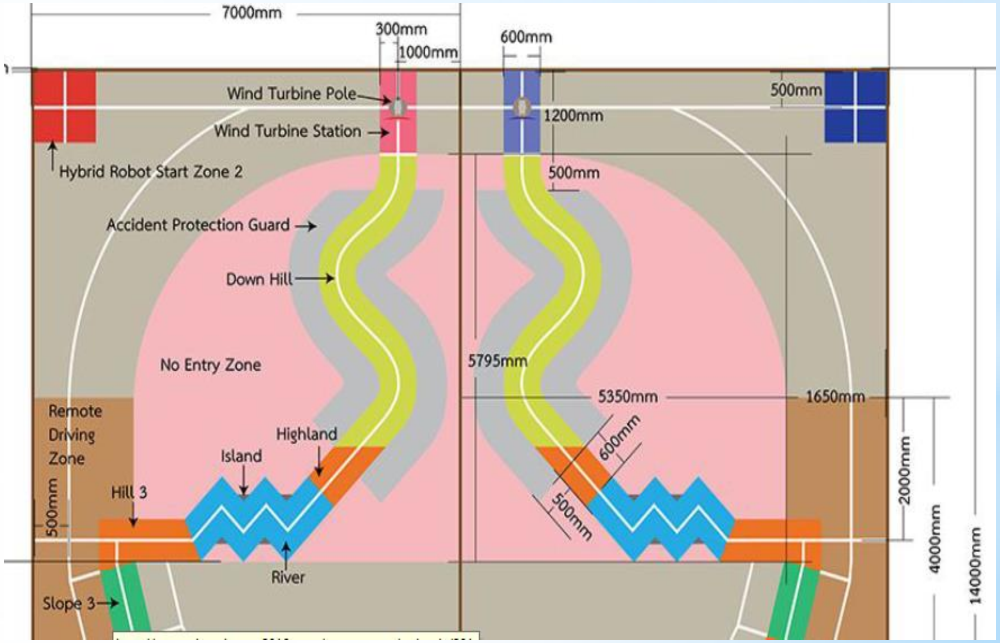
- Frictional Force (F_r) = μ * m * g = 29. 43 N
- Force required (F) = m * a= 149.232 N
- Total Force (F_T) = F + F_r = 178.662 N
- Ʈ = 6.2531 Nm = 62.531 kgfcm ≈ 100 kgfcm

PWM selection for motors on Curve path

* Assumption is that the time required to cover the curve path (t) is 3 sec
* The velocity of wheel for outer radius (V_1) is (Arc length of AB)/ t = (7.304)/3 = 2.4346 m/s
* The velocity of wheel for inner radius (V_2) is (Arc length of CD)/ t = (6.518)/3 = 2.172 m/s

- Rpm of outer wheel of hybrid robot is determined as follows: N_1 = 434.55 rpm
- Rpm of inner wheel of hybrid robot is determined as follows: N_2 = 387.8 rpm
- Pulse width modulation of outer wheel of hybrid robot (PWM_1) = (N_1/ N) * 100 = 86.91%
- Pulse width modulation of inner wheel of hybrid robot (PWM_2) = (N_2/ N) * 100 = 77.56%





Coding for pole climbing mechanism

Limit Switch 1 (high)

Support Actuators (high)

Drive motor (high)

Limit Switch 2 (high)

Drive motor (low)

Eco Robot

Literature review- Studied about following topics

1) Motor- a) Brushed Dc motor
   b) General Dc Motor
   c) Brushless dc motor
   d) Servo Motor
   e) Stepper motor
2) Material for manufacturing robot
   a)Wood
   b) Plastics
   c) Metal
   d) Composites
3) Types drive for robot-
   a) Humanoid l Drive
   b) Wheel Drive-aa) Tank drive
      bb) Omni Drive-m) Swerve drive
         n) Holomonic drive
         o) Mecanum Drive
4) Wheel For Robot- Meccanum wheel, Omni wheel, rubber wheel, castor wheel
5) Analysis for find out dimension of bot.

Design and Analysis of Eco Robot-

Considering Points-

a) At least one rigid dimension >40cm

b) It should have one single actuator to steer.(not driving)

c) Eco robot should be drive by hybrid robot without any physical contact.

d) Eco robot should not have any pre-restored energy source to drive itself.

1) Strategy or oral planning for designing of eco robot.-

a) charged by the wireless induction.
b) stored in the supercapacitor to drive.

2) Type of Drive for Navigation-

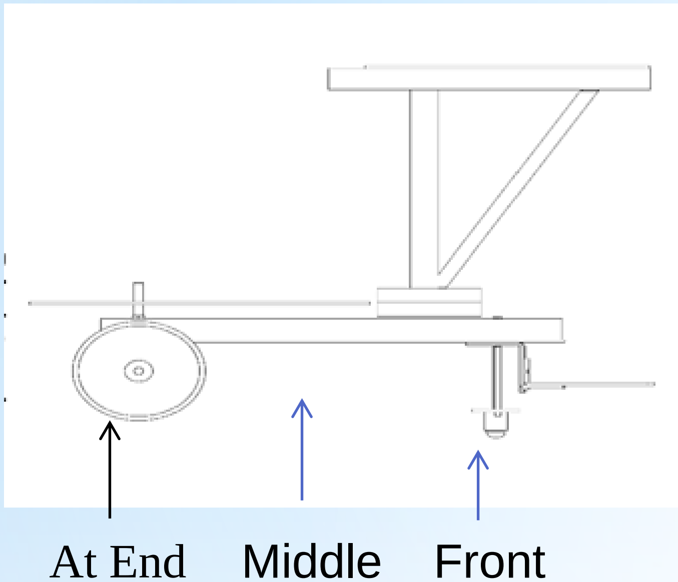
- 3 DOF so omnidirectional drive.

3) Design of experiments for Load distribution across robot-

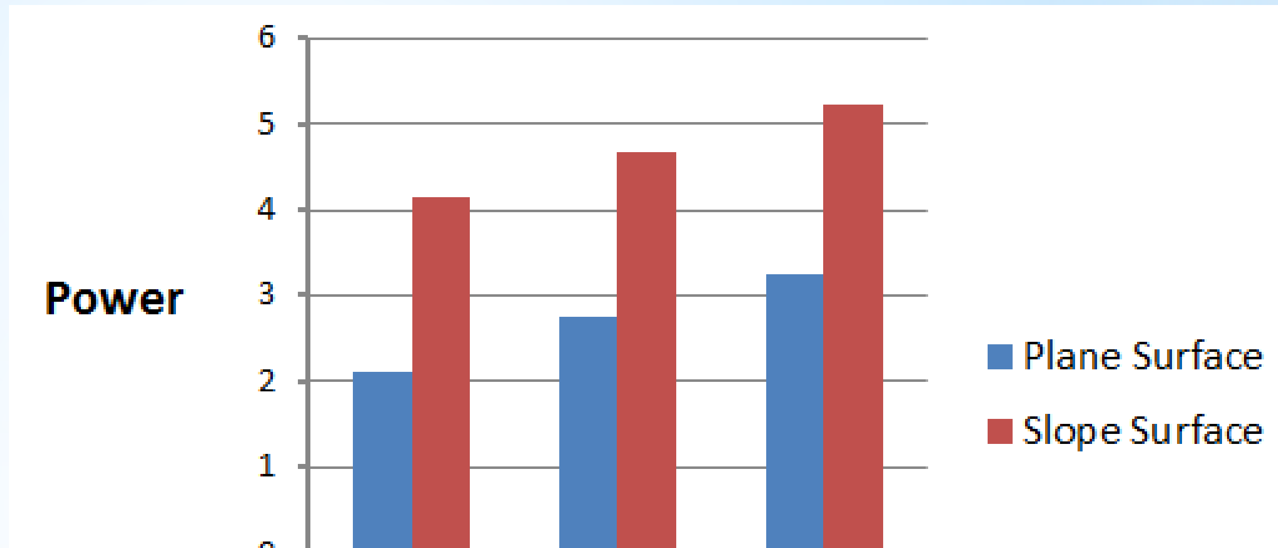
Procedure-

a) Built the robot with assumed dead weight.

b) Load location-



c) Power consumption at high PWM.



	At End	At Middle	At Front
Plane Surface	2.1	2.737	3.248
Slope Surface	4.151	4.676	5.229

Conclusion- Load distribution should be end side of the robot.

5) Selection of Material for Manufacturing of Eco robot-

Material Properties Required-

1. Moderate strength
2. Material should be lightweight
3. Easy to manufacture

\\ so Wood is selected from literature review

Sr. No.	Wood species	Specific gravity	Compressive strength(PSI)	Bending strength(PSI)	Stiffness (Mpsi)	Hardness (lb)
1)	Alder	0.41	5820	9800	1.38	590
2)	Ash	0.6	7410	15000	1.74	1320
3)	Aspen	0.38	4250	8400	1.18	350
4)	Basswood	0.37	4730	8700	1.46	410
5)	Beech	0.64	7300	14900	1.72	1300
6)	Birch	0.62	8170	16600	2.01	1260
7)	Butternut	0.38	5110	8100	1.18	490
8)	Cherry	0.50	5110	8100	1.18	490
9)	Chestnut	0.43	5320	8600	1.23	540
10)	Eim	0.5	5520	11800	1.34	830
11)	Hickory	0.72	9210	20200	2.16	890
12)	**Balsa wood**	**0.12**	**1000**	**2000**	**1.62**	**260**
13)	Maple, Hard	0.63	7830	15600	1.83	1450
14)	Maple, soft	0.54	6540	13400	1.64	950

From following wood Balsa wood is selected.

6) Mathematical modelling of a robot to find out toppling condition of the robot.

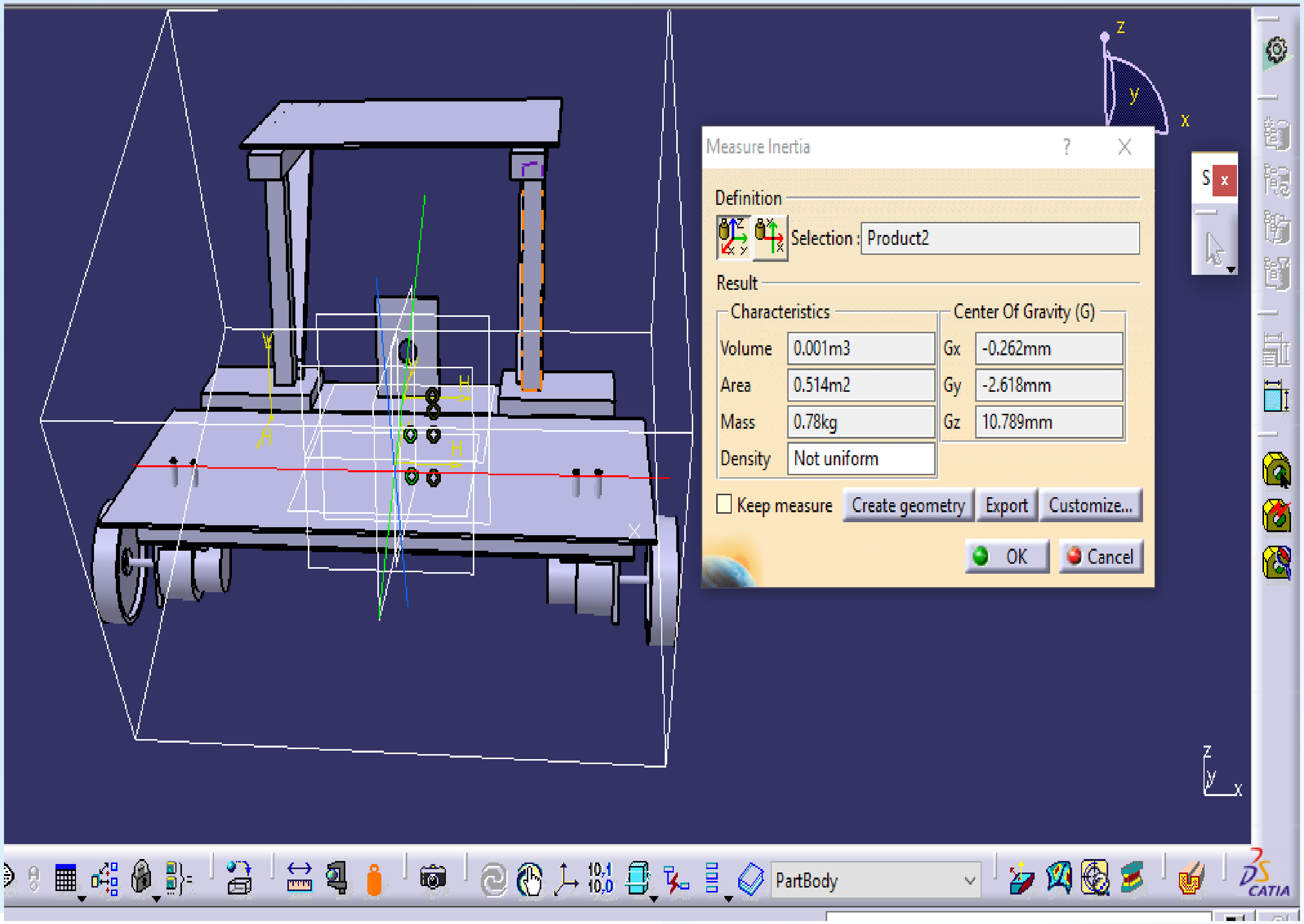
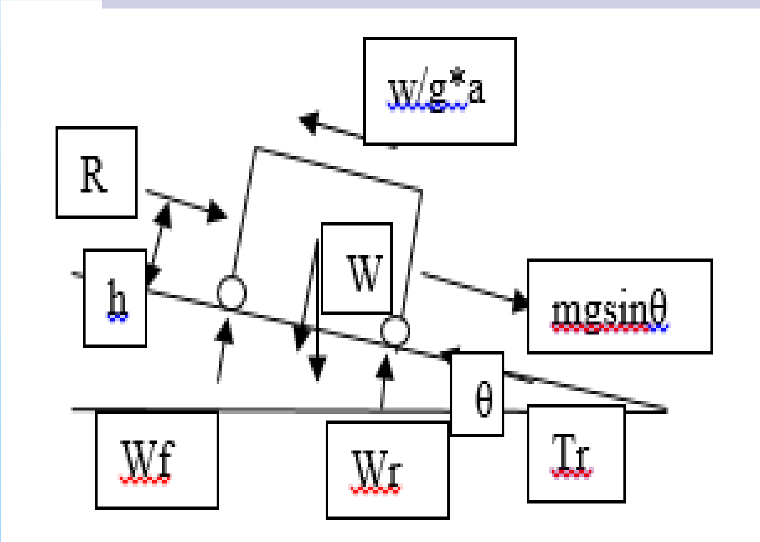


Fig. Coordinates of C.G. location-



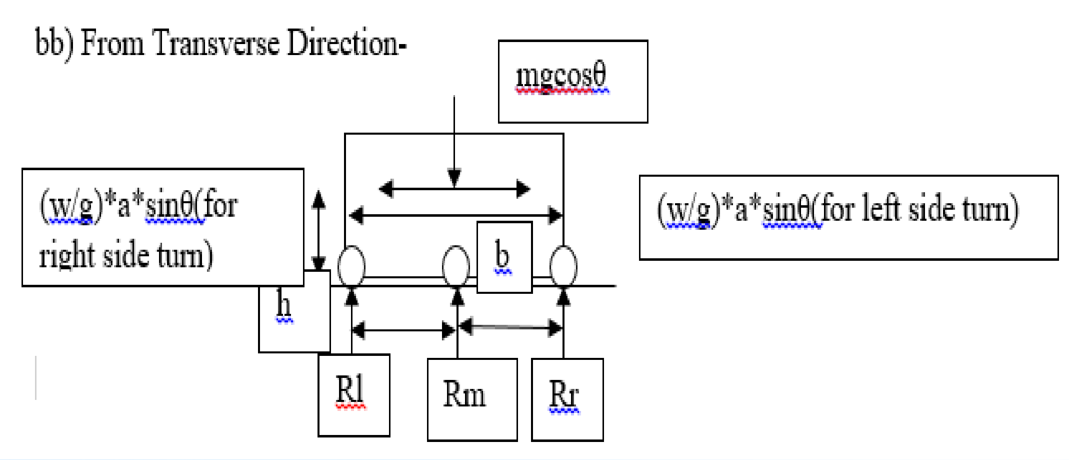
Robot along inclined path-(for longitudinal direction)-

Wr=5.59952N

Wf=1.928854N

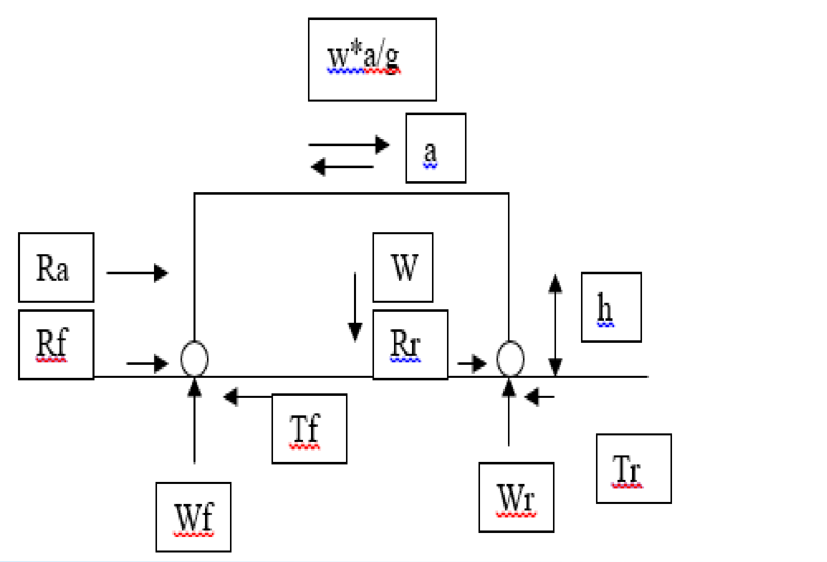
Positive so no toppling condition for loaded weight.

b) From Transverse Direction-



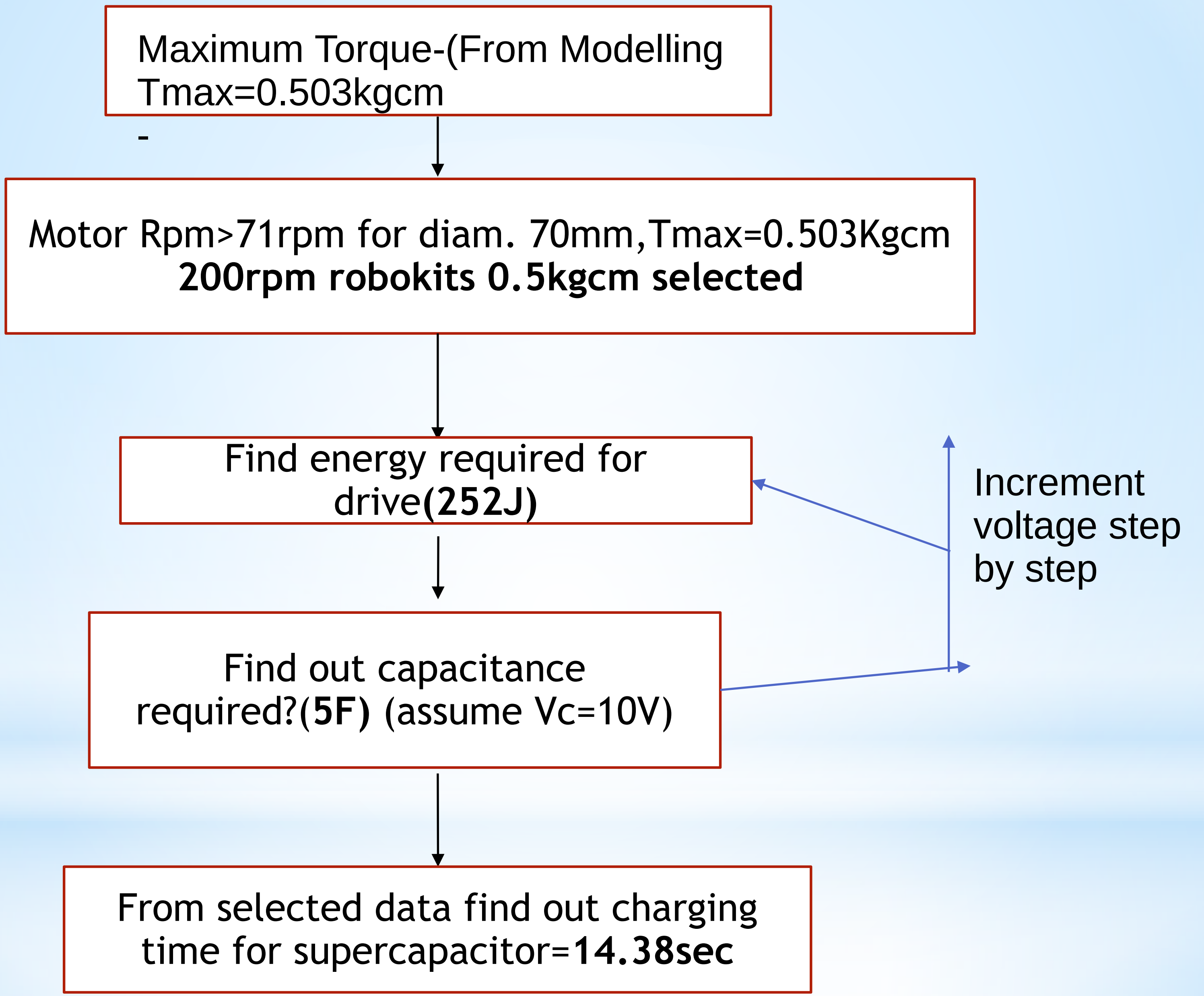
Robot along inclined path-(for Transverse direction)-
Rl=3.608N
Rm=0.16426N
Rr=3.74444N
Positive so no toppling condition for loaded weight.

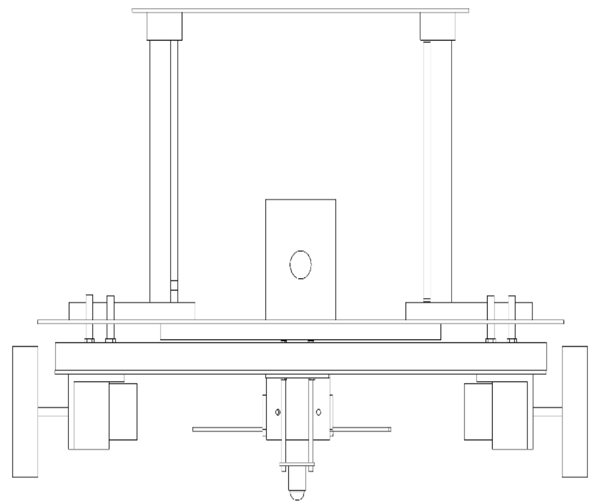
2) Robot Along river and hill



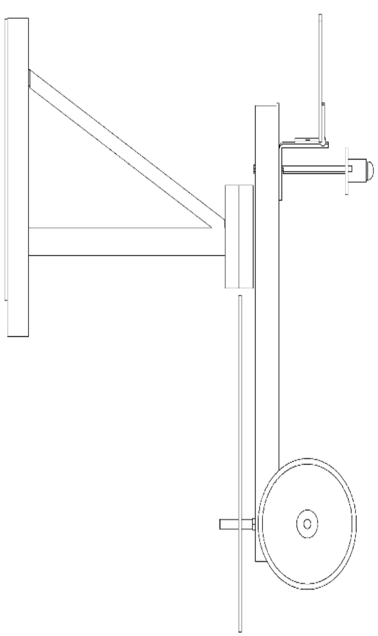
Robot along river and hill path-(for Transverse direction)-
Wf=5.1933N
Wr =2.4585N
Positive so no toppling condition for loaded weight.

7) Motor selection, Calculation of charging time and discharging time for supercapacitor-

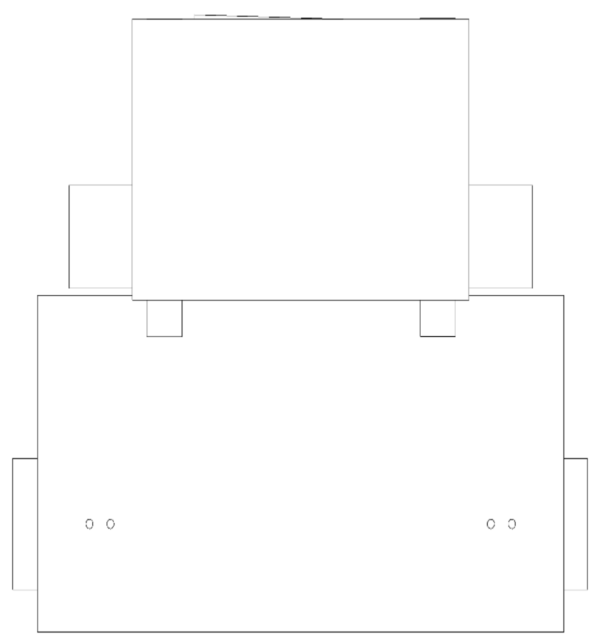




Bottom view
Scale: 1:1



Right view
Scale: 1:1



Front view
Scale: 1:1

8) Manufacturing of Eco Robot –

1) Laser cutting .
2) Hakes-saw cutting.
3) Hand drilling
4) Gluing with fevicol.(glue for wood sticking)
5) Bending of acrylic with heat gun.

9) Testing and modification-

1) Calculated Time- 14.68 sec

   Actual Charging time-25sec

   optimised up To- 20sec.

2) Decided the time to travel=35sec (theoretically)

   Actual practices – 60-70sec

   Optimised up to-50-52Sec

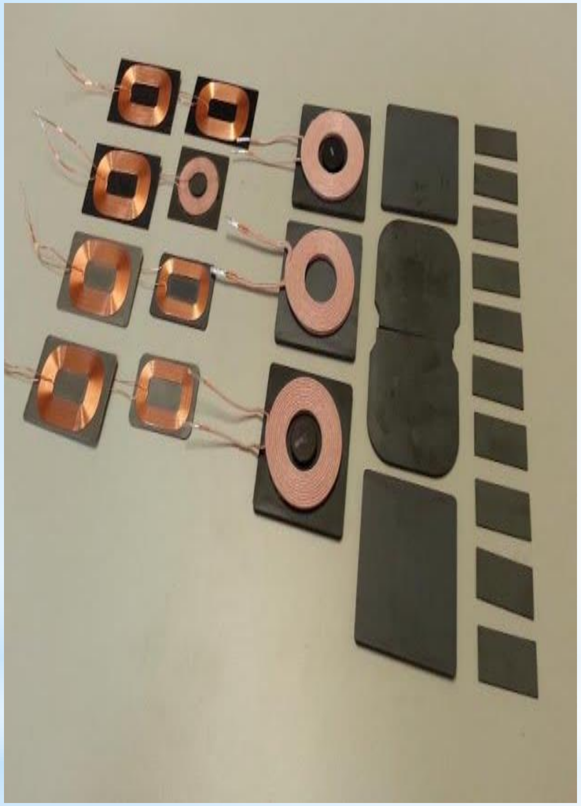
Technique Used-

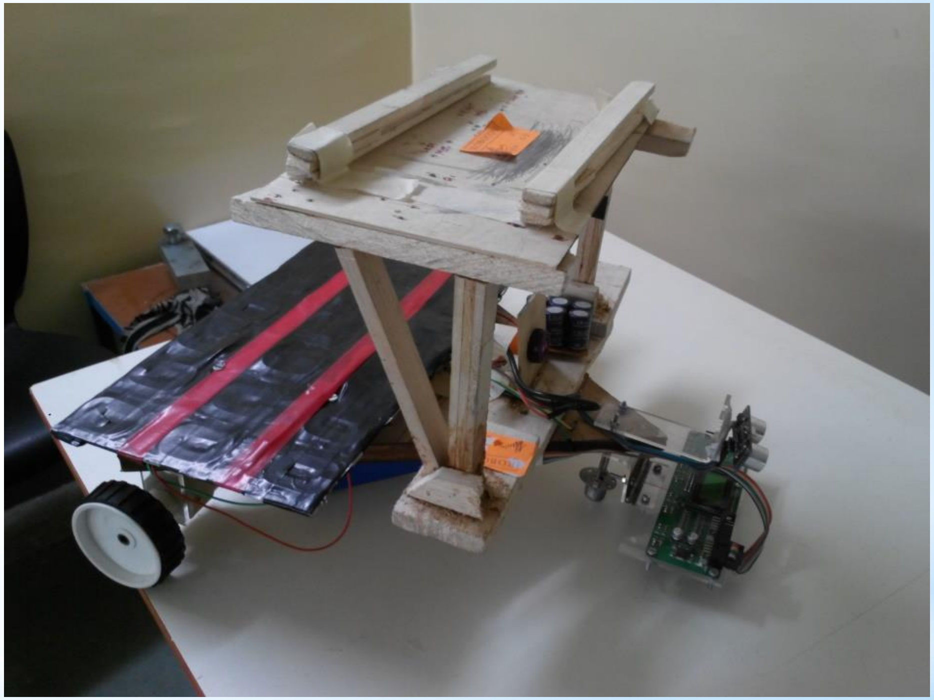
a) Avoid losses in the electrical circuit.
b) Relocation of the load.

STEER AND DRIVING OF ECO ROBOT

* Electronic components used in eco robot:
  * WIRELESS CHARGER (RECIEVER)
  * SUPERCAPACITOR
  * RELAY
  * INFRARED SENSOR
  * LSA08
  * MOTOR DRIVER
  * ARDUINO

Wireless charger





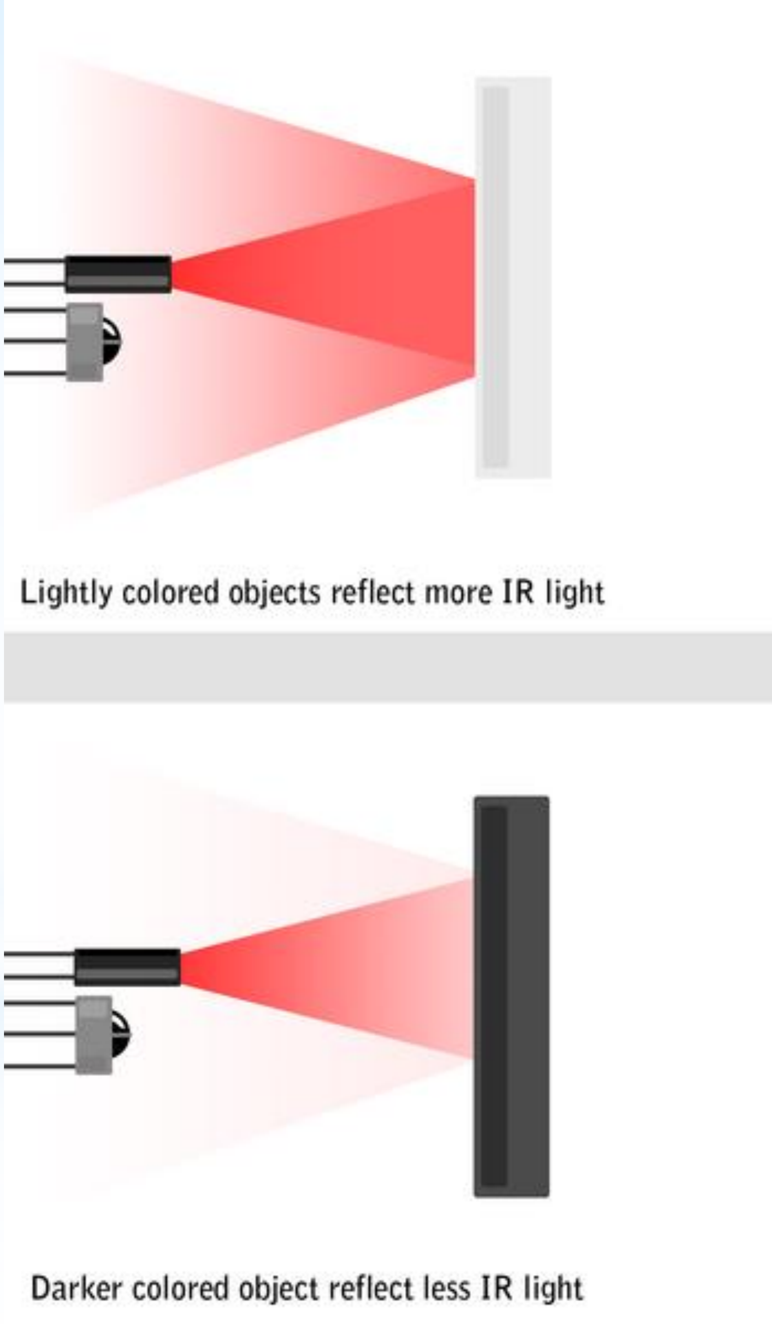
SUPER CAPACITORS

- Changing electric fields between cathode and anode.
- Thickness of dielectric extremely thin.
- Porous carbon increases capacitance.
- Low equivalent series resistance
- Fast charge and discharge
- Charging through absorption and release of ions.

RELAY

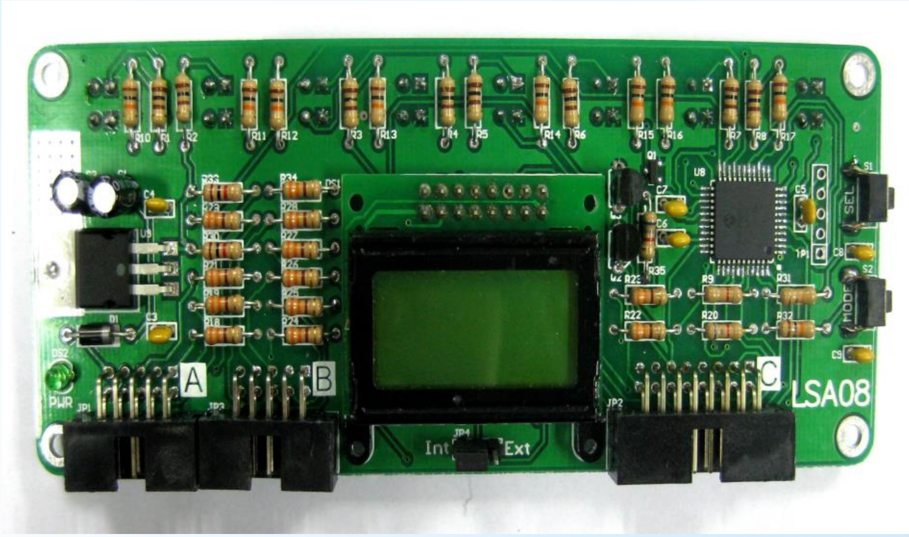
- 5 pins
  - SIGNAL
  - POWER
  - GND
  - NORMALLY OPEN
  - NORMALLY CLOSED

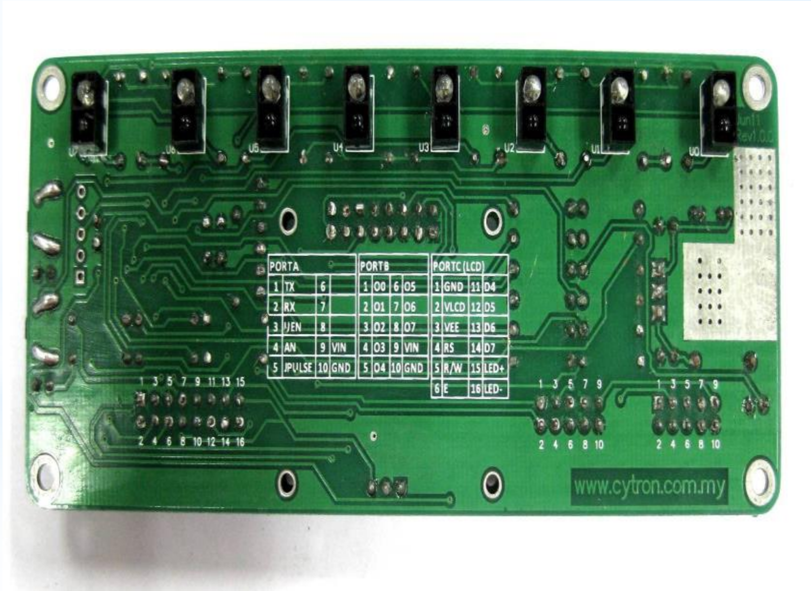
INFRARED SENSOR



LSA08

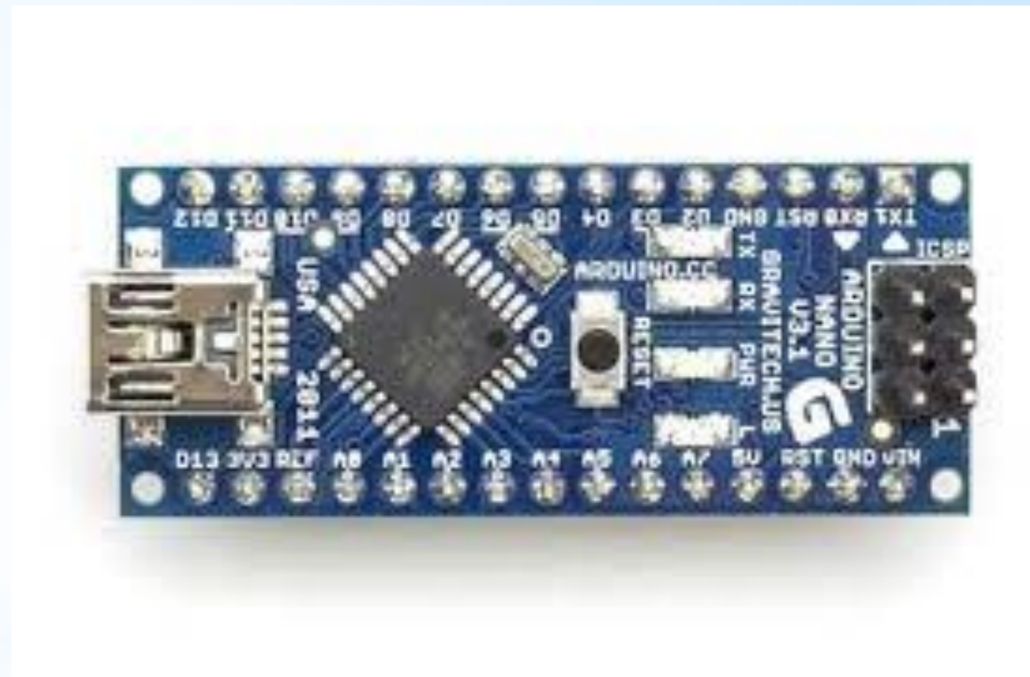
- 8 Sensors at a distance of 6 mm each
- Midpoint 35
- Enable and Jpulse
- Both analog and digital ports available
- Sensor calibration
- Transmitter and receiver pins



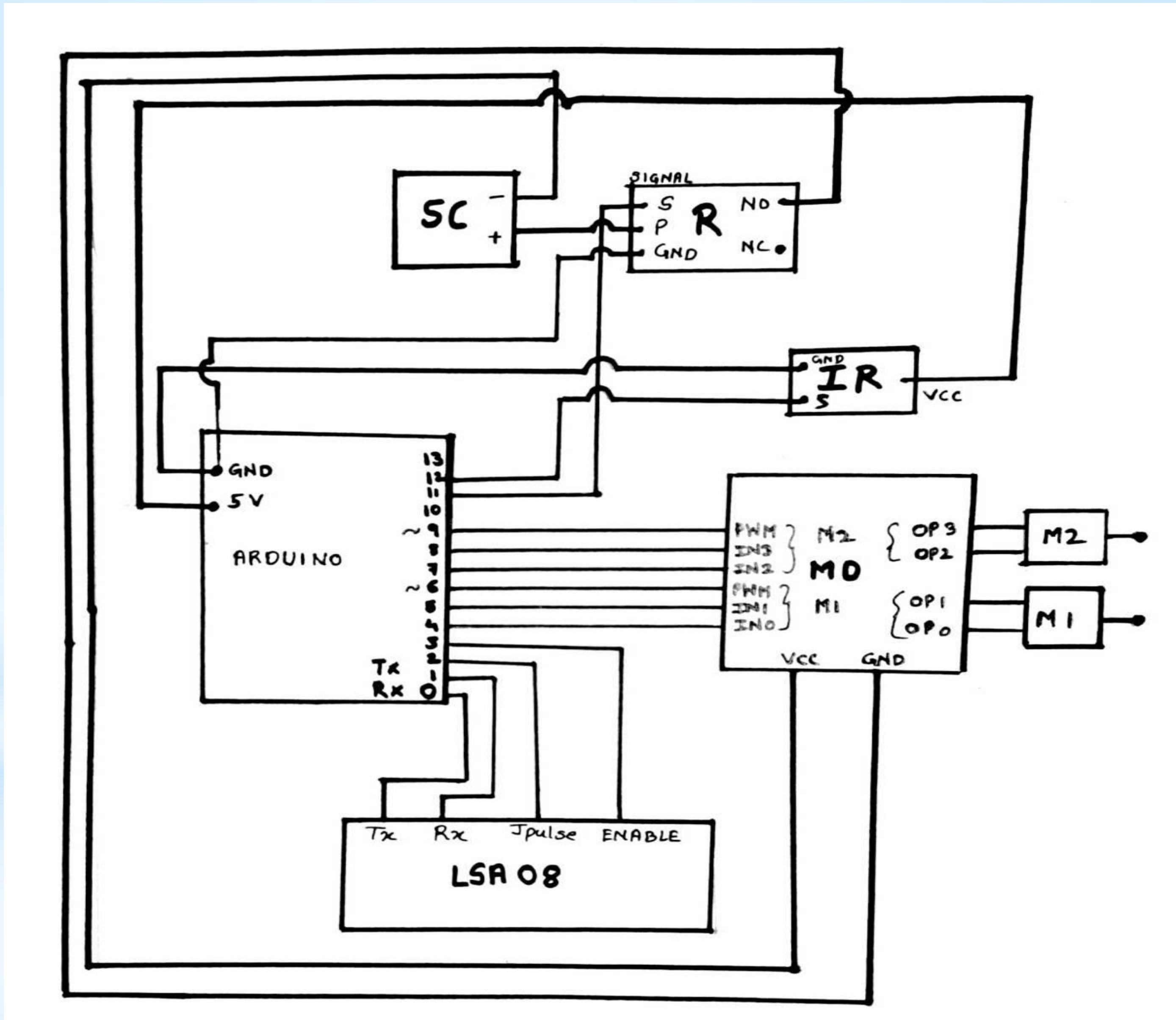


MOTOR DRIVER

ARDUINO



CIRCUIT DIAGRAM OF ECO ROBOT



ARDUINO PROGRAMMING

DECLARATION
- CONSTANTS, SPEEDS
- PINMODES

FORWARD
- PWM 200
- SENSOR READING 25-45

JUNCTION
- JPULSE=3
- RIGHT MOTOR REVERSE
- SENSOR READING 32-38

RIVER LEFT
- SENSOR READING 15-25
- LEFT MOTOR REVERSE
- SENSOR RETURN TO 32-38= STOP

RIVER RIGHT
- SENSOR READING 45-55
- RIGHT MOTOR REVERSE
- SENSOR RETURN TO 32-38= STOP

PID
- error = (bot Position – mid Point);
- Motor Speed = a * error + b * (error – Previous Error)

MOTOR SPEED
- LIMIT TO MAXIMUM SPEED

Time Activity Chart

Sr. No.	Activity	Dates											
		June 15	July 15	Aug 15	Sep 15	Oct 15	Nov 15	Dec 15	Jan 16	Feb 16	Mar 16	April 16	May 16
1	Problem definition	✓.	✓.										
2	Literature survey		✓.	✓.									
3	Design				✓.	✓.							
4	Analysis						✓.	✓.					
5	manufacturing								✓.	✓.	✓.		
6	Testing										✓.		
7	Report										✓.	✓.	

THANK YOU!