Project 2

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Objective

- Build an autonomous robot that performs the 4 tasks.
  a. Manual control of the robot,
  b. autonomous navigation,
  c. autonomous navigation with obstacle avoidance, and
  d. autonomous navigation of a square.

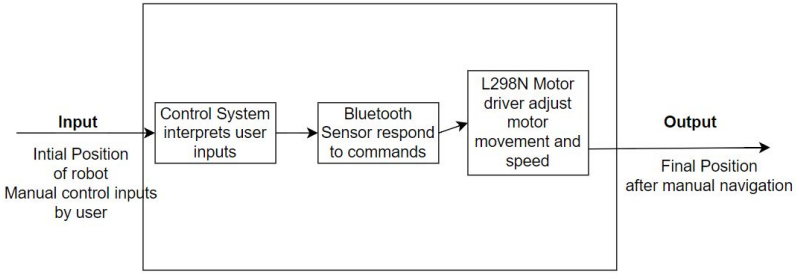
Problem Definition

Product Charatestic	Functional Requirement	Constraints	Performance Metric
Cost Effective	Must use readily available items	$15 budget	$P = \frac{15-cost}{15} * 100\%$
Quick/Responsive	Must use a actuator	Have least amount of travel time	$P = \frac{1}{\#\ of\ actuators} * 100\%$
Reliability	Must have repeatable path	Complete all tasks effectively	$P = \frac{\#\ tasks\ completed - \#failed}{4} * 100$
User Friendly	Must be easy to assembly	Number of Parts is Less than 15	$P = \frac{10-\#Parts\ used}{10} * 100\%$
Resourceful	Must be able to do obstacle detection and navigation	Use ELEGOO kit & pre-owned for electronic parts	$P = \frac{i_{total} - i_{bought}}{i_{total}} * 100$
	Must be able to manual control	Only use household items for mechanical system	
	Must be able to autonomous square path	Three-week timeline	

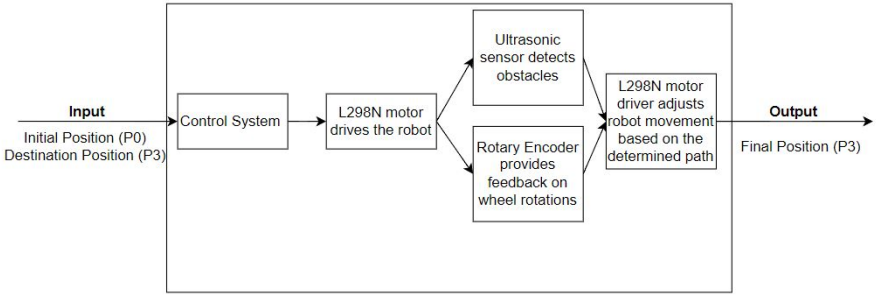
Mind Map


Semi-Autonomous Robot Car
Controller
Method of Control
Actuator
Sensors
Base/Materials
Wheels
Drive
Manual
Autonomous
Program
Sliding Mode Control
PID
Servo Motor
Stepper Motor
DC Motor
Wood
ABS/Plastic
Metal
Particle Board
Dowels
Cardboard
Screws, pilot holes, brackets, super/hot glue
Non-linear Control
Tuning Required
Easy to Implement
Instantaneous Robust
Difficult to Source, Expensive
3-D Printer Required
DC Motor with Encoder
High torque at low speeds
Sustained Output, Proportional to Voltage
PWM
Shaft angle control
"DC Motor with Feedback"
Sustained Output
Stepwise motion (slow)
Torque limitations at high speeds
Low torque to inertia ratio (low acceleration)
Obstacle Following
Remote Control
Joystick Module
Line Following
Obstacle Avoidance
Cheap, Simple, Reliable
Standard Rubber Wheels
Movement System
Smooth Turns
Omnidirectional Wheels
Expensive
1WD
2WD
3WD
4WD
Bevel, Planetary Gears Required
DC/Servo Combo
DC Only
IR Sensor
Proximity Sensor
Photoelectric Sensor
Ultrasonic Sensor
Direct Line of Sight, Short Range
No Contact, High Repeatability
Metallic and Nonmetallic Detection
Fast Response Time
Range: 2 cm - 400 cm
Object must be Large, Flat Surface
High Sensitivity to Temperature
High Reflectivity Needed, Lens Contamination
Low Power
Stability, Speed, Low Cost, Low Power
Cheap, Reliable
Long Life, & Sensing Range
Low Transmission Data Rate
Sensitive to Temperature and Humidity

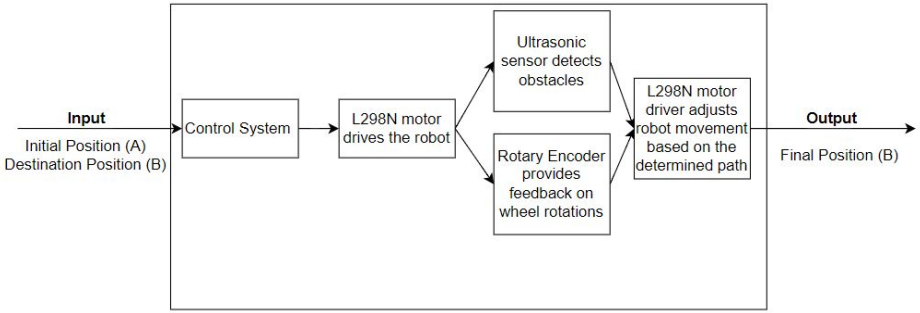
Black Box Diagrams



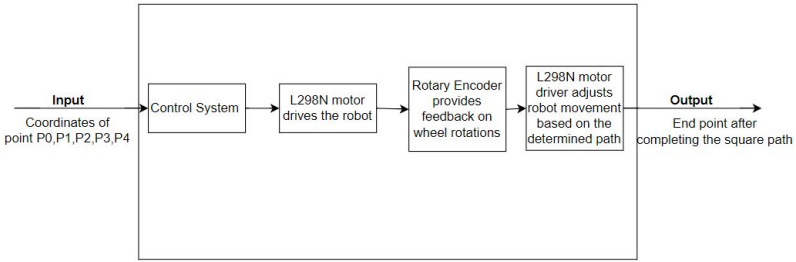
Task 1



Task 2



Task 3

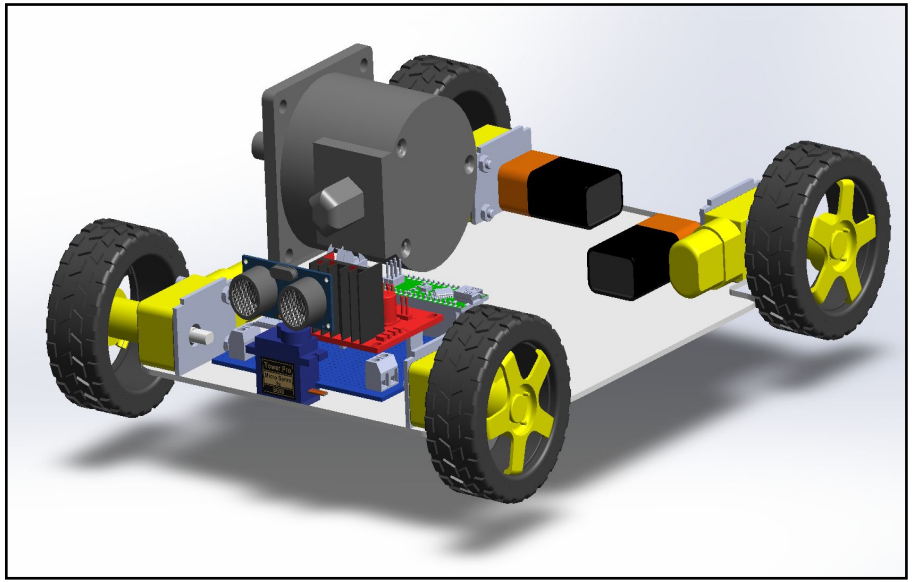


Task 4

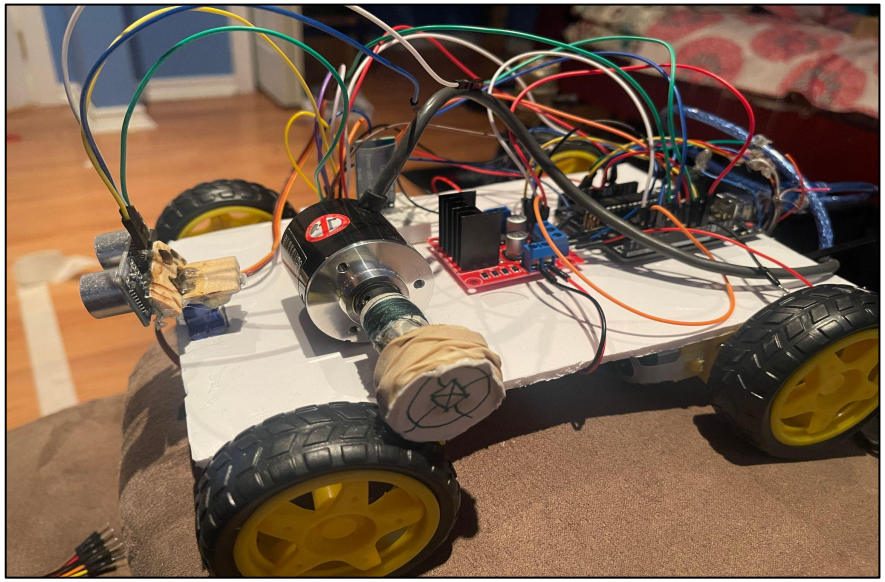
List of Materials

Items	Cost
Arduino Uno	$0 (Arduino Kit)
H Bridge (L298N)	$0 (Arduino Kit)
Gear Motor and Wheels (2x)	$0 (Arduino Kit)
Rotary Encoder	$0 (pre-owned)
HC-05 Bluetooth Module	$0 (pre-owned)
18650 Li-on Battery (2x)	$0 (borrowed from SLC department)
18650 Battery Holder	$0 (Arduino Kit)
Jumper wire	$0 (Arduino Kit)
Foamboard	$0 (home stationary)
Simscape and MATLAB software	$0 (software)
SolidWorks	$0 (software)
Arduino	$0 (software)

Prototype



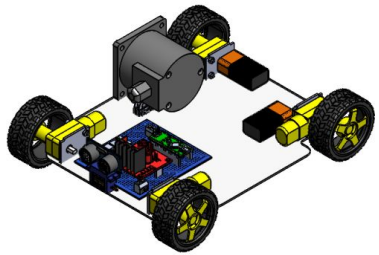
CAD Model

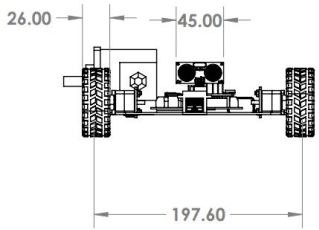


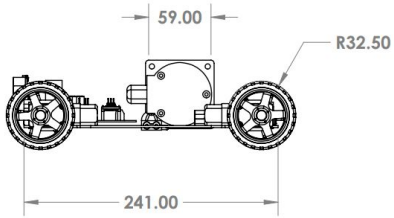
Assembled

Components

ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	Motors		4
2	hc-sr04		1
3	Platform		1
4	encoder		1
5	9 Volt Battery		2
6	Wheels		4
7	Arduino UNO		1
8	H-Bridge		1
9	Ultrasonic Sensor		1
10	SERVO MOTOR		1



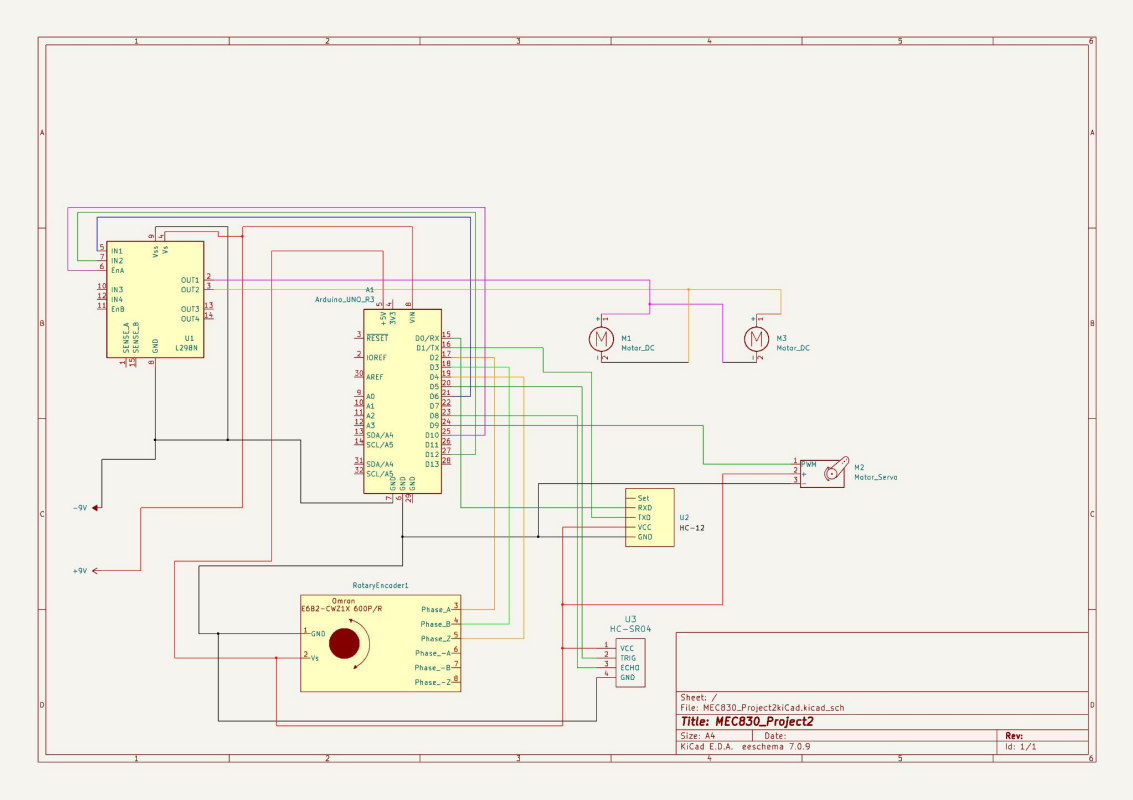




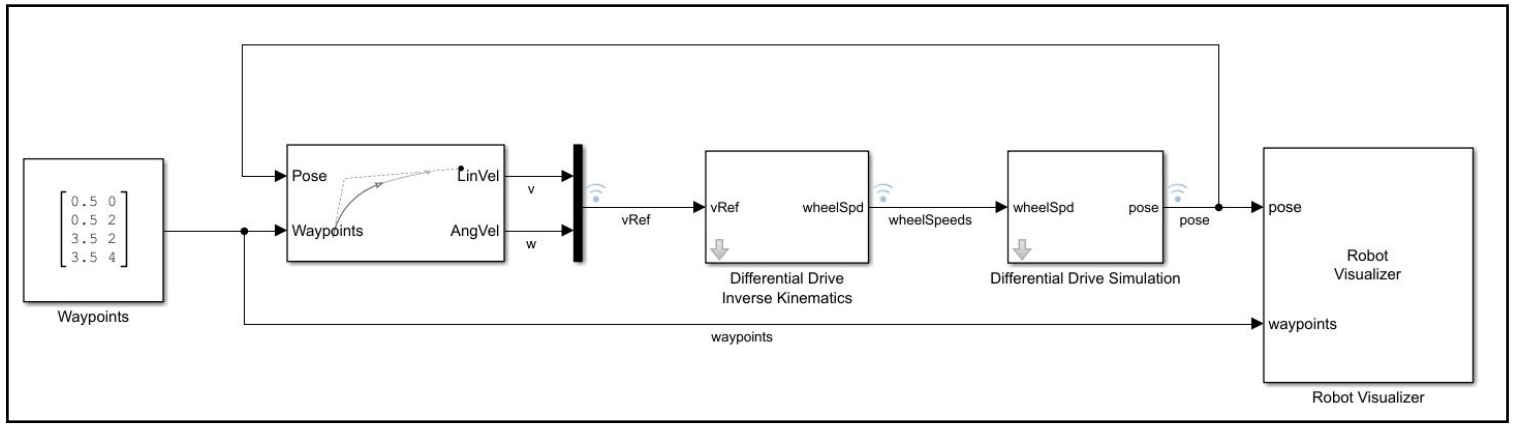
SIZE	DWG. NO.	UNIT
A	Bluetooth Robot Car	MM
SCALE: 1:4	WEIGHT:	SHEET 1 OF 1

SOLIDWORKS Educational Product. For Instructional Use Only.

KiCAD Model


IN1
IN2
EnA
IN3
IN4
EnB
OUT1
OUT2
OUT3
OUT4
SENSE_A
SENSE_B
GND
Vss
Vs
U1
L298N
A1
Arduino_UNO_R3
RESET
IOREF
AREF
A0
A1
A2
A3
SDA/A4
SCL/A5
D0/RX
D1/TX
D2
D3
D4
D5
D6
D7
D8
D9
D10
D11
D12
D13
M1
Motor_DC
M3
Motor_DC
PWM
M2
Motor_Servo
Set
RXD
TXD
VCC
GND
U2
HC-12
-9V
+9V
RotaryEncoder1
Omron
E6B2-CWZ1X 600P/R
Phase_A
Phase_B
Phase_Z
U3
HC-SR04
TRIG
ECHO
Sheet: /
File: MEC830_Project2kiCad.kicad_sch
Title: MEC830_Project2
Size: A4
Date:
Rev:
KiCad E.D.A. eeschema 7.0.9
Id: 1/1

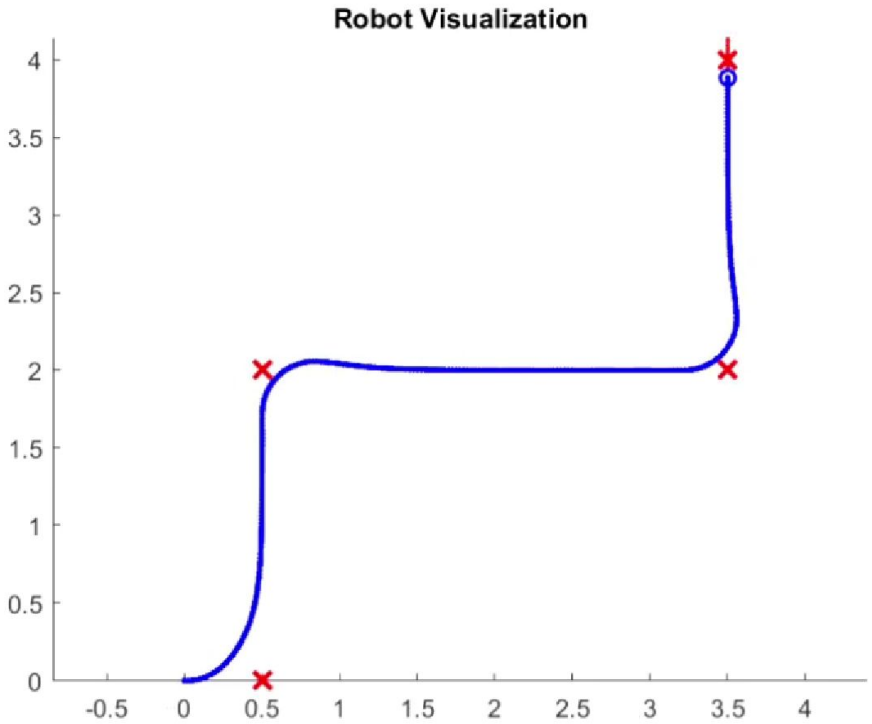
Simulation Software



Block Diagram

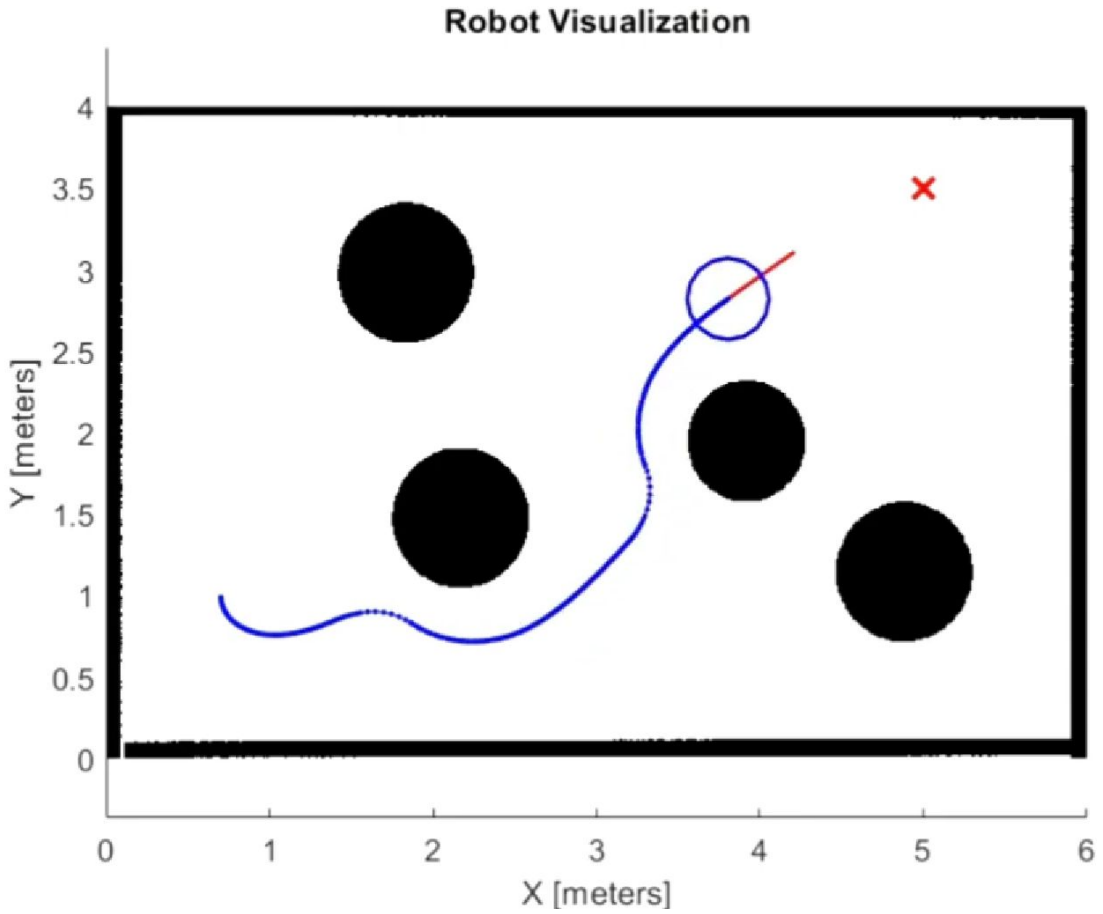
Simulated Tasks 1/2

https://shorturl.at/kxLV8



Simulated Task 3

https://shorturl.at/pqQ12

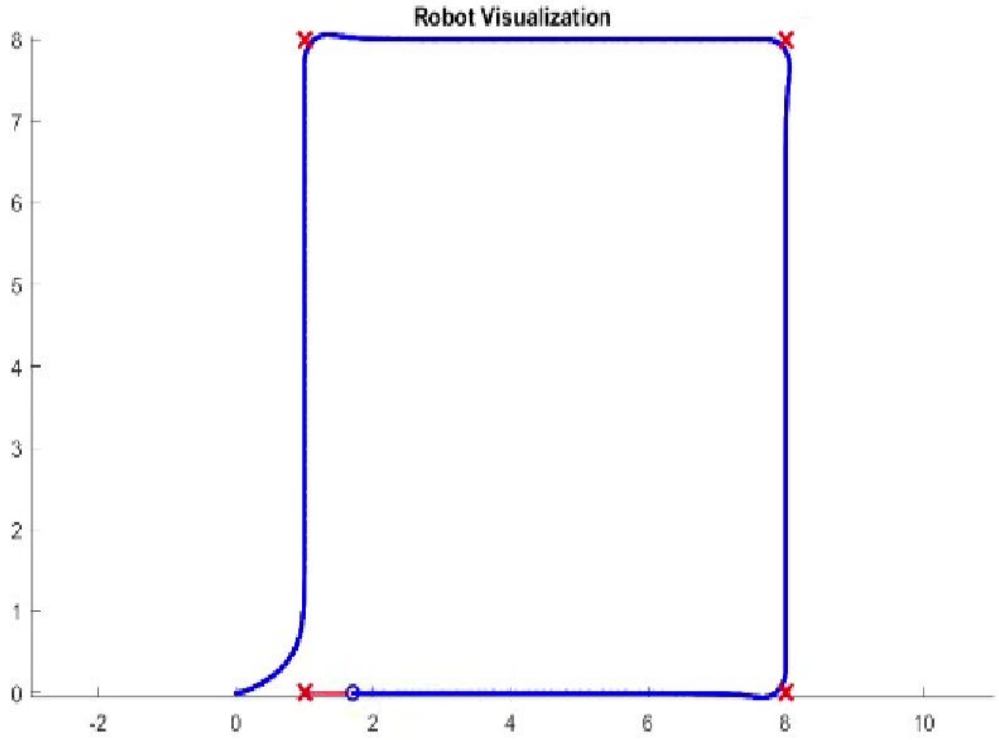


Simulated Task 4

https://shorturl.at/jorO8

Distance:

- Length of Robot
  - L ≈ 24 cm
- Path =6(24 cm)=104 cm



Team Repository

Team Github repository: https://github.com/farrismh/Project-2---Autonomous-Robot-Car/

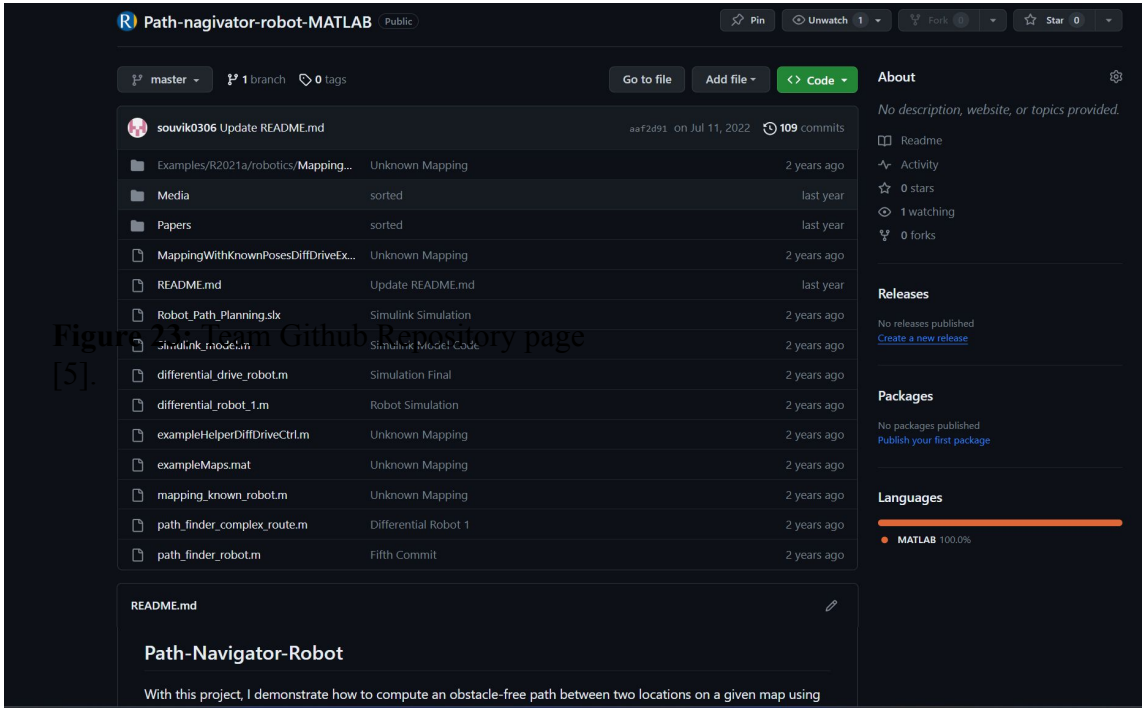
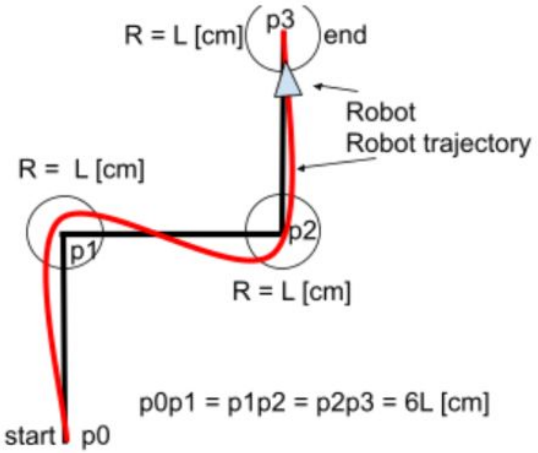
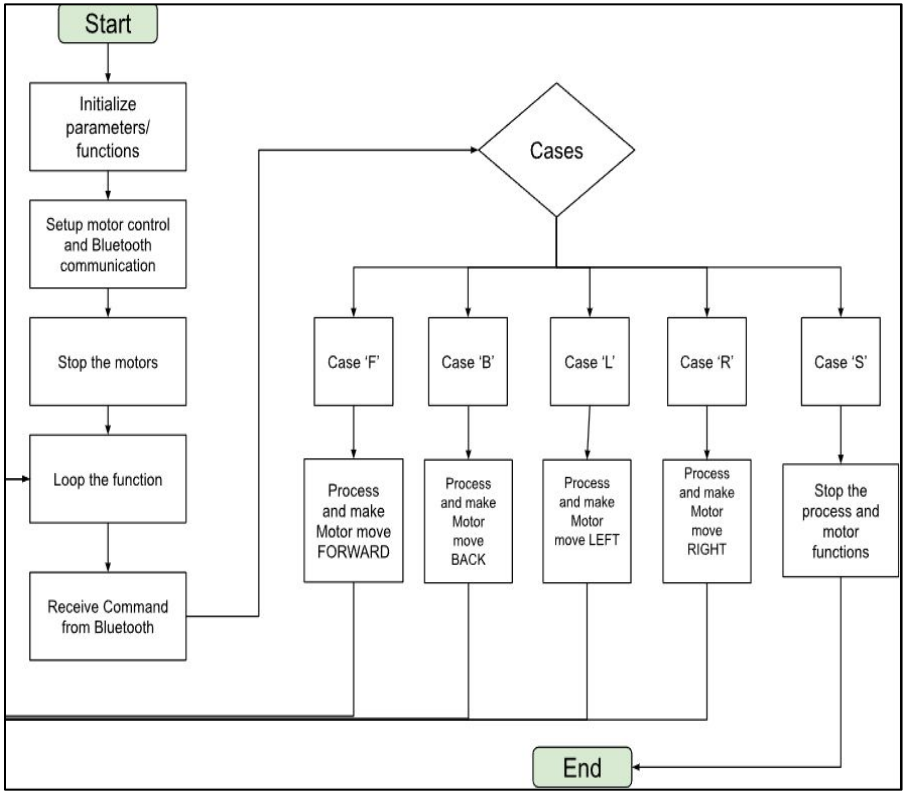


Figure 3: Team Github Repository page [5].

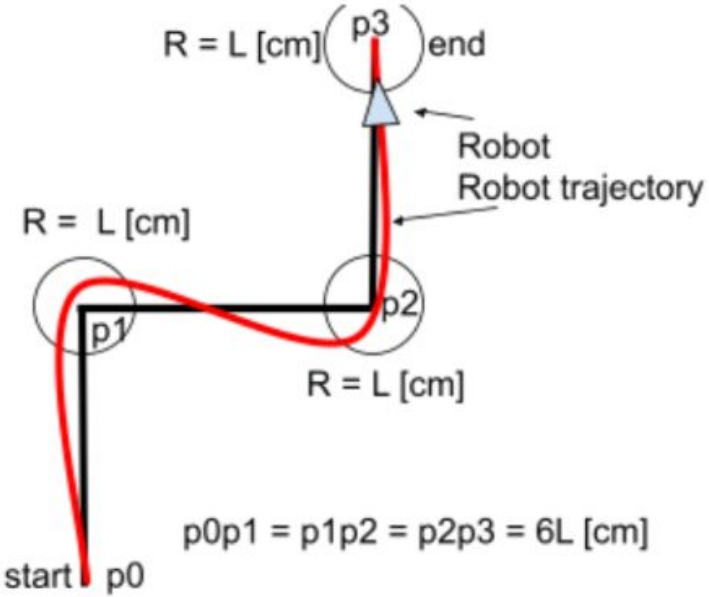
Task 1

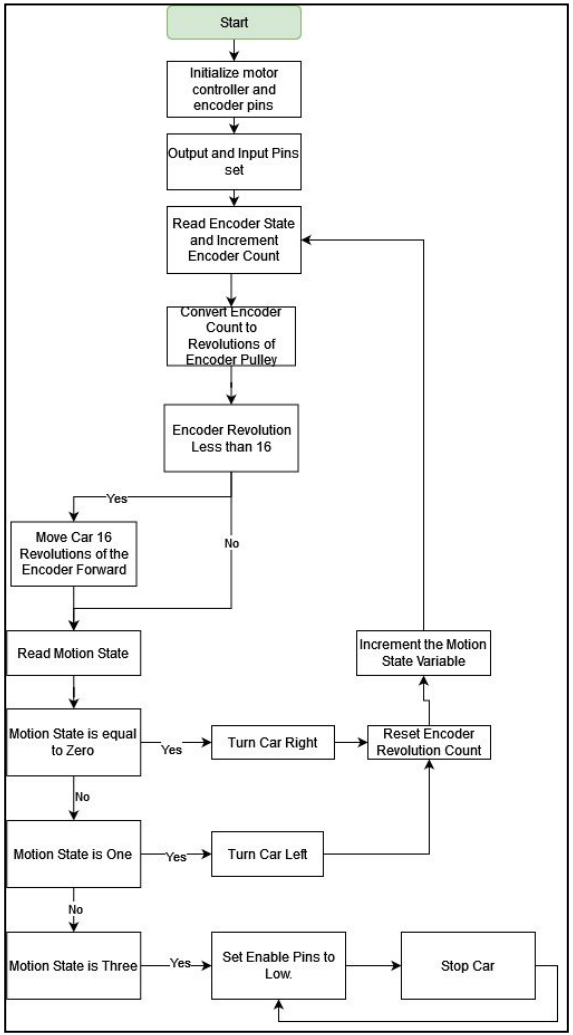
- Bluetooth Module
- Mobile Application:
  - RC Bluetooth interfacing application.





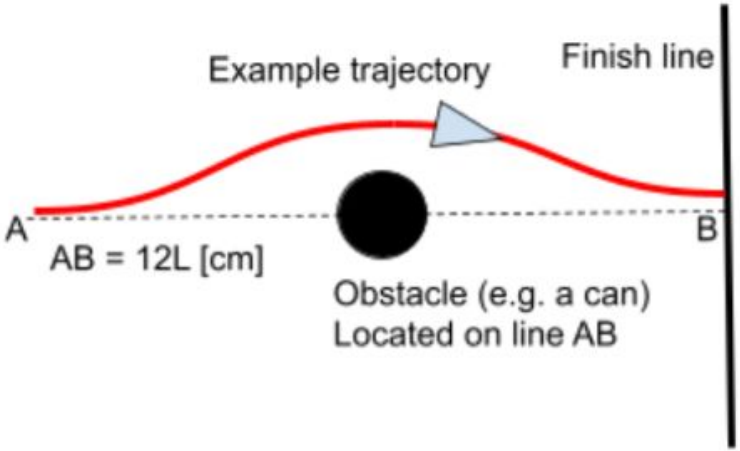
Task 2

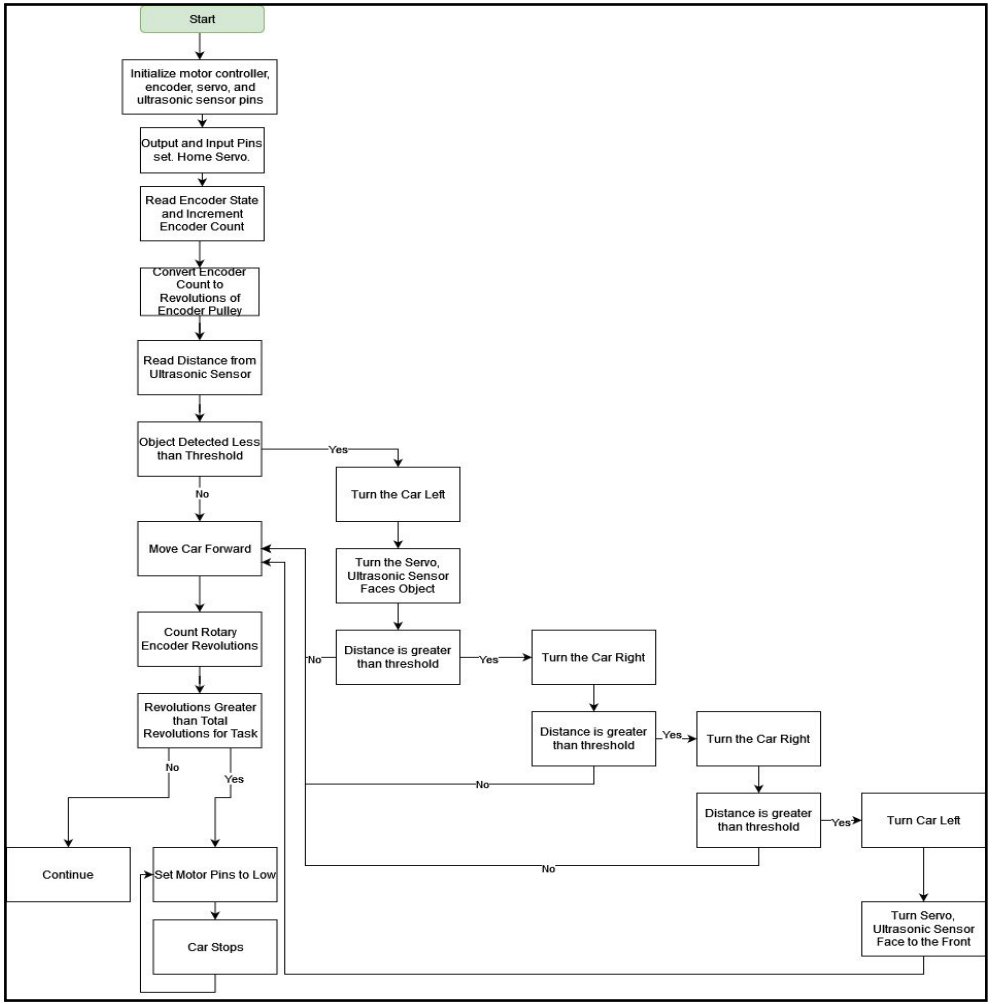

R = L [cm]
p3
end
Robot
Robot trajectory
R = L [cm]
p1
p2
R = L [cm]
p0p1 = p1p2 = p2p3 = 6L [cm]
start
p0


Start
Initialize motor controller and encoder pins
Output and Input Pins set
Read Encoder State and Increment Encoder Count
Convert Encoder Count to Revolutions of Encoder Pulley
Encoder Revolution Less than 16
Yes
No
Move Car 16 Revolutions of the Encoder Forward
Read Motion State
Increment the Motion State Variable
Motion State is equal to Zero
Yes
Turn Car Right
Reset Encoder Revolution Count
No
Motion State is One
Yes
Turn Car Left
No
Motion State is Three
Yes
Set Enable Pins to Low.
Stop Car

Task 3

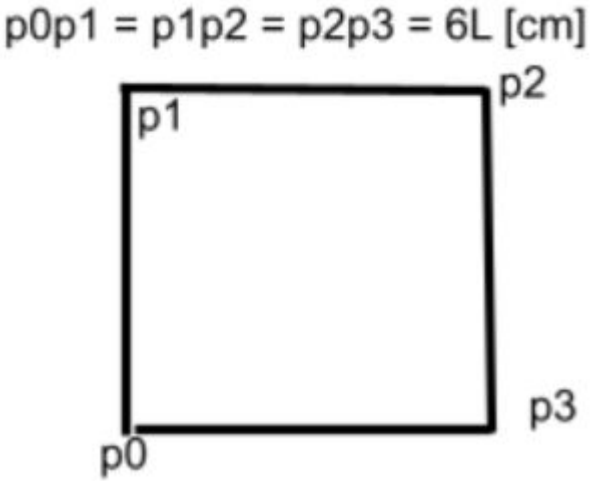
- Ultrasonic Sensor
- Servo Motor
- Encoder

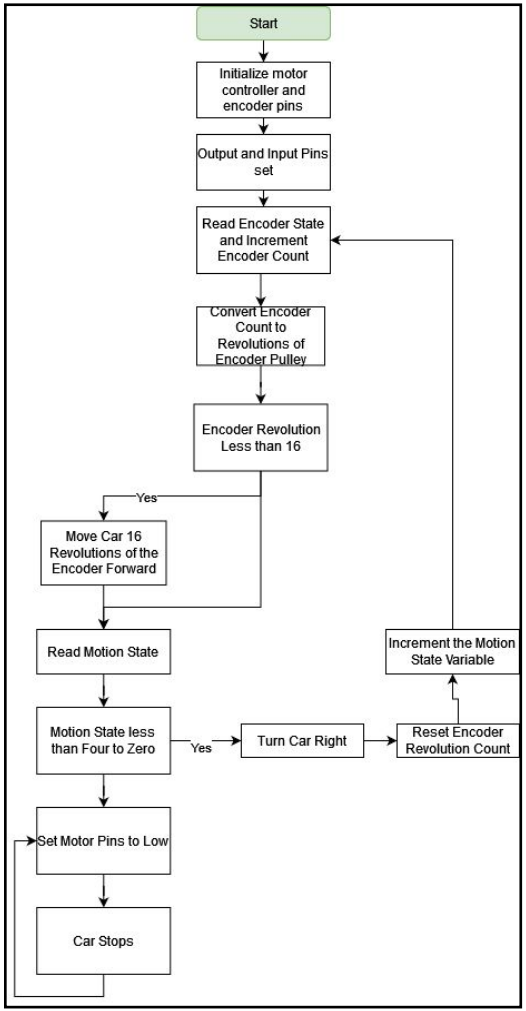




Task 4

- Ultrasonic Sensor
- Encoder
  - Distance travelled is 6L





Demo

Task 1: https://shorturl.at/itF16

Task 2: https://shorturl.at/dehO4

Task 3: https://shorturl.at/nxFL0

Task 4: https://shorturl.at/cptCU

Recommendations

- Battery Mitigation / Power Management
- Articulated Actuation Using 3D Printed Parts