Shri Vile Parle Kelavani Mandal's
DWARKADAS J. SANGHVI COLLEGE OF ENGINEERING
(Autonomous College Affiliated to the University of Mumbai)
NAAC Accredited with "A" Grade (CGPA : 3.18)

**IETE-SF**
**of**
**Electronics & Telecommunication Engineering Department**
**Presents**

**INNOVATIVE PRODUCT DEVELOPMENT (DJ STRIKE)**

**Project Proposal Work**

**On**

# "Autonomous Car using Computer Vision with Raspberry Pi"

**Academic Year: 2020-21**

**Group ID: 37**

**Group Members**

| Name | SAP ID | Department | Year |
|---|---|---|---|
| **1.** Jazib Dawre | 60004190054 | Computer | S.E |
| **2.** Ishita Kheria | 60004190048 | Computer | S.E |
| **3.** Jay Doshi | 60004190051 | Computer | S.E |
| **4.** Jay Jani | 60004190052 | Computer | S.E |
| **5.** Aditya Date | 60005180005 | Mechanical | T.E |
| **6.** Amey Parab | 60005180010 | Mechanical | T.E |

**BE Mentor: - Nishi Modi (BE EXTC II)**

**Faculty Guide: - Prof. (Ms.) Aarti G. Ambekar**

Plot No.U-15, J.V.P.D. Scheme, Bhakti Vedanta Swami Rd, Vile Parle(W), Mumbai, Maharashtra-400056

**Abstract:**

The automobile industry has been reshaping itself since decades with new innovations taking birth every now and then. However, with the industry's focus on making the upcoming technologies smarter, the type of advancements made in the auto sector have changed drastically. Along with the attempt to get the maximum output from cars, we equally research on making them smarter thus evolving them into artificially intelligent machines. In order to maximize safety and homogenous traffic control, both the public and industry's interest in autonomous cars has increased dramatically. Our aim of this project was to equip the team with hands-on experience on building an autonomous car born with self-driving capabilities. Most importantly, learning and understanding the workflow along with handling the challenges on the way to creating a fully functional autonomous car were the major takeaways from this project. Such concepts are being planned to be used in various other sectors too but we limit our project scope to commercial automobiles only. Although the project is based on a simple model, it serves as a prototype which tries to mimic the working of an actual autonomous car on the streets and its responses to constantly changing conditions in the environment the car runs in dealing with road tracking, traffic sign detection and collision avoidance.

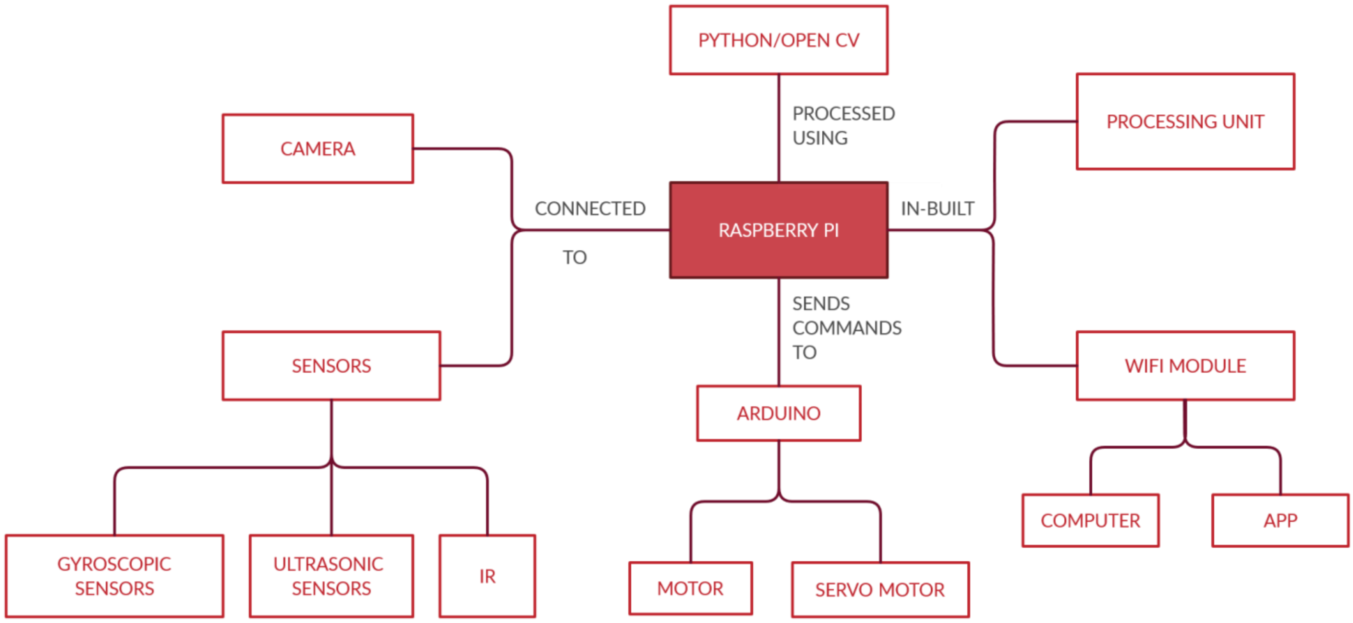
**KEYWORDS:**

- **Automation**
- **Artificial Intelligence**
- **Raspberry Pi**
- **Arduino**
- **Path following**
- **Obstacle detection**
- **Python**
- **App development**
- **Infrared vision**

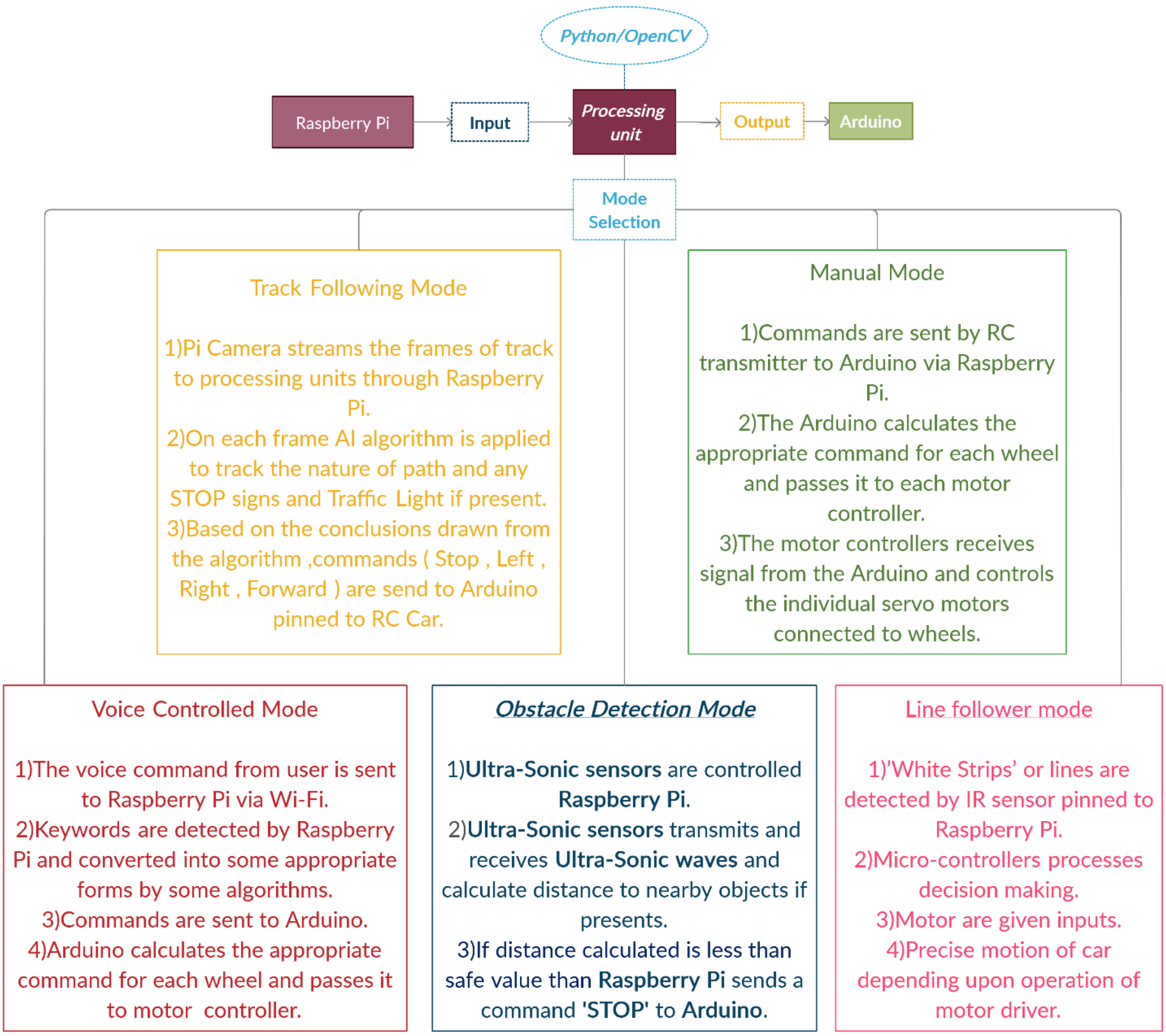
**MOTIVATION / SCOPE OF THE PROJECT:**

Autonomous cars are definitely the future of the automobile industry and it has tremendous opportunities for growth. Now a days, due to the inconvenience caused by public transportation, people prefer to use their private vehicles. Due to a high vehicle density on roads, traffic problems in major cities have been increasing day by day. To resolve the traffic problems, traffic rules are designed but people generally tend to disobey such traffic rules hence causing accidents and no wonder that maximum accidents occur due to human error. To avoid such kinds of incidents, employment of artificial intelligence seems to be the only way out. Thus, the overall scenario motivated us to develop a car powered by artificial intelligence which would contribute to a safer, more efficient and much needed transport solution in the coming future.

## SCHEMATIC / BLOCK DIAGRAM:




## METHODOLOGY:



## DESCRIPTION OF THE PROJECT:

### Planning:

Mode 1: Autonomous Mode

Step 1: The car takes a video stream from its front camera and passes it to the Raspberry Pi
Step 2: On each frame of the image, an AI algorithm detects the edges and curvature of the road and decides what direction should the car move in. In case of any detected signs, for e.g. the STOP sign, the algorithm follows the sign overriding commands from the AI
Step 3: Based on the final output the Raspberry Pi sends the command to the Arduino over a serial port

Mode 2: Voice Controlled Mode

Step 1: The user gives voice command from mobile app
Step 2: The command is received by the Raspberry Pi via Wi-Fi
Step 3: For each 'keyword' detected in the voice, an algorithm sends certain command from the Raspberry Pi to Arduino over a serial port

Mode 3: Line Follower Mode

Step 1: The IR sensors mounted at the front detects any 'white' strips on the road
Step 2: The Raspberry Pi uses the input from the sensors to determine the position of the white strip with respect to the IR sensors
Step 3: For each state (white strip is in middle/left/right), an algorithm sends certain command from the Raspberry Pi to Arduino over a serial port

Mode 4: Manual Mode

Step 1: The user gives commands via an RC transmitter
Step 2: The Raspberry Pi receives those command via a RC receiver and sends them to the Arduino via Serial

### Execution:

Step 1: The Arduino receives instructions from the Raspberry Pi and calculates the appropriate command for each wheel and passes it to each motor controller
Step 2: The Ultrasonic sensor at the front checks for any obstacles in the way
Step 3: If any obstacle is closer than a defined value, the Arduino will stop the car
Step 4: The motor controllers receive signal from the Arduino and control the individual servo motors connected to the wheels thus mobilizing the car

**WORK PLAN / TIMELINE CHART / GANTT CHART:**

| Month | Task to be completed |
|---|---|
| September | Preparing the project documentation |
| October | Work on AI testing and source components for hardware |
| November | Start building and prototyping the RC car base with Arduino and interface the Ultrasonic sensor and the IR sensors for Line Following Mode |
| December | Raspberry Pi and camera interfacing and processing of images for AI algorithms, remote connectivity via Wi-Fi and App |
| January | Integration of both systems, testing |
| February | Submission of the project and its technical paper. |

**BUDGET / Cost Breakdown:**

| Sr. No. | Components | Quantity (in units) | Amount (in Rs) |
|---|---|---|---|
| 1. | Raspberry Pi 4 Model B | 1 | 2685.00 |
| 2. | Arduino Uno | 1 | 300.00 |
| 3. | Ultrasonic Sensor | 3 | 192.00 |
| 4. | Raspberry Pi camera (5 MP) | 1 | 325.00 |
| 5. | L298 2A Dual Motor Driver Module | 2 | 400.00 |
| 6. | Electronic Speed Controller | 1 | 300.00 |
| 7. | Infrared Sensor | 2 | 90.00 |
| 8. | RF Transmitter/Receiver | 1 | 144.00 |
| 9. | Wires, Resistors, Inductors, Capacitors | As needed | 100.00 |
| 10. | 12V Centre Shaft DC Geared Motor | 4 | 500.00 |
| | Total | | 5036.00 |

**Hardware Explanation:**

The main computing system of this project is Raspberry Pi. Raspberry Pi is very powerful compared to its counterparts and its competitors .Our project includes object recognition, edge recognition and many other A.I stuffs. This all requires a great computing power for which Raspberry Pi was the only relevant micro-controller available in the market. This project also has an Arduino in it as it's easy to program . Arduino is responsible for the movement of car OR it acts as a driver of the car ,who just implements the order provided to it .Our project also consists of a bunch of sensors(ultrasonic sensor , infrared sensor) connected to Raspberry Pi which are essential for calculating the position and orientation of car with respect to its current surroundings. A camera is also attached to the Raspberry Pi for object/obstacle detection. Moreover, a RF transmitter/receiver is also attached to the car which is essential for controlling the car in its manual mode.

**Social Impact :**

The introduction of autonomous cars is getting people more and more interested in promoting transportation means which would allow them to travel wherever they need as fast as possible and while being harmless for the environment and not dangerous for the people. Truly, Artificial Intelligence is the key to achieve this as it will reduce the accidents and the journey time will also be reduced, since they know the best path as instructed by the GPS. It will also give the handicaps, a chance to get the feeling of the driver's seat since they do not need to drive it. Thus, a completely different society might emerge with confidence of moving freely anywhere without the fear of getting killed on the roads. It would also be cheaper along with saving the time spent in concentration on the wheel and instead can be used in doing the things we might like.

**Economic Impact:**

1. $1.3 trillion in annual savings to the Economy

2. $158 billion in annual fossil fuel cost savings.

3. $488 billion in annual road accidents cost reduction.

4. $138 billion in annual productivity savings from less congestion.

## SECOND REVIEW REPORT

### Introduction:

The first review briefly discussed various aspects like aim, methodologies, costing, social and economic impacts. A provisional timeline of the project was also decided. Further, the budget was broken into individual part costs. All the modes of the vehicle were elaborated and a rough working mechanism was provided. A visual representation of the circuit and block diagrams were also attached which try to explain the working and roles of the major components working together to produce the desired functioning.

However, the review falls short of displaying the actual working of the hardware and the results obtained after putting together the components and proving a provisional performance preview. It also missed the simulations which were planned to be held after finalizing the timeline and methodology. This second review aims to cover these points and give an update and the progress of the project till now.

### Implemented:

#### Line Follower Mode

The line follower mode operates using two Infrared sensors mounted on the front left and front right bumper of the car. These sensors follow the white central strip in the middle of the row by measuring the reflected light using the IR sensors which helps to localize the position of the car with respect to the central strip. When the car detects that the vehicle is crossing the central line that is it is going off course, the car uses a correction behavior by turning the car in the opposite direction of the rotation hence setting it back on the central path. This mode was implemented using an Arduino, IR sensors and LED’s as a placebo for the motors during the testing phase. The IR threshold was set according to the surface by trial and error. This mode is briefed ahead with screenshots and explanations for the different behaviors.

#### Manual Mode

The manual mode, as discussed earlier involves an infrared sensor and remote combination which makes the manual maneuver possible. The L293D Motor Driver is employed to have simultaneous control of 2 dc motors. Along with the conventional four direction movement ability, this mode also supports the speed control of the vehicle. Due to unavailability of the hardware, a digital prototype on Tinkercad was made to display the working. This mode is explained with simulation screenshots below.

#### Obstacle Avoidance Mode

As the name suggests, this mode deals with the vehicle moving on its own by judging the distance to the obstacle placed in front then making the turns and avoid it accordingly. Like manual, this mode was also made into a digital prototype on Tinkercad. In our project, the threshold distance was set to 50 cm below which the vehicle detects the obstacle and rotates the left motor in the opposite direction producing a left turn and essentially avoiding the obstacle. The obstacle detection was provided by an Ultrasonic sensor placed in between the two motors as shown above. Moreover, the serial monitor displays the distance to the obstacle placed in the way.

**Working Previews:**

## 1. Line Follower Mode

### A. Forward Motion

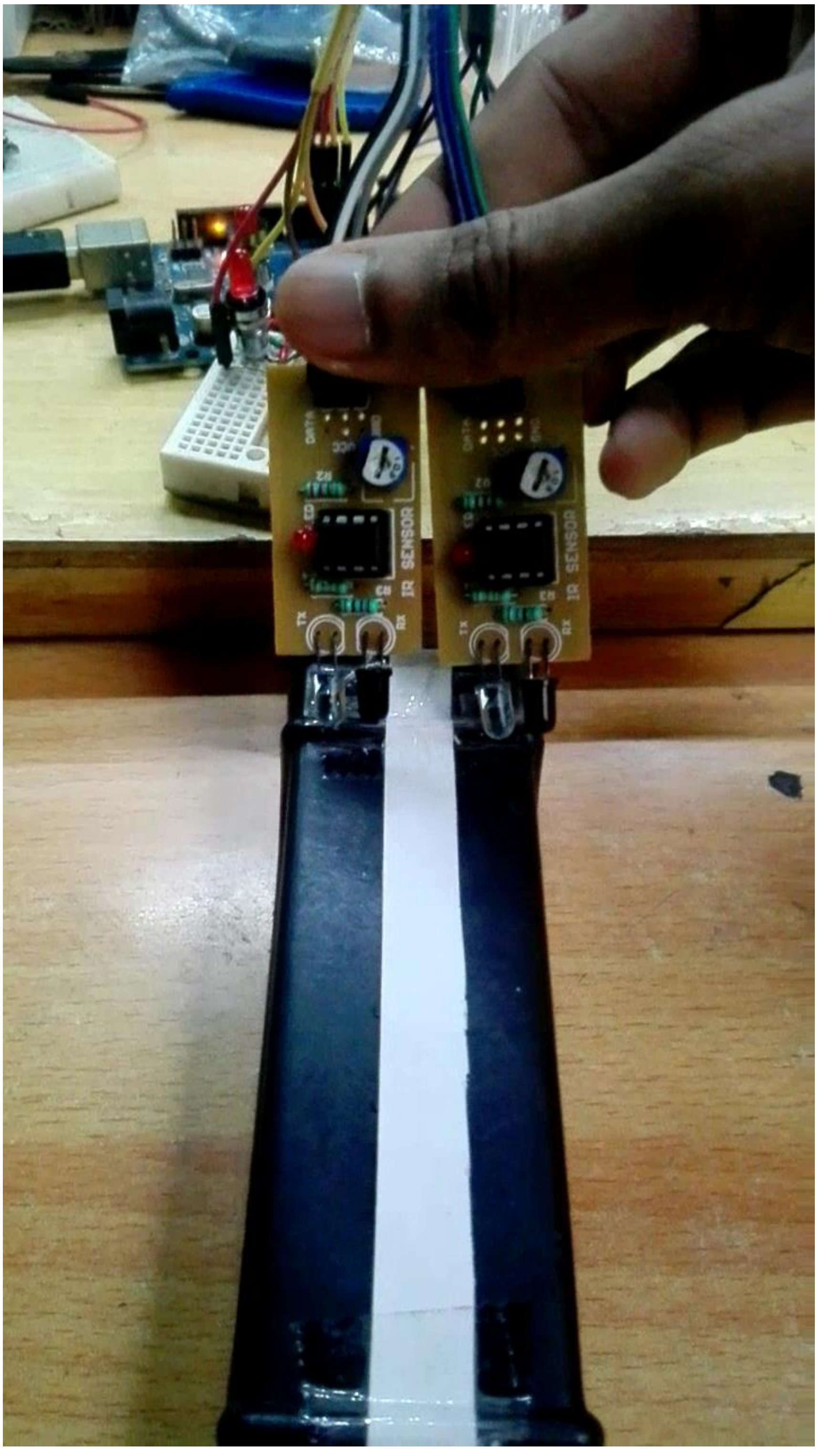



Fig 1.A Both sensors detect black

When both left and right sensor senses black, it signifies that the white line is in the middle of the sensors, hence then car moves forward.

### B. Right Turn

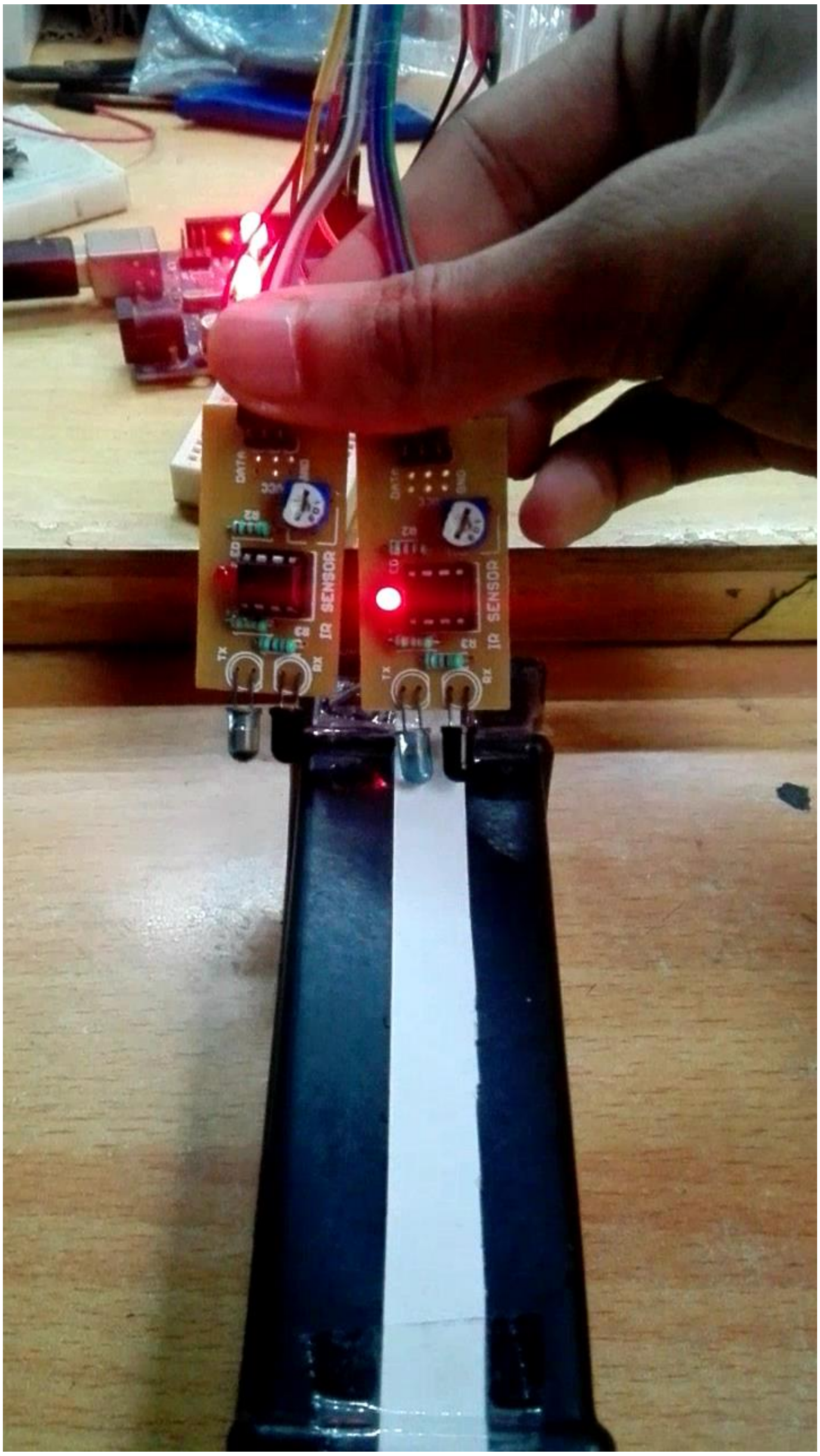



Fig 1.B Left sensor detects black and Right sensor detects white

When the left sensor detects black and right sensor detects white, it signifies that the right side of the car has crossed the center line that is the car is turning to the left, hence to correct the motion the car steers towards the right.

### C. Left Turn

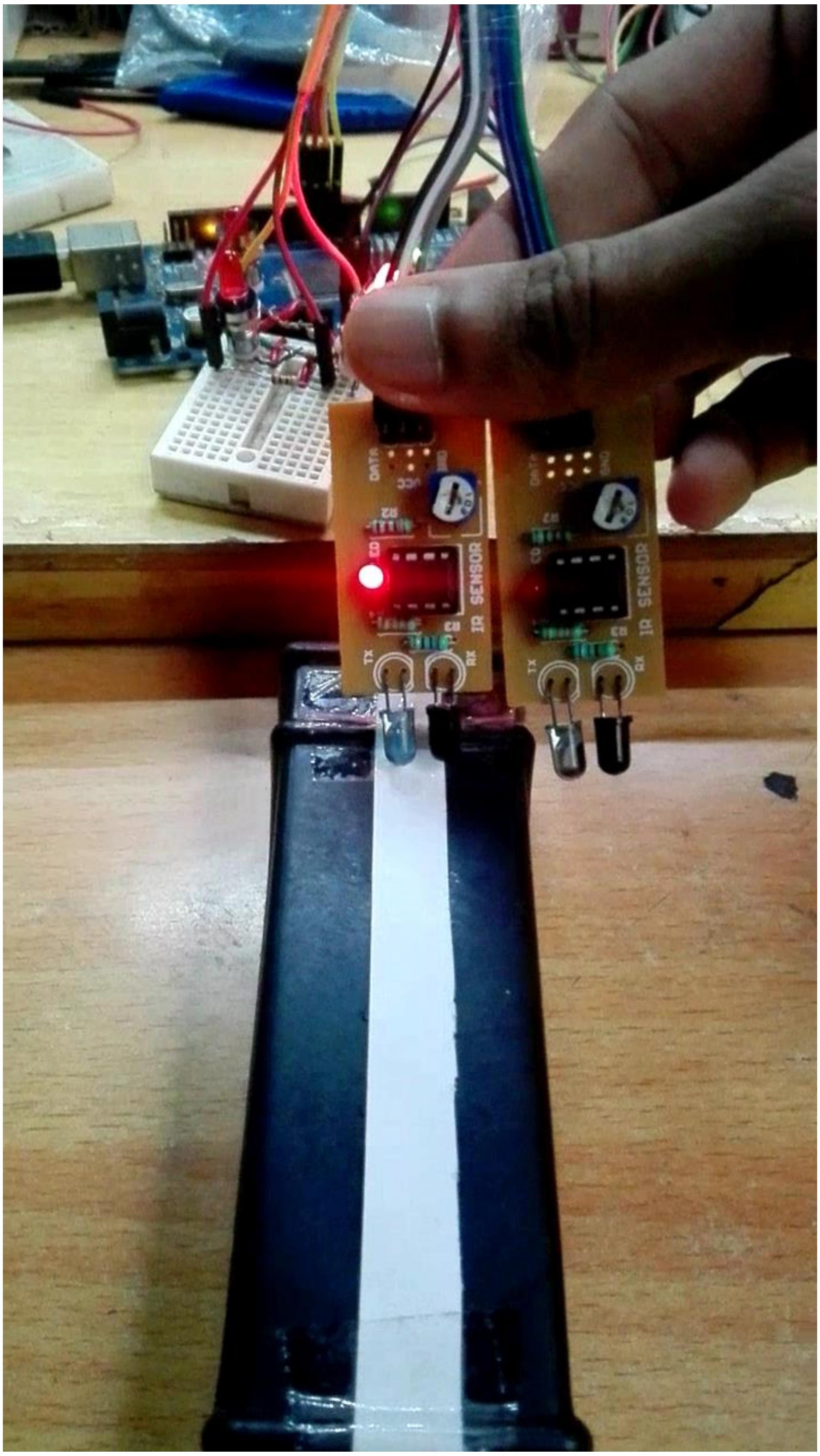


Fig 1.C Left sensor detects white and Right sensor detects black

When the left sensor detects white and right sensor detects black, it signifies that the left side of the car has crossed the center line that is the car is turning to the right, hence to correct the motion the car steers towards the left.

## 2. Manual Mode

### A. Forward and backward motion:

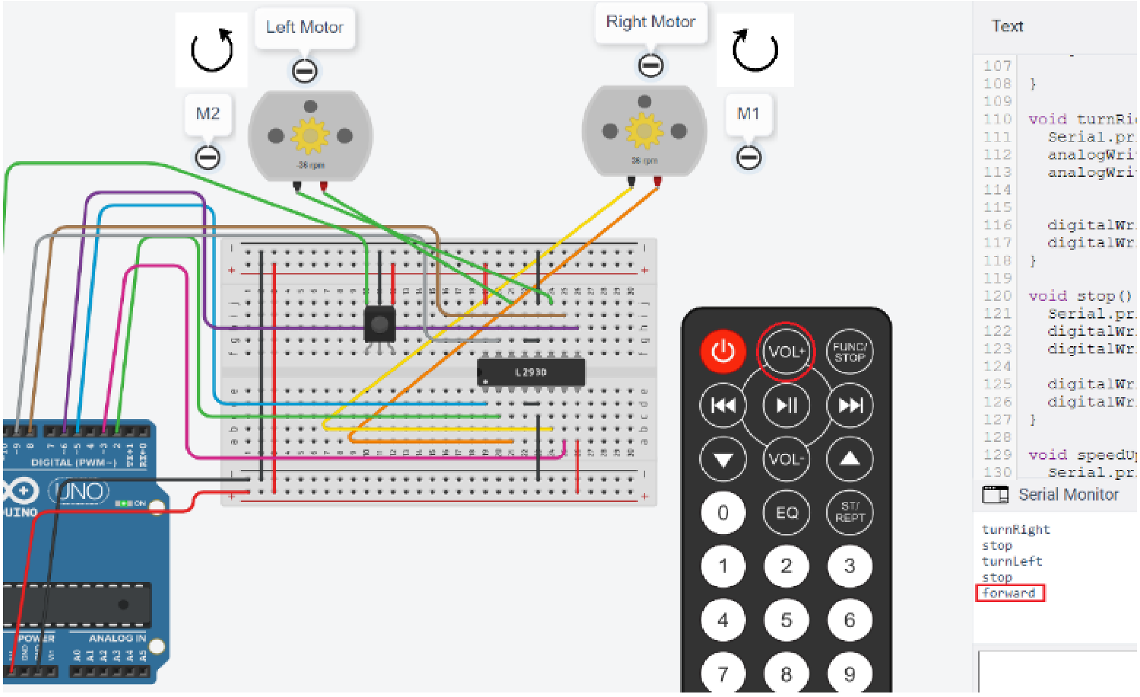



Fig 1.A.1 Forward Command

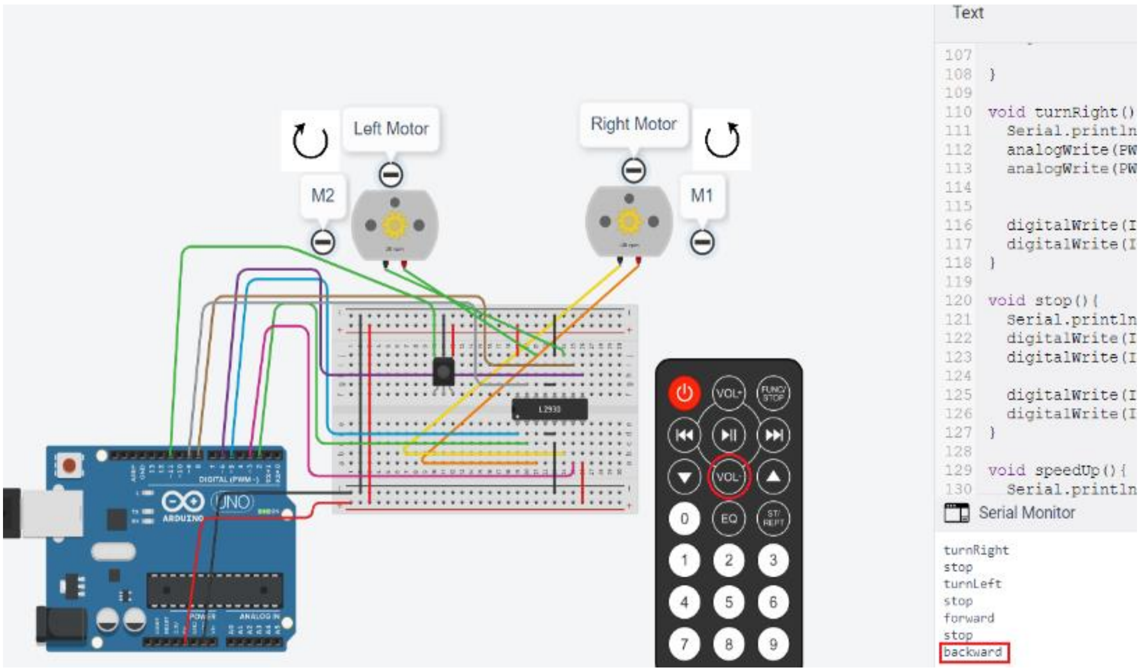



Fig 1.A.2 Reverse Command

The two motions are shown above. The Volume increase and decrease buttons were used to make the vehicle travel forward and backward respectively. The movement direction is also displayed in the serial monitor to the right. The direction of the motor rotation is also attached to understand the working easily.

## B. Left and right motion:

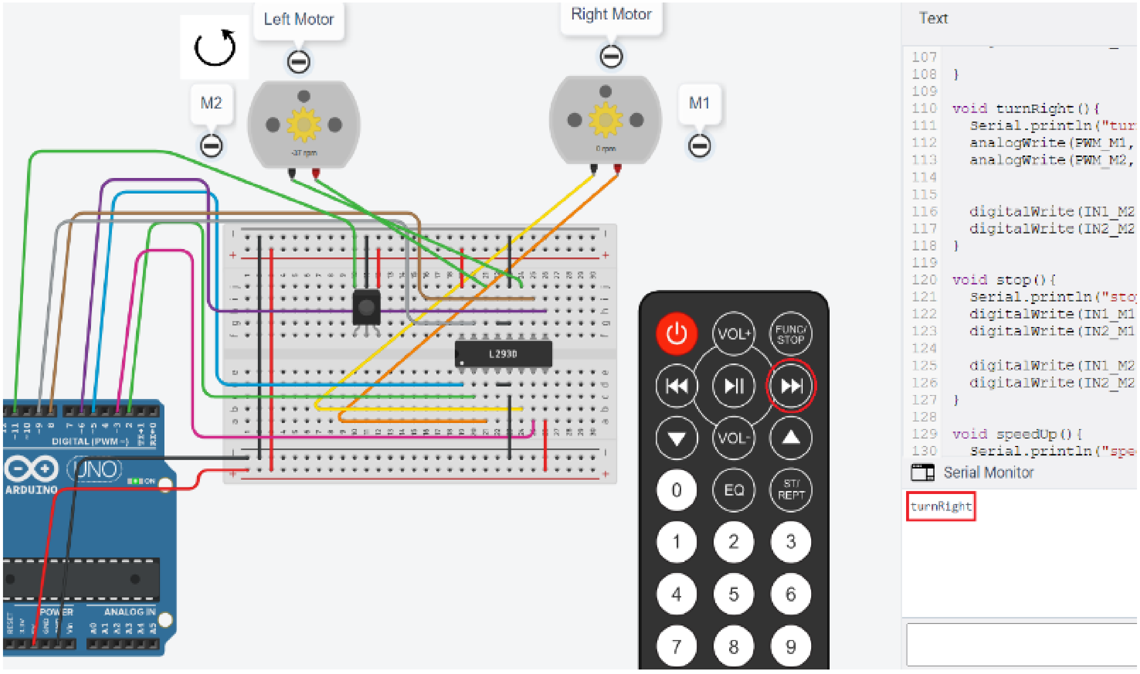



Fig 1.B.1 Right Turn Command

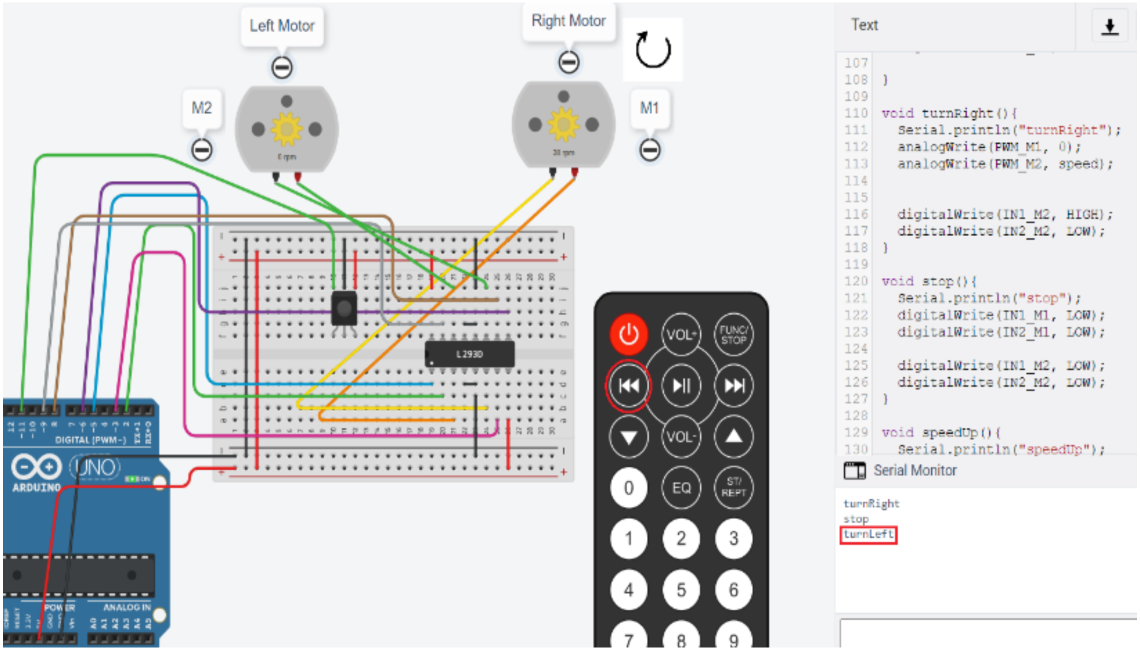



Fig 1.B.2 Left Turn Command

As the vehicle lacks a proper steering system, the power unit or the motors were also used for the turning motion. For example, to turn left, it can be observed in the left image that the left motor is stopped while the other rotates clockwise essentially creating an anticlockwise torque and turns the vehicle towards the left. Similarly, the same principle is used to turn the vehicle rightwards. In this, the next and previous buttons were used for the steering.

## C. Speed control:

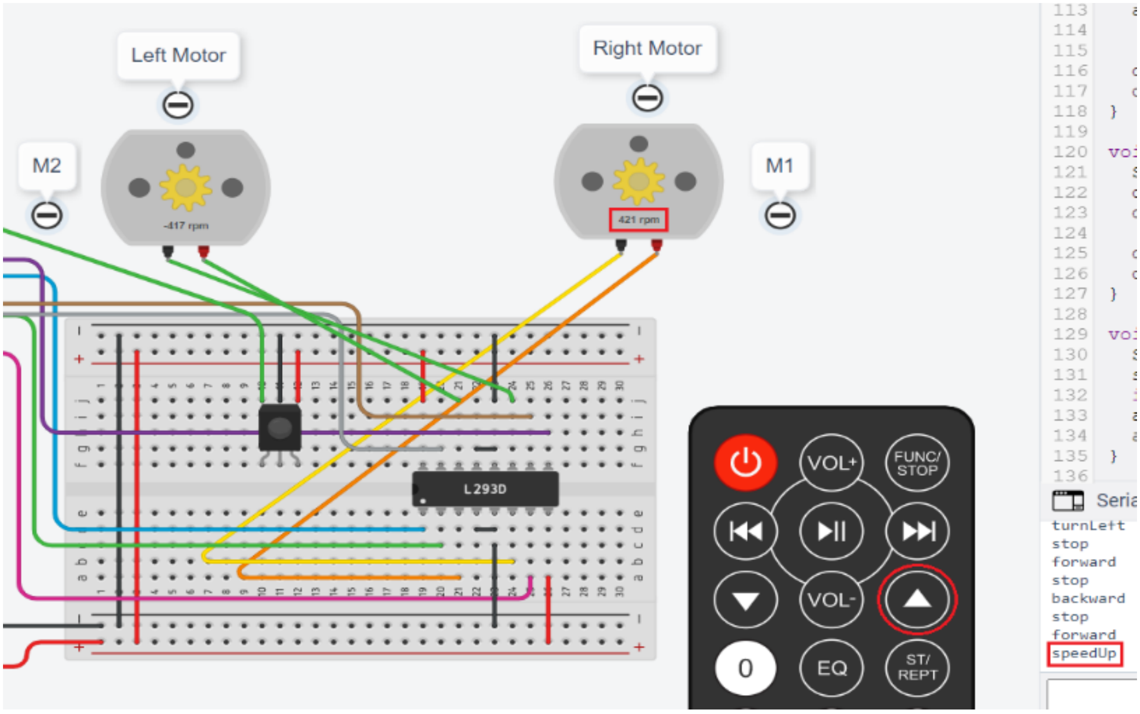



Fig 1.C.1 Speed Increase Command

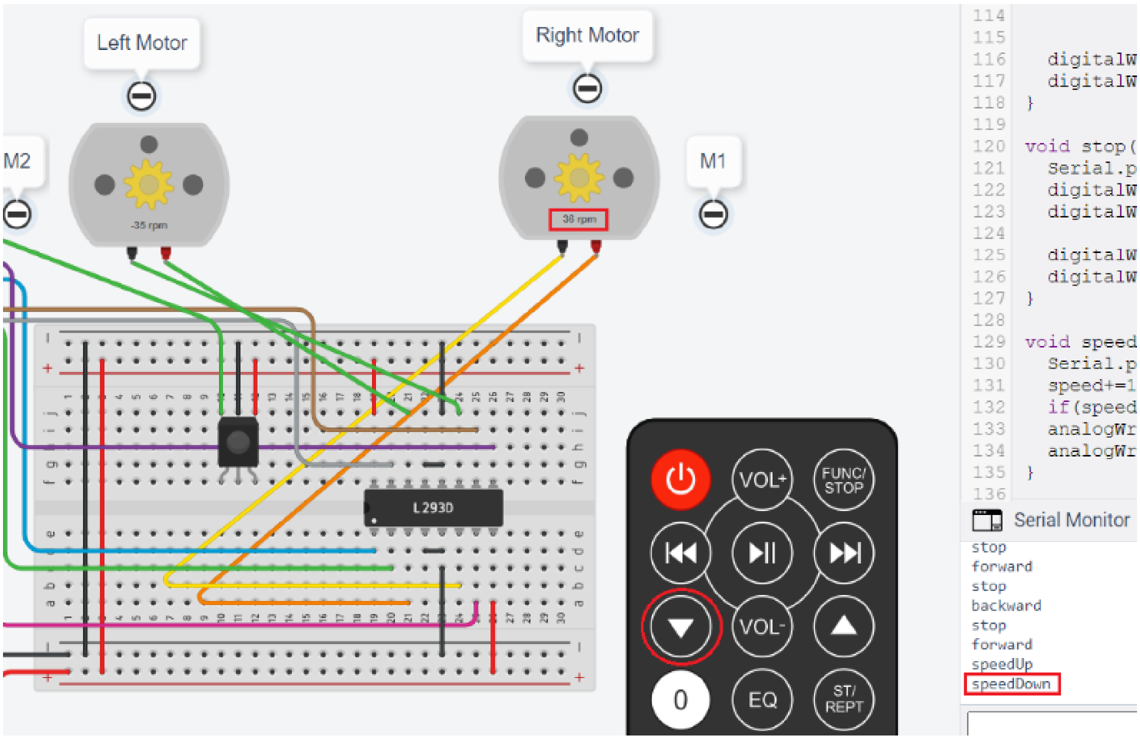



Fig 1.C.2 Speed Decrease Command

Every vehicle is incomplete if it lacks a speed control mechanism and so would ours. This functionality was made possible by Pulse Width Modulation which enables us to control the motor speed and thus the vehicle speed. It is noticed that the RPM of the motors change after the vertical up and down arrows are pressed. This is the last of the 3 major vehicle controls which the manual mode is equipped with.

### 3. Obstacle Avoidance Mode

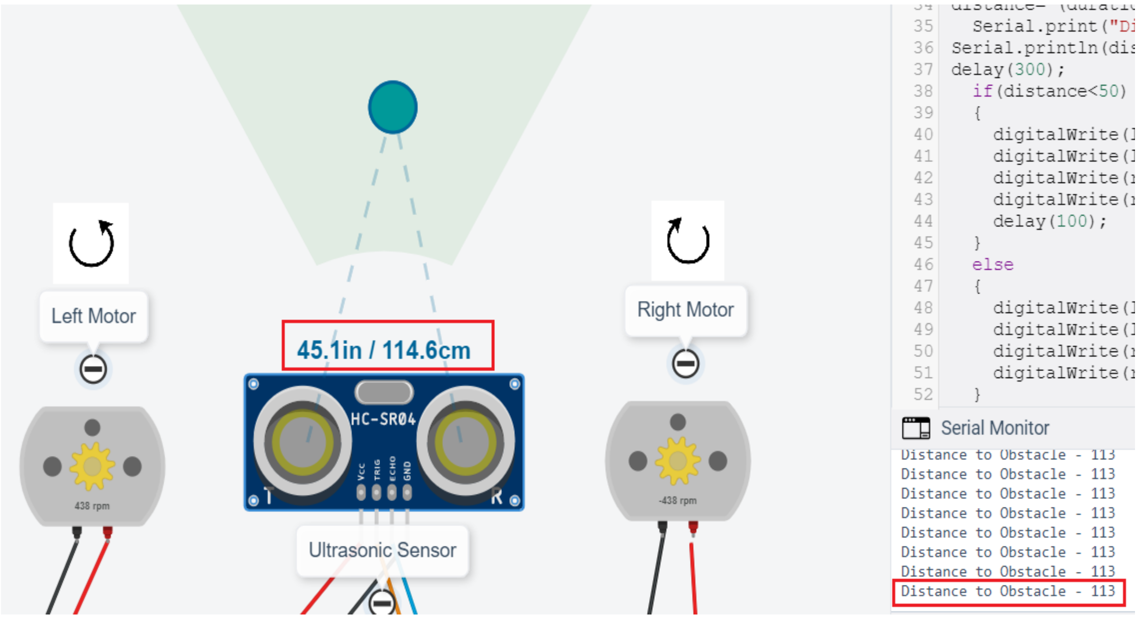



Fig 2.1 Obstacle farther away from sensor

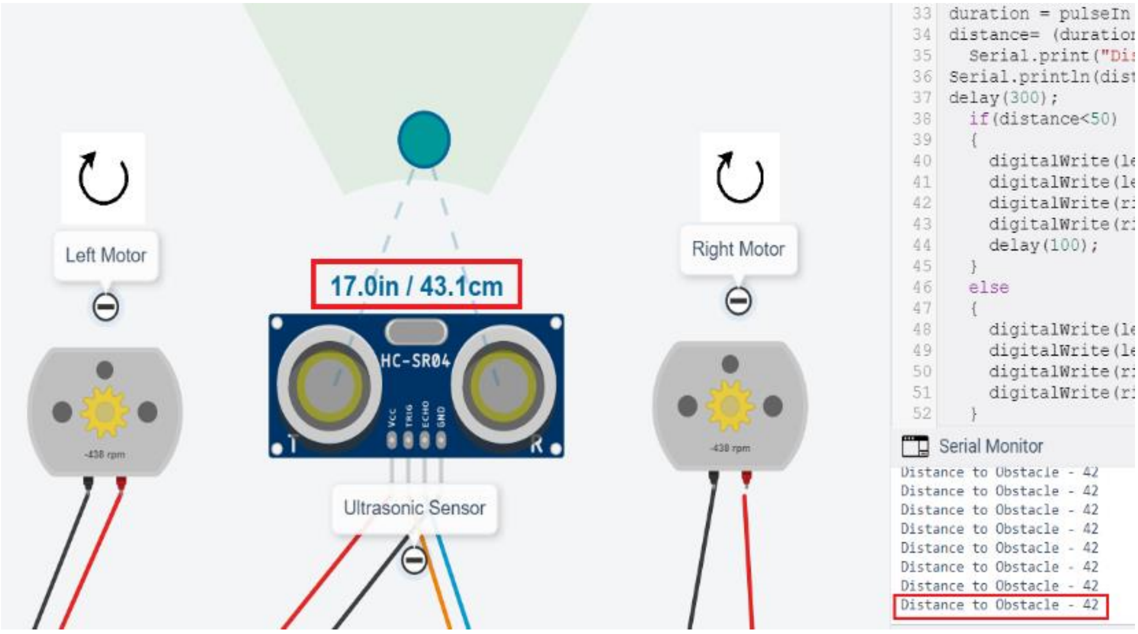



Fig 2.2 Obstacle closer to sensor

There's an Ultrasonic sensor placed in between the motors which is used for Obstacle Avoidance. When distance falls below 50cm it causes the car to stop going forward to avoid a crash. The car then steers towards the left until it finds an open path in the front, at which point it starts to move forward. The direction of turn was chosen as the left arbitrarily and can be switched to the right depending on the situational needs.

### Conclusion

We have thus implemented the Line following mode, Manual mode and the Obstacle avoidance mode either using hardware or in a simulation using tinkercad and have tested their operation against different scenarios and verified their resultant behaviors.

## REFERENCES:

[1] Pratibha I Golabhavi , B. P. Harish.,” Self-Driving Car Model using Raspberry Pi-Issue 2,” in International Journal Of Engineering Research & Technology, in volume 9 February 2020. [Online]. Available: https://www.ijert.org/self-driving-car-model-using-raspberry-pi

[2] Prof. Z.V. Thorat, Sujit Mahadik, Satyawan Mane, Saurabh Mohite, Aniket Udugade.,” Self Driving Car using Raspberry-Pi and Machine Learning-Issue 3,” in International Research Journal of Engineering and Technology, in volume 6 March 2019. [Online]. Available: https://www.irjet.net/archives/V6/i3/IRJET-V6I3178.pdf

[3] Sertap Kamçı, Dogukan Aksu*, Muhammed Ali Aydin,” Lane Detection for Prototype Autonomous Vehicle,” Computer Engineering Department, Istanbul University-Cerrahpasa, Istanbul, Turkey, Rep. FBA-2019-33004.

[4] Tiple Anjali Hemant, Tiple Hemant P, Gurav Sagar Hanumant.,” Prototype of Autonomous Car Using Raspberry Pi-Issue 4,” in International Journal of Engineering Research in Electronics and Communication Engineering, in volume 5 April 2018. [Online]. Available: https://www.technoarete.org/common_abstract/pdf/IJERECE/v5/i4/Ext_56874.pdf

[5] K.N.V.Satyanarayana, B.Tapasvi, P.KanakaRaju, G.RameshBabu.,”Implementation Of Artificial Intelligence for Autonomous Cars-Issue 12,” in International Journal of Engineering Research and Application, in volume 7 December 2017. [Online]. Available: https://www.ijera.com/papers/Vol7_issue12/Part-5/L0712057682.pdf