A Project Report on

Self Driving Car - Path Control

By

Mr. Purvang M Shah
(B150390933)

Mr. Arbaaz Khan
(B150390871)

Mr. Soham Patil
(B150390911)

Ms. Shivani Sahane
(B150390928)

Guided by

Dr. Dinesh N Kamble

Department of Mechanical Engineering

BRACT's
Vishwakarma Institute of Information Technology, Pune

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BRACT's
Vishwakarma Institute of Information Technology, Pune

C E R T I F I C A T E

This is to certify that ***ENTER NAME HERE*** has successfully completed the Project work entitled **“Self Driving Car - Path Control”** under my supervision, in the partial fulfilment of Bachelor of Engineering - Mechanical Engineering, by Savitribai Phule Pune University.

Date:

Place:

Guide: Dr. Dinesh N Kamble | External Examiner

Head of the Department | Principal
Prof. (Dr.) Ashok R Mache | VIIT, Pune

Seal

1. ACKNOWLEDGEMENT

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We are highly grateful to **Dr. B S Karkare (Principal)**, all the staff members of Mechanical Engineering Department and to all those who directly or indirectly helped us in the successful completion of this dissertation.

We would also like to thank **Dr. A D Kale** for his expert advice and helping us in the calculations of our project. Also for guiding us towards a mathematically correct project.

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5. Nomenclature

- **Autonomous drive-** A self-driving car, also known as an autonomous vehicle is a vehicle that is capable of sensing its environment and moving safely with little or no human input.
- **L 298 H bridge-** L298 is a high power version of L293 motor driver IC. It is a high voltage, high current, dual full-bridge driver designed to accept standard TTL logic levels (Control Logic) and drive inductive loads
- **Arduino circuit-** Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online.
- **Raspberry Pi-** The Raspberry Pi is a low cost, credit-card sized computer that plugs into a computer monitor or TV, and uses a standard keyboard and mouse. It is a capable little device that enables people of all ages to explore computing, and to learn how to program in languages like Scratch and Python.

6. ABSTRACT

Self-driving cars are a result of an integrated system of machine hardware and software developed to make vehicles smart and independent in their approach. Primary motive of such systems is safety. Pillars for such technology are sensors, radar and computer vision. The research targets to achieve stage 1 automation by driving a car over a controlled path without any human intervention on a mechanical output through integrating microcontrollers and servomotor as a prime mover to deliver an output. In the modern era, the vehicles are focused to be automated to give human driver relaxed driving. In the field of automobile various aspects have been considered which makes a vehicle automated. Google, the biggest network has started working on the self-driving cars since 2010 and still developing new changes to give a whole new level to the automated vehicles. In this paper we have focused on two applications of an automated car, one in which two vehicles have same destination and one knows the route, where other don't. The following vehicle will follow the target (i.e. Front) vehicle automatically. The other application is automated driving during the heavy traffic jam, hence relaxing driver from continuously pushing brake, accelerator or clutch. The idea described in this paper has been taken from the Google car, defining the one aspect here under consideration is making the destination dynamic. This can be done by a vehicle automatically following the destination of another vehicle.

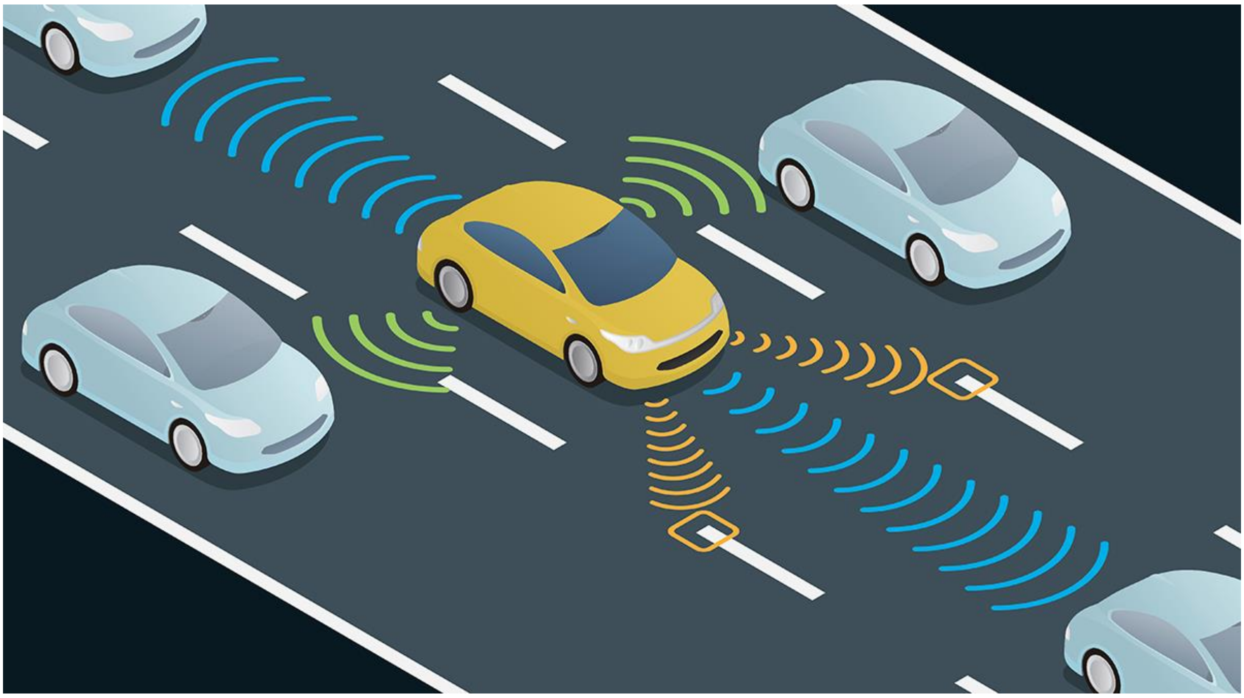


Fig 6.1

7. Introduction:

Problem Statement:

To design a car (bot) on the basis of all the exterior factors and physical parameters like weight, force and coefficient of friction, which will follow a self driving principle accompanied with path control (change in direction, variation of speed and stop go motion) with the help of simulation and an unison between mechanical and electronic factors.

7.1 Objectives:

- We as mechanical engineers wanted to combine the theoretical knowledge of automobiles, vehicle design with computer-vision and electronics to create a self-driving, real-time feedback car with endless possibilities.

- The primary objective was to create and train a vehicle self-sufficient enough to avoid all obstacles like other vehicles and pedestrians as well as be aware of its environments like the road terrain and signals and adapt itself to the ever-changing surroundings.

- Also to include all the digital features like indications while turning and stopping, make a self sufficient driving protocol which will help the car to travel on every terrain and can be scaled up to an actual sized car.

Fig 7.1

7.2 Scope:

The scope of this project is to achieve autonomity of the self driving car with lane detection, path control and obstacle (pedestrain) detection on a small scale model which can be scaled to an actual size in the coming future.

7.3 Methodology:

The project involves building a self driving car model which include building chassis, selection of component, use of hardware and software like raspberry pi, OpenCV etc ,

Chassis for self driving car model is build using SOLIDWORKS. Various parameters are considered while developing CAD model for chassis Eg: placement of battery, motors, ardunio board, wire connections etc.

Lane line detection takes place using OpenCV. Human can easily identify the lanes on the road, and we do the steering based on that. But to do this with machines, it’s a difficult task and that’s when computer vision comes in. We build complex computer vision algorithms in order to teach machines to identify the lane lines. Approach here is to build a sequence of functions in order to detect lane lines using OpenCV4.

I. Image capturing

i. Loading the image and converting it into grayscale.

The reason why we have to convert this image to grayscale is that Processing single channel is much faster than 3 channel RGB and is less computational intense. A colorful image would have 3 channels, Red, Green, and Blue. But that in Gray Scale would have the intensity for just one color ranging from 0 to 255.

Image Frame

Fig 7.2

ii. Reduce Noise and Smoothen Image

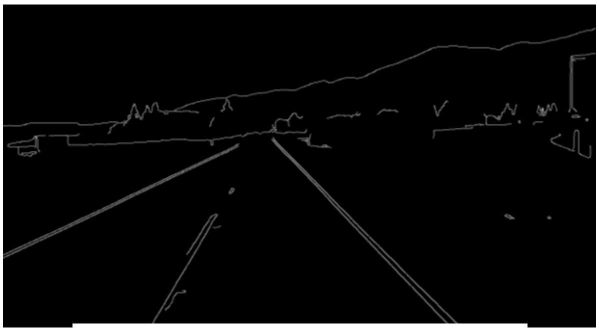
Noise can be removed by blurring it. Image Noise creates false edges and can ultimately affect edge detection which is a very crucial step in lane line detection.

Gaussian Blur of Kernel 5X5

Fig 7.3

iii. Canny Edge Detection:

Canny Edge detection is one of the widely used Edge Detection Algorithm. The image is first scanned in both horizontal and vertical direction to find a gradient for each of the pixel. After getting gradient magnitude and direction, a full scan of an image is done to remove any unwanted pixels which may not constitute the edge.



Canny Edge Detection Image

Fig 7.4

iv. Region of interest:

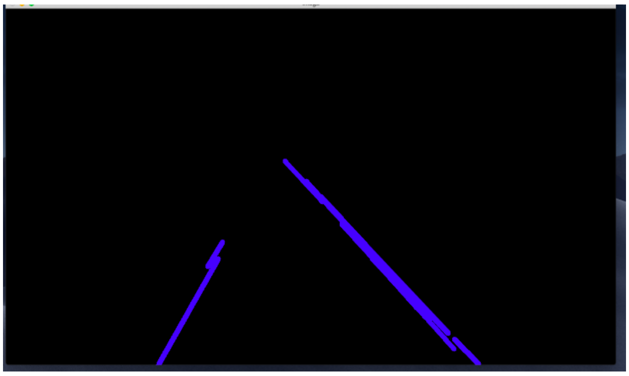
Region of interest

Fig 7.5

The area inside this red triangle is the region of our interest. We then find coordinates of these points to define our region of interest.

v. Line Detection:

The Hough space for lines has two dimensions θ and r, and a line is represented by a single point.



Lines Generated

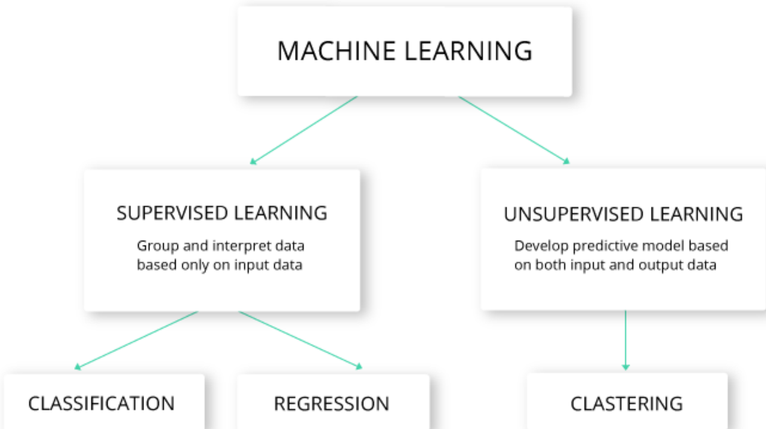
Lines displayed on top of image.

Fig 7.6

Finally, we combined the lane image with our zero-intensity image to show lane lines.

vi. Machine Learning

Machine learning is a subset of artificial intelligence. It focuses on improving how a machine performs some task. Here's the most important part: learning means that the machine goes beyond the training data. In other words, where traditional programming fails, machine learning and artificial intelligence can succeed.



Deep learning is subset of machine learning. It is a class of machine learning that focuses on computer learning from real-world data using feature learning. Thanks to deep learning, a car can turn raw complex data into actionable information.

Applications of machine learning in self-driving cars include:

- localization in space and mapping
- sensor fusion and scene comprehension
- navigation and movement planning
- evaluation of a driver's state and recognition of a driver's behavior patterns

Machine Learning Algorithms for Autonomous Cars

- Regression Algorithms
- Pattern Recognition Algorithms (Classification)
- Cluster Algorithms
- Decision Matrix Algorithms

vii. The Four Sub-Tasks:

- Object detection
- Object identification/recognition
- Object localization
- Movement prediction.

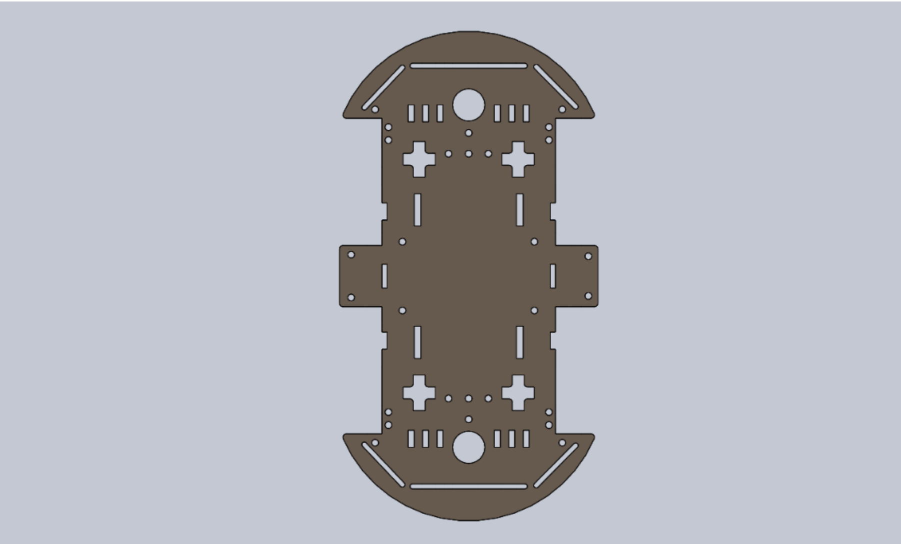
viii. CAD model of chassis:

Design criteria for developing chassis:

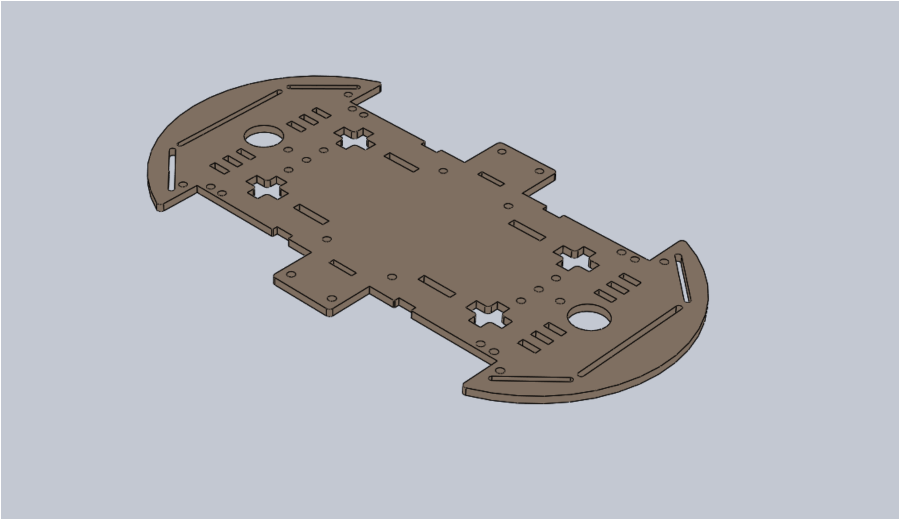
1. Light in weight.
2. Placement of electronic components like ardunio board, L298 H bridge, motors, etc
3. The size of the chassis should be ideal.
4. Ease of manufacturing.
5. Aesthetics of the car.

One of the fundamental stages of chassis design was the placement of various electric components keeping the size of the chassis ideal. Various wire connections are going in out from arduino board to a battery, H bridge to motors. The material selected for chassis is processed Acrylic sheet due to the following reasons:

1. Light in weight
2. 30X stronger than glass
3. Less expensive
4. Easier to work with.



Top view of chassis



Isometric view of chassis

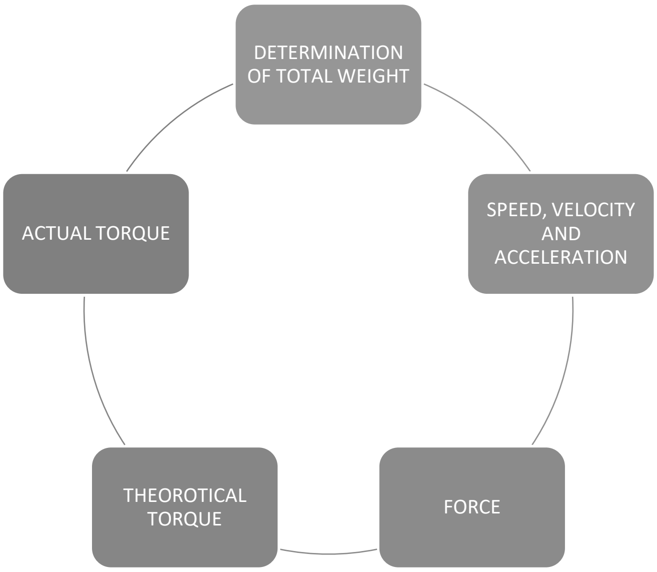
Fig 7.7

Two sheets of acrylic placed one above each other, separated by 10cm distance. This way we achieved light weight and ideal size of the chassis .The Bottom sheet supported H-bridge, motors, Battery and connection pine. The top sheet supported the ardunio board, camera connections. Slots are provided on the acrylic sheet for in and out of connecting pins, holding the sheets with help of circular rods.

Fig 7.8

Chassis assembly

II. Initial calculations:



Calculations for Motor Selection: -

Q] Determine the torque required for a car of mass 2kg which can run at a target speed of 1km/hr i.e. covers 1km distance in 1 hour. Car will have a wheel diameter of 6cm.

{Assumption: the car target speed of 1km/hr is assumed which is more than sufficient for the project}

Step 1: Determination of total car weight: -

(All weights in grams)

1. Transparent chassis: 250*2 = 500
2. H-Bridge: 40*2 =80
3. Motor + wheel: 60*4 =240
4. Arduino UNO + Raspberry Pi: 120
5. 8 cells: 30*8 = 240
6. Cell Case: 60
7. Camera case with camera: 10
8. Power bank: 700
9. Miscellaneous: 20

Total Weight: 1970 g …….can be approximated as 2000 g or 2 kg.

Step 2: Speed and Velocity Calculations: -

Diameter of car wheel = 6cm =$6*10^{-5}$ km

Perimeter of car wheel = pi*D = $18.84*10^{-5}$ km

(Perimeter is the distance covered by the wheel in I revolution)

So, for covering 1 km distance how many revolutions will be required?

N = $1/18,84*10^{-5}$

= 5308 revolutions per hour (rph)

&

N = 5308/60 = 88.47 revolutions per minute (rpm)

Thus, for covering a distance of 1 km 88.47 revolutions per minute are required.

Step 2: Alternate method to determine speed (N): -

N = Total distance travelled per hour/ linear distance

= 1000 (m/hr)/18.849 (km)

= 1000/0.18849*60 rpm

= 88.422 rpm

Both the N values from 2 methods are equal and thus we can proceed further with the velocity calculations: -

Now, Velocity, V = pi*D*N/60

=pi*0.06*88.47/60

=0.2779 m/s

V =1000.459 m/hr or 1km/hr

Thus, our initial assumption of velocity is correct.

Step 3: Power Calculations

Power, P =

{[(mass) *(acceleration due to gravity)*(velocity)*(coefficient of rolling resistance)] +

[(air density) *(coefficient of drag) *(Area of vehicle) *(velocity)^3]}

The power P, is the input power in W and 1 W = 1 N.m/s

Thus, for formula validation the units have to be taken into due consideration,

P = {[(kg) *(m/s^2) *(m/s)] +[(kg/m^3) *(m^2) *(m^3/s^3)]}

Note: 1 N =1 kg.m/s^2

P ={N.m/s} +{(kg.m/*s^2).(m/s)}

P = {N.m/s} +{N.m/s}

Or P will be in the units of Watt, thus the formula is correct.

Coefficient of rolling resistance selection:

Tread Material	Floor Material	Coefficient of rolling friction
Forged Steel	Steel	0.019
Cast Iron	Steel	0.021
Hard Rubber	Steel	0.303
Polyurethane	Steel	0.030 to0.057
Cast Nylon	Steel	0.027
Phenolic	Steel	0.026

Table 7.1

To help quantify rolling resistance in industrial wheels, there is the coefficient of rolling friction or resistance. This is a number that has been empirically designed for different materials, and can be vary by the speed of the wheel, the load on the wheels and the material the wheel is contacting. In the chart above it is not surprizing that the softest tread material(rubber) has the highest coefficient of rolling resistance while the hardest material (forged) steel has the lowest rolling resistance.

Air Density:

The ISA or International Standard of Atmosphere states the density of air is 1.225 kg/m^3 at sea level and 15-degree C. the IUPAC uses an air density of 1.2754 kg/m^3 at 0 degree C and 100kPa for dry air. Density is affected not only by temperature and pressure but also by the amount of water vapour in the air.

Thus, for the climatic conditions in Pune a value of air density as 1.30 is safe and practical for use.

Coefficient of Drag:

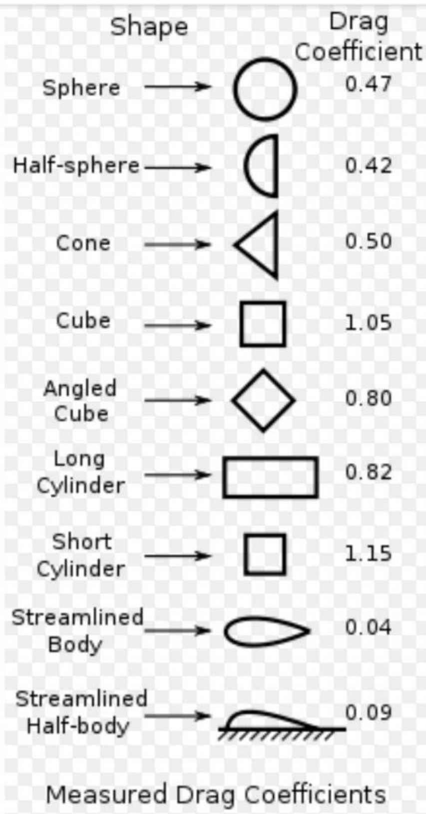


Table 7.2

The various coefficient of drag values for different shapes is shown in the figure above.

Assuming our bot is a long cylinder the drag coefficient of 0.82 is safe to assume.

$P = [2 *9.81 *0.278 *0.0303] +[1.30 *0.82 *(0.26924 *0.127) *0.02148]$

$P = 0.1652 + 5.51 *10^{-4}$ W

$P = 0.165751$ W

Generally, a motor has efficiencies ranging from 80% to 90%. Thus, taking motor efficiency as 85% for calculation purpose

P_{out} = Efficiency $*P_{in}$

Note: $P_{out} = T *w$

Where, T = Torque Required

w = Angular velocity = 2*pi*N/60

w = 9.2645 rad/s

So, T*9.2645 = 0.85*0.165751

T = 0.0152073 N.m

Or T = 15.2073 N.mm………………………………..1

This is the minimum torque required to be generated by motor to move a 2kg car by a velocity of 1km/hr.

Motor having a stall torque of 771 g.cm was selected

T_s = 771 g.cm

Continuous rated torque is the continuous torque generated as an output by motor at rated speed, which is close to the maximum speed of the motor. The motor performance can be judged in a better manner as it is the motor’s torque at speed.

Continuous stall torque is the continuous torque of the motor at 0 speed (at stall). This is the locked rotor torque. Manufacturers test this by locking the rotor and then monitoring the motor temperature as current is powered into the motor.

Magnetic losses and thermal losses of the motor are considered and taken into account by the rated torque. At 0 speed, these losses are 0 and thus the stall torque is higher than the rated torque.

Peak toque is the maximum output toque generated by the motor and stall torque can be taken as 3.1 times the peak torque.

$T_s = 3.1*T_{peak}$

Therefore, T_{peak} =75.6351/3.1

T_{peak} =24.3984 N.mm……………………………………..2

As the value of motor generated torque is greater than the minimum torque required to move the vehicle, the motor selection is valid. (2 >1)

This concludes the motor selection calculations.

III. Components:

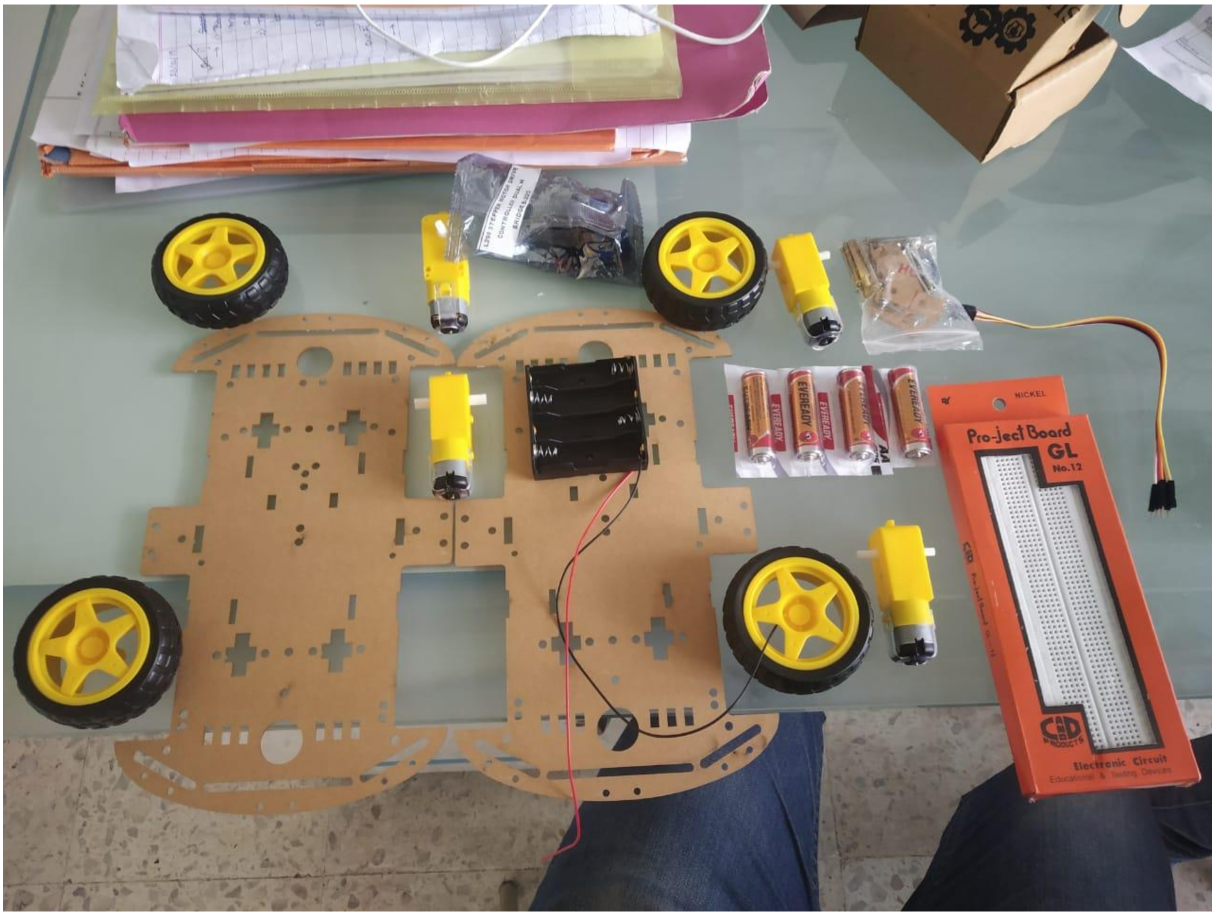


Fig 7.9

As observed in the diagram of the setup the car is a mixture of electronic and mechanical components. This is a nexus between both the fields which work in unison to produce an autonomous nature of the car. The components are mentioned in the list given below

- Car chassis
- L298 H Bridge
- 1000 mAh battery power bank or PP3 (9 Volt battery)
- Raspberry Pi 3B+ with case
- RaspiCam 2 Camera 8 MP
- Arduino UNO
- USB cables and jump wires

- USB micro cable
- 16 GB SD card
- Miscellaneous items like I555 timer, LEDs, Breadboard, DMM, Solder.

1. Chasis: The car chasis was designed on AutoCad and with the help of manufacturing processes the chasis was produced out of a compound made of plastic infused with glass. Several holes and gaps were allowed on thr chasis which will facilitate the provision to pass several electronic components and wires through them. Two chasis having the same design were produced and the electronic components will be trapped between both of them.The lower chasis will be then connected to the wheels and motors. These motors are connected to the MASTER-SLAVE circuit which controls the entire motion of the car.

Fig 7.10

2. **Power Source**: The initial power source is given with the help of power bank or AA+ cells which are fitted inside the chasis and is connected to both Arduino and raspberry pi boards. The power source is also needed to be given to the motors of the wheels.

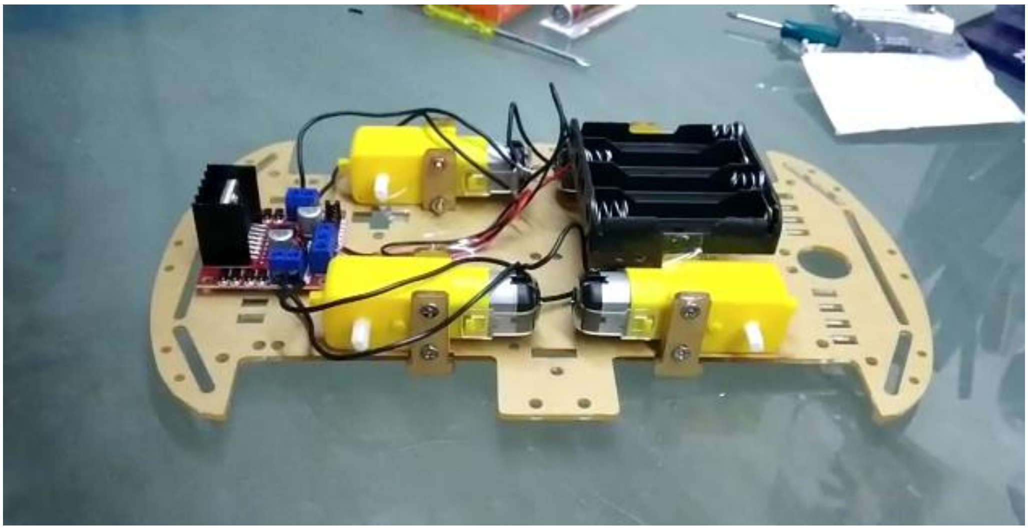


Fig 7.11

3. **RaspiCam 2 Camera 8 MP**: The **Pi camera module** is a portable light weight camera that supports Raspberry Pi. It communicates with Pi using the MIPI camera serial interface protocol. It is normally used in image processing, machine learning or in surveillance projects. It is commonly used in surveillance drones since the payload of camera is very less. Apart from these modules Pi can also use normal USB webcams that are used along with computer.For the digital data capturing and entry into the raspberry pi board, a raspi cam is used which is compatible to the board. This is a 8 MP camera and is fitted inside a cover and is connected to the board with help of jumping wires.

The image of the **camera** is given below,

Fig 7.12

The **pin configuration** of the camera is given below,

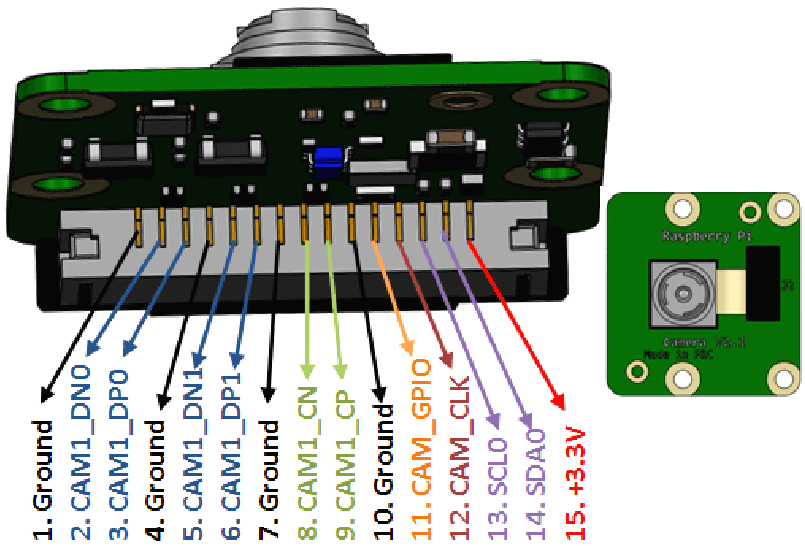


Fig 7.13

4. **L298 H Bridge**: The L298 H bridge is used for voltage controlling purpose. The information of the bridge is given below. This is used a s avoltage limiter.

L298N Motor Driver IC

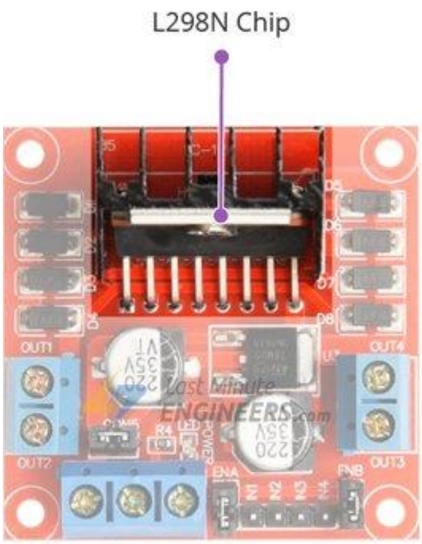


Fig 7.14

5. **Raspberry Pi**: For this project we have used a Raspberry Pi 3B+ which will act as a "MASTER" in the master slave circuit. The function of the raspberry pi is to connect the outer atmosphere and establish a connection between the outer world and circuit. For the purpose of collecting the digital data a camera is used compatible to the raspberry pi circuit. The programming is done on the suitable interface and is then uploaded on the board which will then control the arduino and then eventually the car.

Fig 7.15

The specification of the board used are as following,

The Raspberry Pi 3 Model B+ is the final revision in the Raspberry Pi 3 range.

- Broadcom BCM2837B0, Cortex-A53 (ARMv8) 64-bit SoC @ 1.4GHz
- 1GB LPDDR2 SDRAM
- 2.4GHz and 5GHz IEEE 802.11.b/g/n/ac wireless LAN, Bluetooth 4.2, BLE
- Gigabit Ethernet over USB 2.0 (maximum throughput 300 Mbps)
- Extended 40-pin GPIO header
- Full-size HDMI
- 4 USB 2.0 ports
- CSI camera port for connecting a Raspberry Pi camera
- DSI display port for connecting a Raspberry Pi touchscreen display
- 4-pole stereo output and composite video port
- Micro SD port for loading your operating system and storing data
- 5V/2.5A DC power input
- Power-over-Ethernet (PoE) support (requires separate PoE HAT)

6. **Arduino circuit**: **Arduino Uno** is a microcontroller board based on 8-bit ATmega328P microcontroller. Along with ATmega328P, it consists other components such as crystal oscillator, serial communication, voltage regulator, etc. to support the microcontroller. Arduino Uno has 14 digital input/output pins (out of which 6 can be used as PWM outputs), 6 analog input pins, a USB connection, A Power barrel jack, an ICSP header and a reset button.This is the “SLAVE” component in the circuit and is connected to the raspberry pi board on one side and to the motors on the other. It is given power through a power source in the form of cells or a power bank. This will control the turning of the wheels and also the speed control will be done with the help of the Arduino circuit. The turning of the car and the speed of the car will be done with the help of PWM pin on the circuit. Also the circuit is connected to a voltage limiter so that the excess voltage will not damage the motors. For this project an Arduino UNO board is used, the image of which is shown below.

Fig 7.16

As seen in the image the board is very compact and very handy to use, so that it will easily fit in between the chasis.
The pin diagram of the arduino uno is given below.

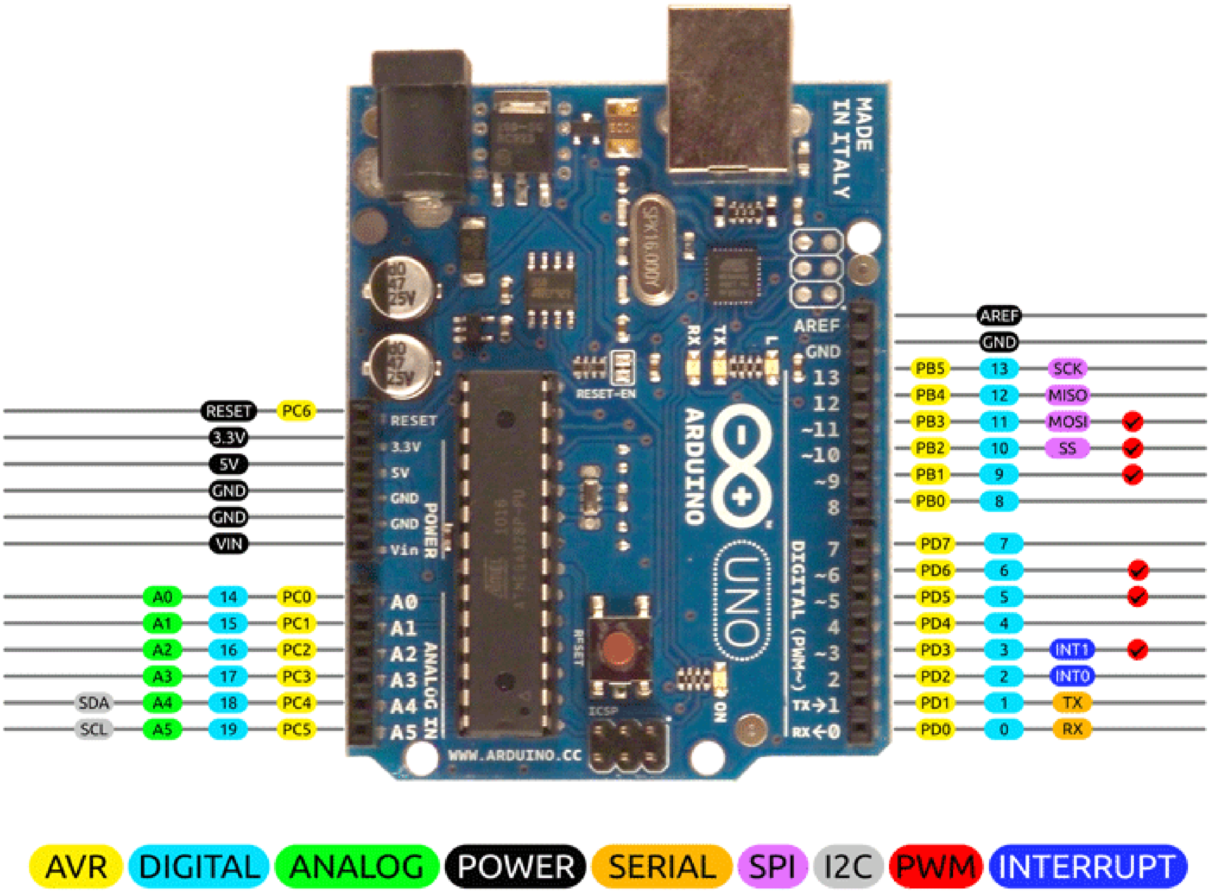


Fig 7.17

USB cables and jump wires (Miscellaneous): This includes the wires which are used to connect all the boards, cameras and the power sources. This also includes the 16 GB memory card which will hold all the data of the programming and the coding of the softwares.

Connections and calculations

Arduino UNO to-H Bridge-to Motor Connections:

The Arduino UNO and the H bridge are used to control the movements of speed and spinning direction of motors.

This motion helps to rotate wheels which invariably moves our bot.

Arduino UNO and the H bridge carry out the above function by bonding and synthesizing by communicating and working together.

For controlling any robot, it is invariable to understand the controlling of DC motors. Interfacing the Arduino with the L-298 H bridge is one of most inexpensive and easiest ways to do so.

Two techniques are used to control the speed and rotation of DC motors. They particularly are as follows: -

1. PWM- For controlling speed
2. H-Bridge – For controlling rotation direction

Arduino UNO pins required: -

- **Ground Pins: -**

  One thing to note with the grounds is that the grounds of all the circuits should always be together and make sure that all the grounds of components are correctly linked. Ground pins are generally represented as GND.

  For measuring and setting any voltage Arduino board needs ground. So, everything in the circuit needs to be connected to the ground for comparison of voltages.

If common ground is absent its like measuring the height of two persons and one of them is standing on a box. There is no common ground reference hence measurement is useless.

To get correct measurement the two people have to be at the same level. Hence, common ground is necessary.

- **Digital pins: -**

There are 14 digital pins that can be seen on the Arduino bard numbered from 0 to 13.

These digital pins are used to READ or WRITE data. The digital pins used for connections are 4,5,6,7 and 8,9,10,11.

The configuration of each and every digital pin used is necessary before its actual usage. It can be either INPUT or OUTPUT mode. INPUT mode is used to read data and OUTPUT mode is used to write data.

- **PWM pins: -**

Some of the digital pins can also be used as PWM pins.

Pin numbers 3,5,6,9,10 and 11 of Arduino UNO are compatible with PWM.

By varying the input voltage, the speed of a DC motor can be controlled. PWM is a common technique is used for this process.

In this technique the voltage is varied by sending a series of ON OFF pulses.

Width of pulse is called the Duty Cycle. Higher the value of duty cycle, higher will be the voltage transferred.

The following illustration may help us understand duty cycle effects better

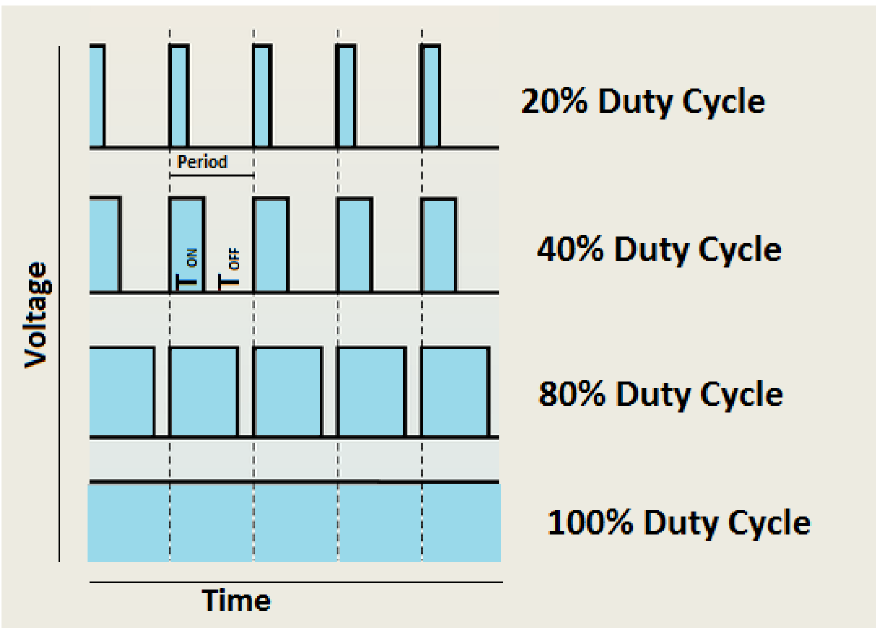


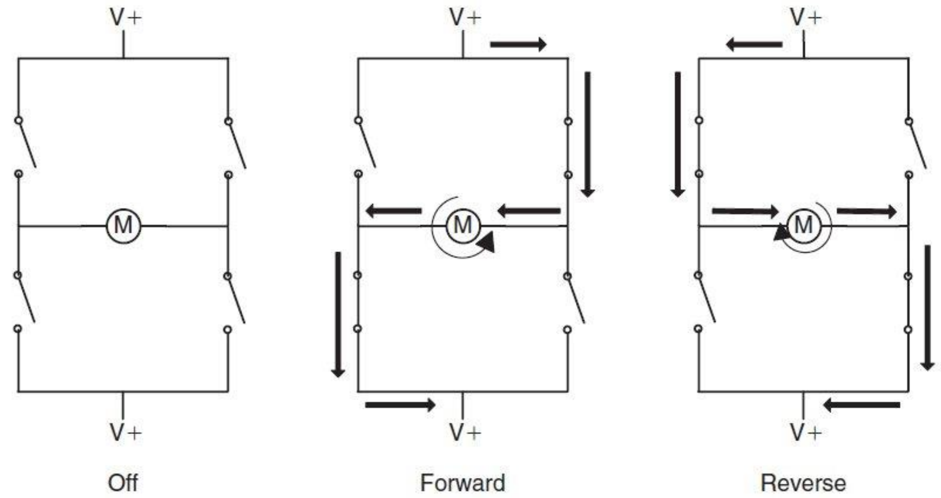
Fig 8.1

The PWM pins can be used to control the speed of the motors used, but it remains an achievable additional function. Currently not implemented.

6.3 . H-Bridge pins required: -

The polarity of the input voltage plays an important role in deciding the direction of rotation of the DC motor. A common technique used for this is the H-bridge.

An H shaped structure or circuit is formed with the motor at the centre and the 4 switches surrounding it.



As illustrated in the figure when any two opposite switches are closed the motor starts to rotate in opposite directions. This is the result of polarity changes which drives the motor in opposite directions.

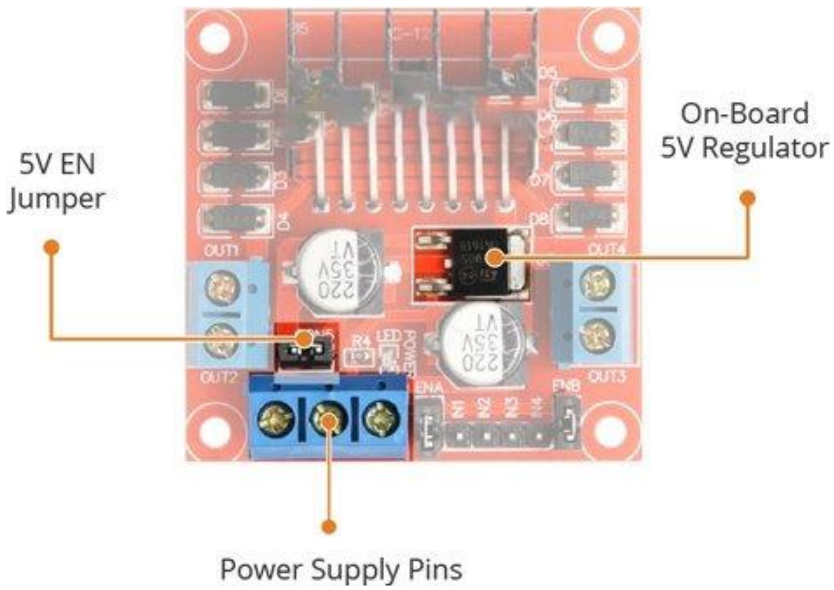


Fig 8.2

As shown in figure the 3 power supply pins are marked out of which the leftmost pin is used for motor power supplies ranging from 5V upto 35 V. The central connection is the common GND whereas the rightmost pin is used for driving the logic circuitry.

6.4 . Voltage drop in L298N: -

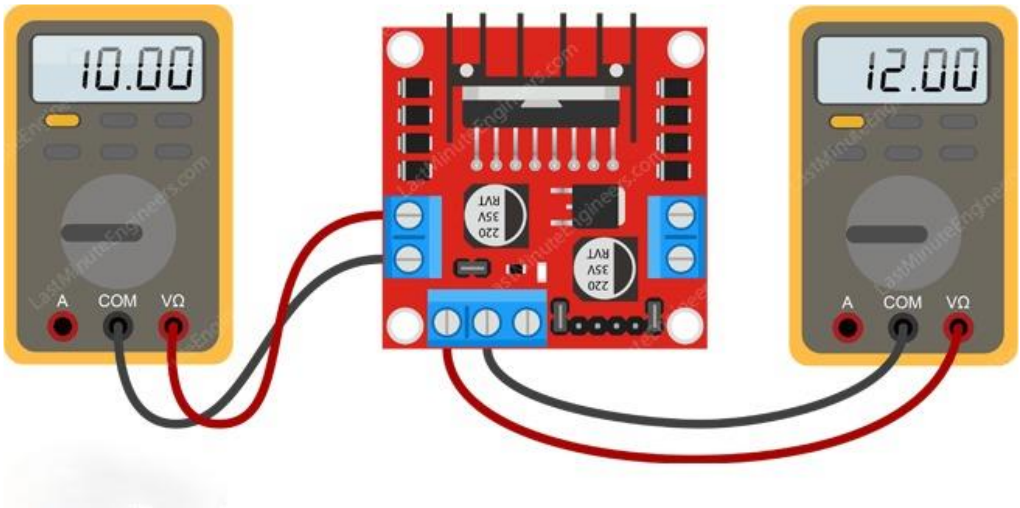


Fig 8.3

The voltage drop across a H-Bridge is about 2 volts. As shown in the figure the digital multimeter probes connected between input and output probes shows a voltage drop of 2V.

The switching transistors in the H-Bridge cause this internal voltage drop.

So, if a 12V battery is used the complete voltage wont be available to the motor and it will never rotate at full speed. A speed lower than the maximum value can be reached.

Only if we use a higher input voltage say for example 14V, the it may be possible to get 12V at output and obtain desired rotating motor speed which is maximum.

6.5 . Output pins: -

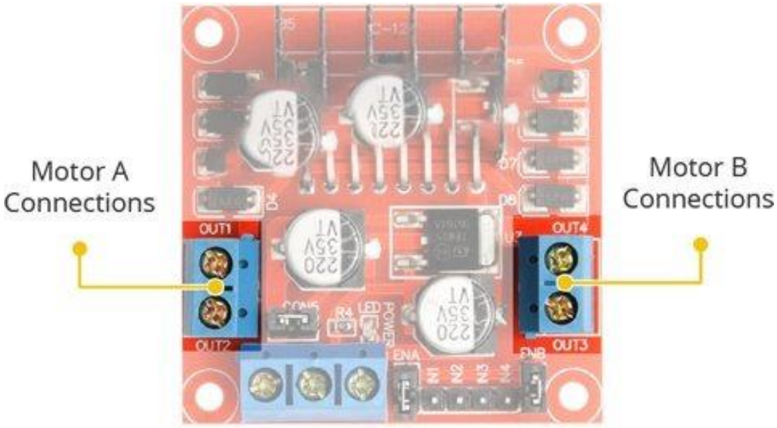


Fig 8.4

At a time 2 motors can be run, or a parallel connection of 4 motors is feasible to control by the H-Bridge. The motor connections A and B are placed on opposite side of the board as shown in the figure. Each output has two output channels each with 3.5mm pitch screw terminals.

6.7. Control Pins: -

Two types of pins are available on the H-Bridge viz. the direction control pins and the speed control pins. Used to control motor speeds and directions respectively.

6.8 **Direction control pins: -**

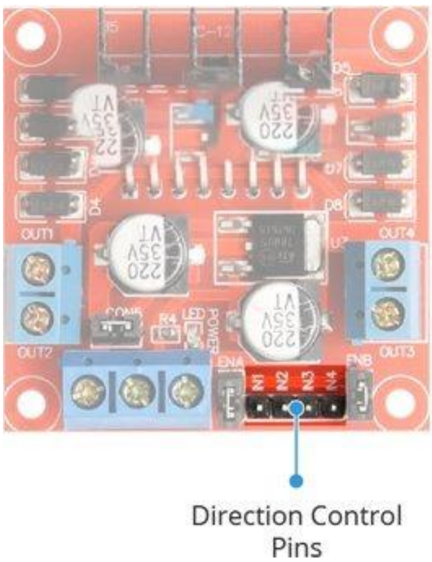


Fig 8.5

Using these pins the direction of motor spin is decided i.e. forward or backward.

The module has 4 direction control pins IN1, IN2 IN3 and IN4. The 1st two pins control the spinning direction of motor A whereas The other two pins control the spinning direction of motor B respectively.

The spinning direction of motor can be controlled by giving HIGH or LOW logics to these inputs. Following table may illustrate it further:-

INPUT 1	INPUT 2	Spinning Direction
LOW(0)	LOW(0)	Motor OFF
HIGH(1)	LOW(0)	Forward
LOW(0)	HIGH(1)	Backward
HIGH(1)	HIGH(1)	Motor OFF

Table 8.1

6.9. Speed Control Pins: -

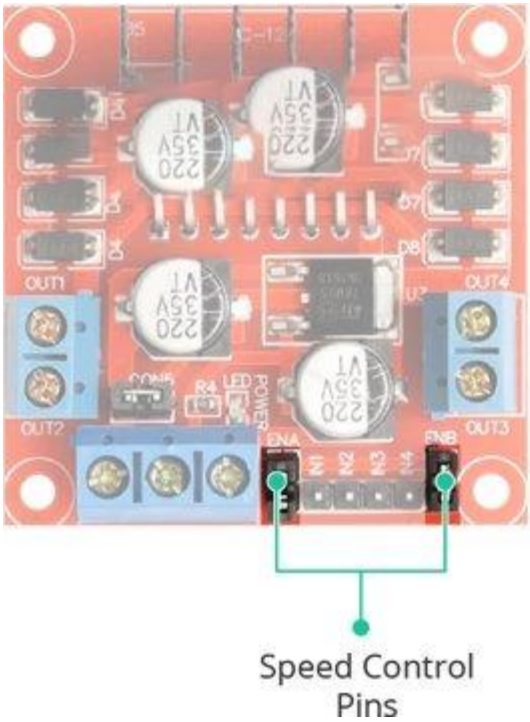


Fig 8.6

The speed control pins ENA and ENB are use to turn the motors ON and OFF thereby controlling its speed.

Complete L298N Motor Driver Module pin configuration :-

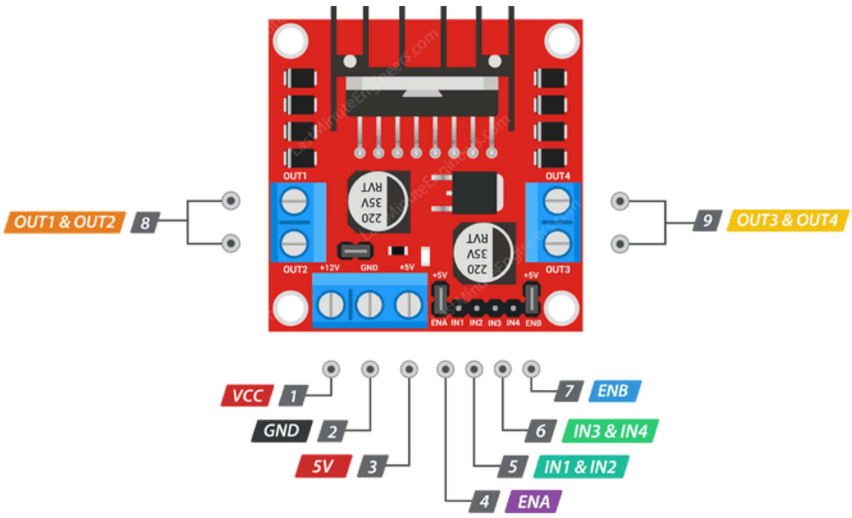


Fig 8.7

Wiring L298N motor driver module with Arduino UNO: -

The above discussion covers the pin configurations used and covers everything about the module, now the process of connecting Arduino with H-Bridge can be commenced.

The first step is to connect the power supply to the motors. The DC motors which are used in the drive robots are chosen. The selection criteria for the same will be elaborated in the next section.

Generally, motors are rated between 3V to 12V. So, a power source of 12V or above is suitable.

One terminal of the power source will be connected to the Vcc terminal of H-Bridge and other terminal to the ground.

Two separate H-Bridges are used to drive the couple of motors in parallel connection on either side.

It was done to reduce the risk of a short of the H-Bridge and better working.

The input pins IN1, IN2, IN3 and IN4 are connected to digital pin numbers 4,5,6,7 of Arduino respectively and for the other H-Bridge input pins IN1, IN2, IN3, IN4 the digital pins 8,9,10,11 of Arduino were connected respectively.

The output terminals from motor were connected to the OUT1 and OUT2 pins of both the H-bridge respectively.

It will lead to a similar illustration as shown below

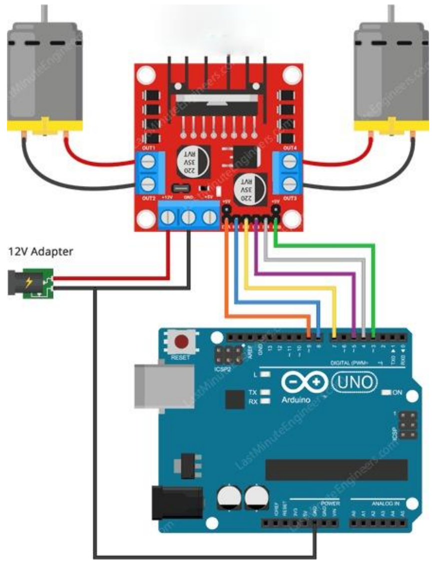


Fig 8.8

Fig shows a simple illustration of connecting two motors for understanding, but the connection for 4 motors is slightly complex as shown below: -

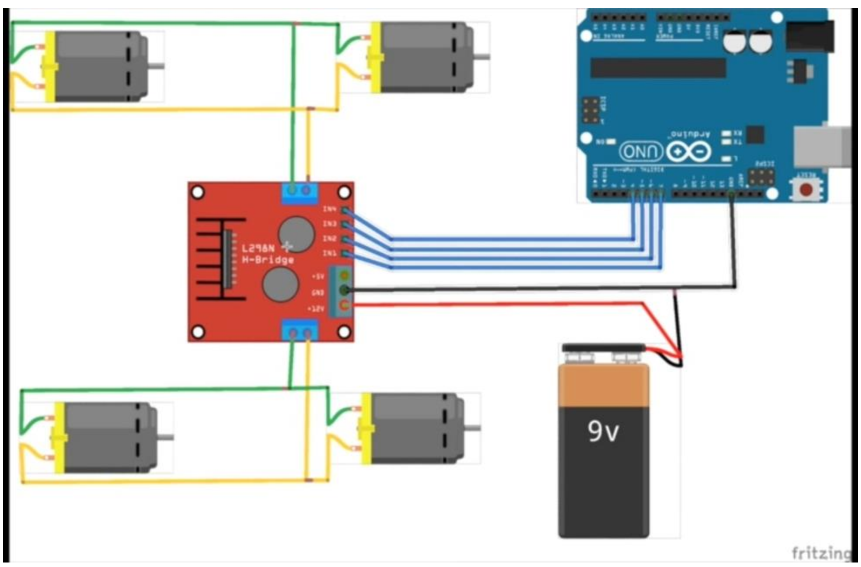


Fig 8.9

This figure shows the initial attempt of connecting all 4 motors with a single H-Bridge, but instead the use of 2 H-bridges on both sides has been used.

The following figure illustrates the actual bot connections:-

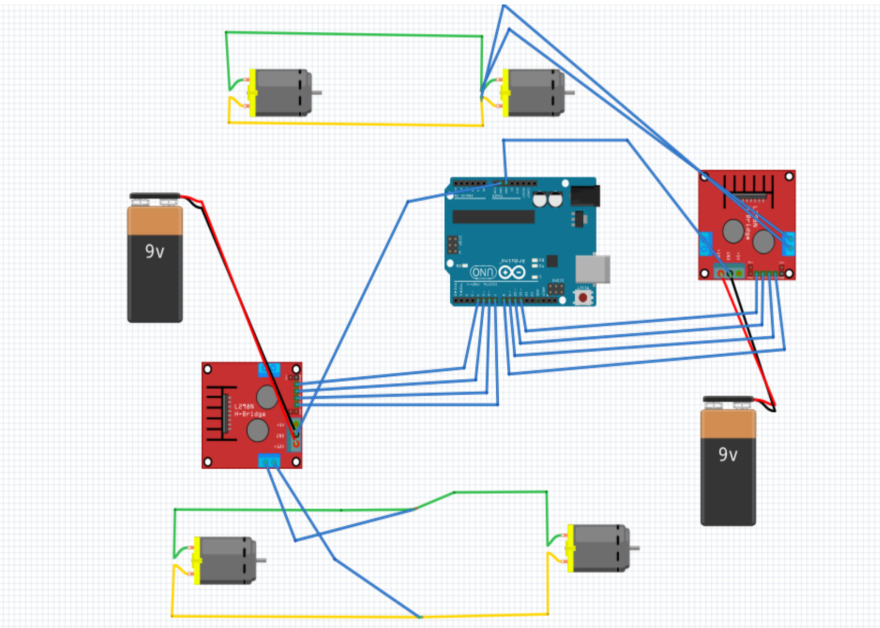


Fig 8.10

Above figures have been created in the fritzing software for demonstration purposes.

7.4 Organization of dissertation:

The entire project document has been categorized into 5 chapters starting from the introduction upto the concluding remarks and future scope.The chapters are arranged such that readers would easily grasp on to the flow of the project and continuity is maintained throughout.

The first chapter is the introduction which contains the problem statement, objectives, scope and methodology that gets the reader in sync with the mindset behind developing the project.

The work done so far by the researchers in the domain area and their significant conclusions are noted in the second chapter which is the literature review.

Next chapter which is the third chapter dives into the crucial aspects of the projects that involves a series of numerical calculations (for motor selection) and CAD models (for chassis design). This chapter enables the component selection process as well.

After the component selection process the fourth chapter is divided into two halves, the first half focusses on the hardware, various electronic and electrical components and most importantly their specifications. This is followed by the detailed explanation of all components and subsequently the connections established between all the components as well. The second half of this chapter entirely covers the aspect of computer vision, algorithm development and simulation in the project.

The fifth and final chapter is all about the conclusion of the above work and the innumerable future scopes and targets which may be achieved regarding the concept of the project.

8 Literature review:

The papers referred for the project are mentioned below but an overview of that papers will be given in this segment. The main source of information was taken through a mixed report including both videos and written programs, which was written by – Siraj Raval. The main aim behind referring this paper was that it matched our goal, which was to generate a self driving car. The main task of teaching the artificial intelligence the track records and all the data input was done with the help of this resource.

The second paper that we studied was an IEEE paper, titled- Self driving and driver relaxing vehicle. This paper gave the whole overview regarding the position of self driving cars in today’s world. It mentioned that the self driving concept was brought up in 2010 and prominently was studied by major companies and also had the assistance of google for that. It stated the purpose of a self driving car and its function.

How it included the mixture if mechanical and electrical concepts was mentioned in the paper. It included arduino for the electronic aspect and motor and steering wheel for the mechanical aspect. It also sytated the use of Google GPS for its practical use on roads.

It also included the starting and stopping mechanism whenever an object comes in its front, this principle is used in this project too. This is known as traffic control when if a car comes in front of the project car it will automatically stop and will start after the car or the object in front will be cleared off.

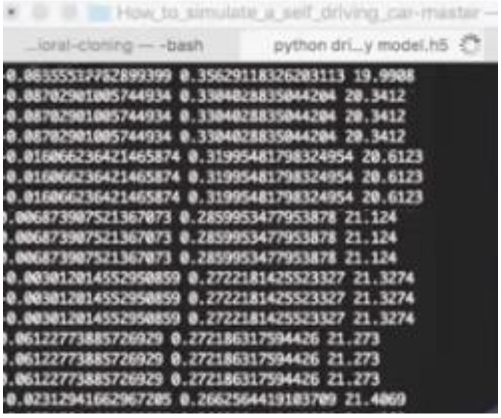
The next aper we referred was- Autonomous cars, which showed the presence of automation technology in cars, It in genefal showed the importance of automation by representing various examples in the past and also in the present. It showed how automation will reduce human efforts which is the main aim of creating a self driving car.

9 Simulation:

Simulation is the main base of the project, the initial values like turning radius and speed of the car will be determined with the help of simulation software. The car is trained on different terrains and the digital inputs as well as analog inputs are recorded and stored in a folder. The data is then taken into the programming in a suitable software. This data is used for training the car and using it in the autonomous mode.

Fig 9.1

This is the image of the simulation software, the turning radius are obtained with the help of this software and are recorded in the word document.



The above shown image is the recording of the turning radius.

On the base of all these values a track is created which will consist of two lanes and a white border which will help the camera to distinguish between the lanes. The distance between the two lanes is approximately 30 cm, and the white borders are 1 cm in length.

Fig 9.2

This is a part of the track that has been designed for the testing purpose.

10 Experimental validation

1) The real time autonomous mode is done with the help of raspi cam, which is fitted on the bot which captures all the images in front of the car. This input is feeded to the boards and the response is sent to the motors through the arduino board, the programmed action is taken according to the conditions, like- turn right, turn left, stop, and go.
2) The images taken on the camera are shown below,

Camera Views

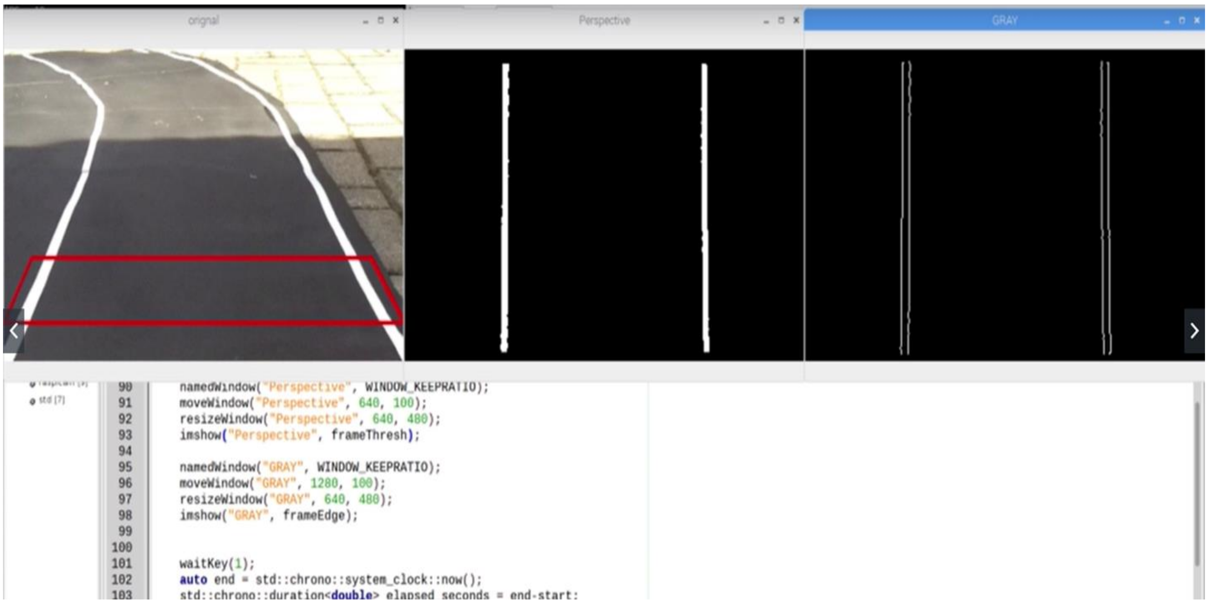


Fig 9.3

Road view captured by camera

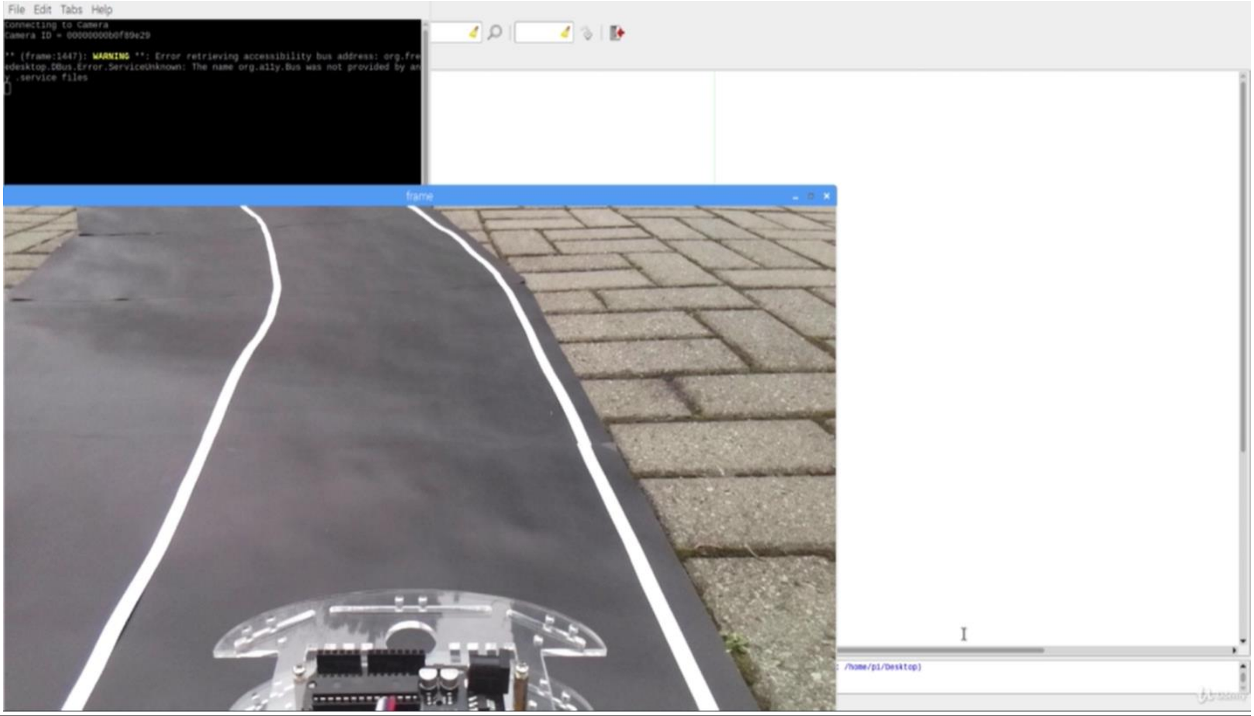


Fig 9.4

This camera view shown above in the figure shows how the digital data is captured. This will help the car to travel on the track that we have designed for the project.

It is observed that the car will run on an autonomous mode and is observed that the car will turn on the turns produced on the track. Also few obstacles were constructed on the track, to which the car will react. For example whenever a signal is detected by the car it stops according to the programming done on the board.

11 Future scope and conclusion

1. Future plans

1. Obstacle detection and control
2. Signal detection
3. End of road and turn detection
4. Indicators for turning left and right
5. PWM (Pulse width modulation) for speed control and deceleration

2. Future Aspects

Currently the concept of lane tracking and object detection has been applied to the prototype developed. But these concepts have widespread future applications. Along with robotics the concept can bring radical changes even in the automobile sector with certain modifications.

Some novel future scopes for the same have been listed below:

6.1 Reduced Accidents:-Cause for more than 90% road accidents are human errors. So this concept particularly aims at reducing accidents due to human errors and improving safety.

6.2 Reduced traffic congestion:-With automated vehicles, traffic caused due to human driving behavior can be reduced. Bottlenecks, lane changes, mergers and other disruptions are avoided.

6.3 Reduced CO2 emissions:-A reduction in traffic congestion will automatically reduce the excess CO2 emissions.

6.4 Increased lane capacities:-Autonomous vehicles can increase highway capacity by 100% and improve expressway travel speeds by 20%.

6.5 Ergonomic Considerations:-The reduction in accidents may lead to developing car bodies with extremely light materials which drastically reduces cost of manufacturing.

6.6 Lower fuel consumption:-A reduction in emissions and body weight of automotives has a direct and positive impact on fuel consumptions and they are bound to be lowered.

6.7 More efficient parking:-A large amount of real estate is wasted due to haphazard parking. The concept may further revolutionize parking arrangements and free up lands for other productive applications.

6.8 More effective and affordable transportation:-Waiting time for transportation from buses or cabs can be reduced from minutes to few seconds. This brings down transportation costs drastically and motivates usage of public transport facilities.

3. Conclusion

Hardware in the loop simulation gives us the better knowledge of the system in real time environment by giving the virtual inputs in the simulated environment and observing the behaviour of the hardware. The training of the vehicle is done in the simulator with the help of convolutional neural network using deep learning approach without considering the torque required to rotate the steering wheel. It has been observed that with the help of camera sensors, the automated steering system can be developed which will be useful in development of driverless cars.

12. References

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