Autonomous Car

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CERTIFICATE

This is to certify that the project work embodied in this report entitled "**Autonomous Car"** was carried out by Mr. Darshit Dudhwala, Mr. Abhishek Punjabi, Mr. Mony Kansara and Mr. Alakshendra Tyagi at U.V. Patel college of Engineering, Ganpat University for partial fulfilment of B.Tech. Degree to be awarded by Ganpat University. This project work has been carried out under my supervision and is to the satisfaction of department.

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Place:

Internal Guide

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Prof. Umang Shukla

HOD

DR. Hemal Shah

Signature and Name of Principal

Seal of Institute

ORIGINALITY PAGE

We hereby certify that we are the sole author of this report and that neither any part of this work nor the whole of the work has been submitted for a degree to any other University or Institution. We certify that, to the best of my knowledge, my work does not infringe upon anyone's copyright nor violate any proprietary rights and that any ideas, techniques, quotations, or any other material from the work of other people included in my report, published or otherwise, are fully acknowledged in accordance with the standard referencing practices. Furthermore, to the extent that we have included copyrighted material that surpasses the bounds of fair dealing within the meaning of the Indian Copyright Act, I certify that I have obtained a written permission from the copyright owner(s) to include such material(s) in my work and have included copies of such copyright clearances to my appendix. I declare that this is a true copy of my report, including any final revisions, as approved by our supervisor.

Date:

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Abhishek Punjabi
Mony Kansara
Alakshendra Tyagi

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Date: **Student Name**

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Abstract

In present times fatal accidents are taking lives of innocent people. The aim of this project is to avoid such accidents taking place by making car smartly by using Machine Learning algorithms Internet of Things and cloud. Here, car is self-driven without human interaction and takes decision on its own. Here, the autonomous car automatically captures the image of the objects through Pi-camera and through image comparison Scikit algorithm with training set of images of paths on the cloud. From the result of gain ratio and info. of gain from decision tree the car will be able to take turn left, right or move Forward based on the correct path of the destination. Moreover, not only path detection but also it will be able to detect any potential accidents.

Keywords: Machine Learning, autonomous, Scikit, Internet of Things.

1. Introduction

There is a huge market for home automation and its appliances. Nowadays people are moving with the trend of technology. These devices provide great comfort and ease in our lifestyle. In this age of technology our cars and other automobiles should also be much more innovative to provide comfort while driving. According to "Association for Safe International Road Travel". Nearly 1.3 million people die in road crashes each year, on average 3,287 deaths a day. An additional 20-50 million are injured or disabled. This is a major disadvantage for World's economy and human life. No matter how much we educate and increase rules, the increasing number of vehicles and traffic problems have only increased the number of accidents every year. In India one precious human life is lost in every four minutes. Delhi the capital of India has highest number of road crash deaths. For a developing country its a major setback. To decrease the number of accidents we must develop autonomous car and it's applications to reduce the driver's distraction while driving. The idea of the project is to move car automatically it will detect the path to travel and ensure safety of the passenger.

1.1 What is Autonomous?

An autonomous car is a vehicle that can guide itself without human conduction.

1.2 Why Internet of Things, Machine Learning and Cloud?

You might have seen many application with Internet of Things in it and the Cloud part in it. But, there are nearly less amount of projects and researches which include all the three aspects. I am glad that I have one project that has all the three aspects covered.

The technologies and solutions that enable integration of real world data and services into the current information networking technologies are often described under the umbrella term of the Internet of Things.

A subfield of computer science and artificial intelligence that focuses on the design of systems that can learn from and make decisions and predictions based on data. Machine Learning programs are also designed to learn and improve over time when exposed to new data.

Cloud computing is shared pools of configurable computer system resources and higher level services that can be rapidly provisioned with minimal management effort, often over the Internet.

These were the definition of the Internet of Things, Machine Learning and Cloud which will make you understand that what these technologies/paradigm provide. Therefore for an application covering all three aspects is a plus as compared to one or two.

1.3 Purpose

The main aim of this autonomous car is to help people by taking them to the destination without spending precious time on travelling by providing luxury of not driving car and feel safe. If a driver is drunk, health issues, or any physical or mental issues like remembering the roadmaps this autonomous car help him out to reach at that place by comparing the real time path images received from Pi-camera with paths of original destination.

1.4 Challenges

- OS installation on Raspberry Pi 3
- Working with relay using Raspberry Pi
- Connection of AWS Dynamo database with lambda function.
    - AWS console cost was expensive.
- Applying CNN on image received from Pi-Cam
- Fetching data from Firebase

2. Existing System

2.1 Introduction

Here, we are going to discuss Google Driverless Car.

Figure 1. Google Driverless Car

2.2 Technical specifications

- LIDAR: Laser Illuminating Detection and Ranging Radar, High-Powered Cameras, Sonar Advance and highly detailed Maps, Sophisticated Software for machine learning
- Laser illuminating detection and ranging builds a 3D map having 360 degree view and allows the car to “see” potential hazards with laser beam to determine the distance of the objects. The Google Car uses a Velodyne 64-beam laser that rotates on a custom built base.
- Radars are also placed on front and rear bumpers of car to avoid obstacles and give signals for acceleration and break. Some prototypes used high powered cameras each camera has view angle of 30 degrees and determines the obstacle by image processing and machine learning.
- Advance and highly detailed Maps are used to determine path of the car with use of GPS sensors. It uses machine learning to improve the system according to user. Predicting the location having high traffic areas and best alternative route. A pot hole or foreign item in the street shows a increase in probability of a driver swerving to avoid it. Congestion in the left lane means that some drivers are more likely to attempt to enter the right lane. Even adding or updating new locations in its database. All the data is stored at Google's data center.

2.3 Limitations[11]

- Advance and highly detailed Maps are used to determine path of the car. Currently, Google has mapped approximately 2,000 miles of road for the driverless car to operate on.
- Car has issues that would prevent it from driving in snow, ice or heavy rain.
- Unable to tell the color of traffic lights when sensors are blinded by sun or glare.

- Sensors detect objects as pixelated shapes, this clearly shows, the car would respond in the same way by swerving to miss a child in the road, or a newspaper that was floating past.
- Cost of the car is too high
- Chances of accident are too high if another vehicle tag's the car.

3. Proposed System

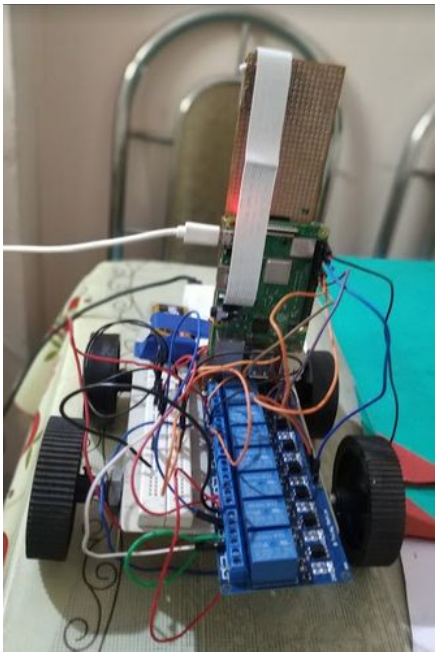

Figure 2 Autonomous Car

3.1 Working

- Car automated system consist of a raspberry pi camera module which captures image and tests it with existing training set of images available on cloud and returns back the direction of car to move.
- After image is captured by raspberry pi camera module it goes into python file for image processing.
- Here the image high resolution is reduced to 320 x 240 pixels after this image is converted into grayscale using numpy, pandas and scikit libraries.
- This image is then used as testing set image and is send to Firebase cloud server via api in JSON format.
- At Firebase this image is compared with already existing training set and is classified accordingly.
- The is basically detecting weather there is a path (road) ahead of it or not.
- If road is ahead then the image binary code (grayscale code) will have more number of 0's than number of 1's in the central region. Hence the car will be instructed to move ahead if it matches the training set more than 70%.
- If it is not central region then it will go reverse and take a left turn or right turn accordingly
- The training set is stored on Firebase cloud.
- Python code uses scikit-image library to work with Firebase.

3.2 System Flow

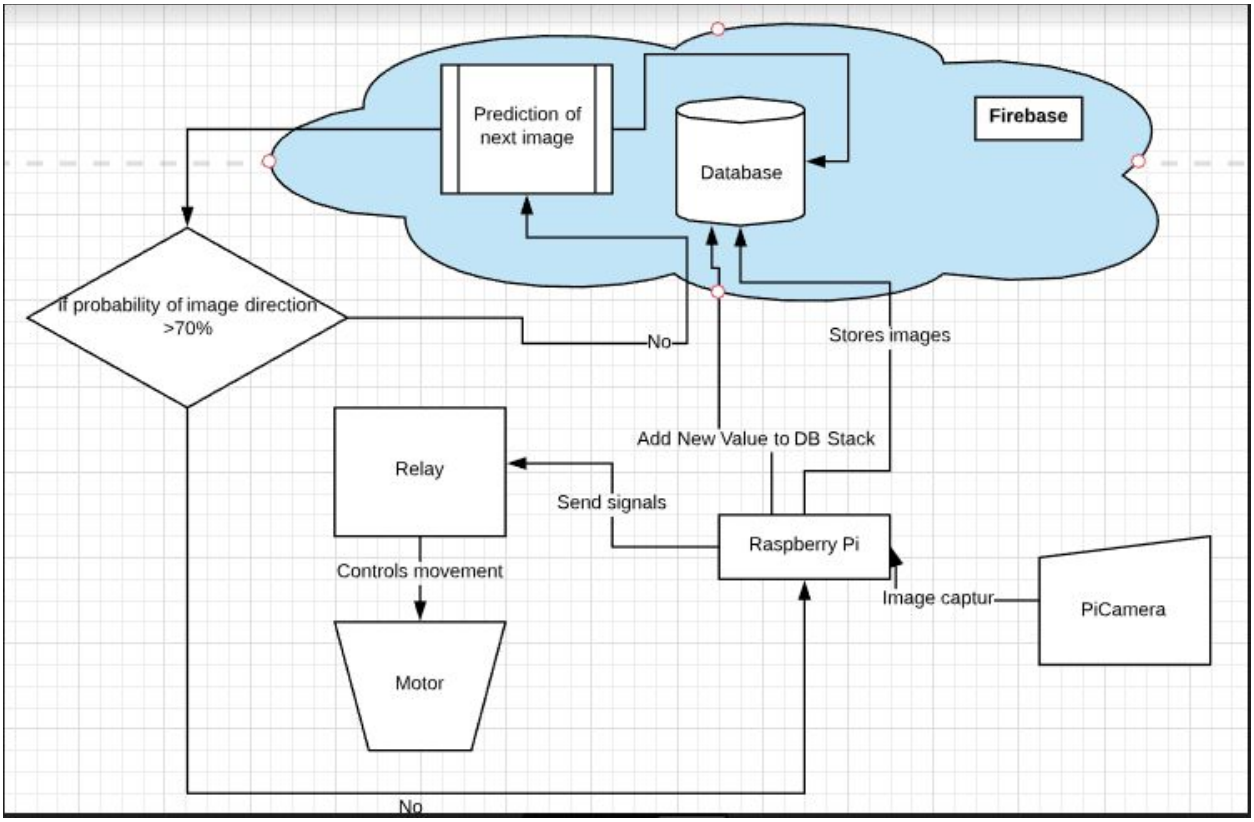

Figure 3: Flow Chart

3.3 Machine Learning

In this section we will discuss about SSIM algorithm that is going to be used in our Machine Learning part for image prediction and how that image will be trained and tested.

3.3.1 What is SSIM ?

The **structural similarity** (SSIM) index is a method for predicting the perceived quality of digital television and cinematic pictures, as well as other kinds of digital images and videos.

An image quality metric that assesses the visual impact of three characteristics of an image: luminance, contrast and structure.

3.3.2 Why SSIM ?

This method allows to compare index maps of images and returns a value in decimal which shows the structural similarities between the images. The value lies between 0 and 1, which means if the value is 0, the images have nothing in common and if the value is 1, the images are 100% match with each other. The decimal values between 0 and 1 indicates the ratio of match.

Sample :

Figure 4

Figure 5: Original vs Original

SSIM: 1.00

Figure 6: Original vs Contrast

SSIM: 0.78

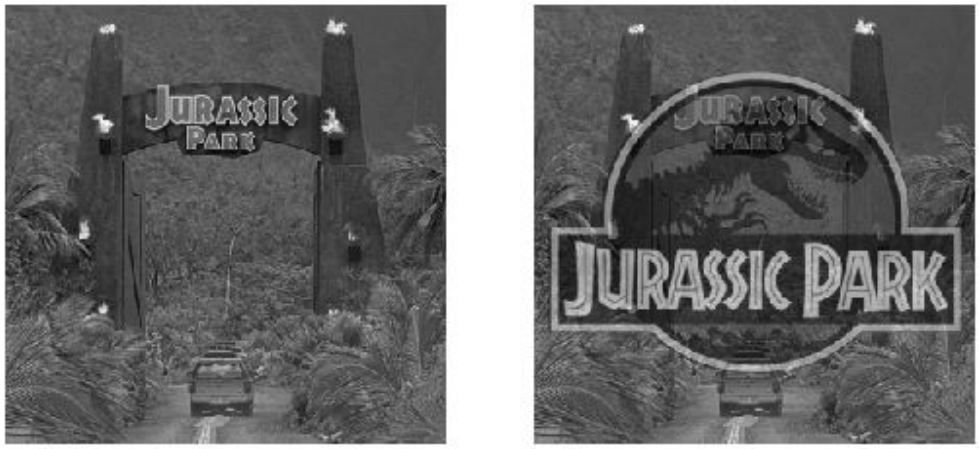

Figure 7: Original vs Photoshopped

SSIM: 0.69

3.3.3 Training

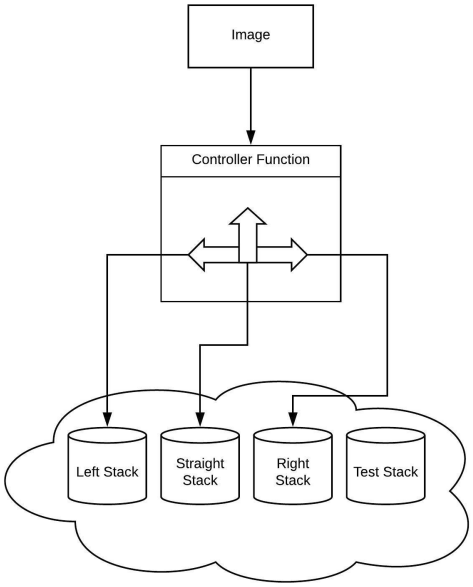

Figure 8:Training Process FlowChart

- Captured image from RPI is sent to the controller function.
- The image is converted into string (using base64 encoding), because cloud needs JSON format to store the data and image is not accepted in JSON format.
- The user make the decision based on the situation whether the car should take left turn, right turn or go straight on the road.
- After the user makes the decision, the image in string format is loaded into the particular stack of the decision

3.3.4 Testing:

- The image will be captured by RPI and will be converted to string.
- Then Image string will b uploaded to cloud to the testing stack.
- Now the image strings stored in left stack, straight stack and right stack will be compared with test stack image string in SSIM function.
- All the values of the comparison will be stored in a stack.
- After that threshold will be applied and the comparison results higher that 0.7 will be the decision.

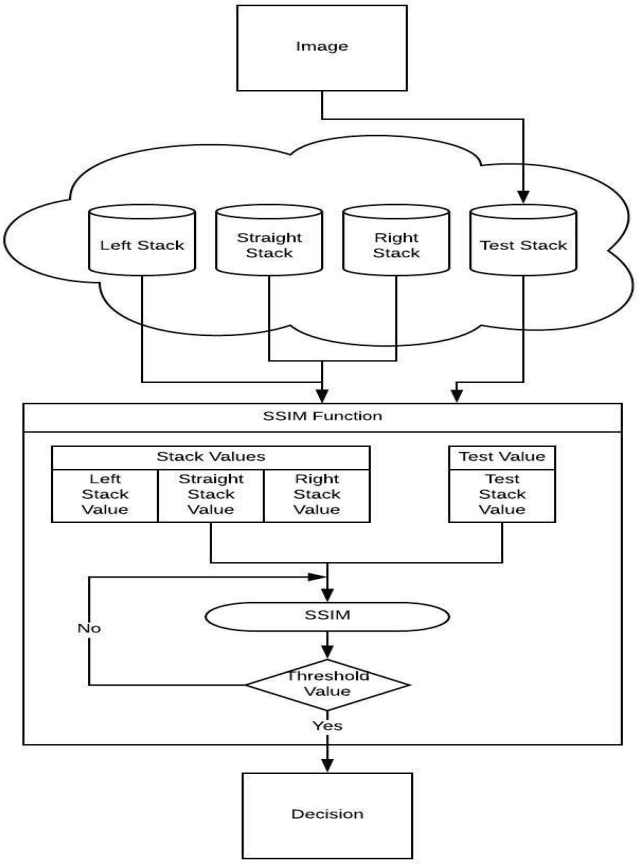

Figure 9:Testing Process FlowChart

3.4 Tools and Technologies

In this section, we will see various tools and technologies that are being used in this proposed system. These are the most needed tools and technologies that has led this project to be built.

- Raspberry Pi [6]

Figure 10:Raspberry PI Model 3B

- The Raspberry Pi is a series of small single-board computers developed in the United Kingdom by the Raspberry Pi Foundation to promote the teaching of basic computer science in schools and in developing countries. The original model became far more popular than anticipated, selling outside of its target market for uses such as robotics. Peripherals (including keyboards, mice and cases) are not included with the Raspberry Pi. Some accessories however have been included in several official and unofficial bundles.
- The Raspberry Pi 3 uses a Broadcom BCM2837 SoC with a 1.2 GHz 64-bit quad-core ARM Cortex-A53 processor, with 512KB shared L2 cache.

- Raspberry Pi-Cam[7]

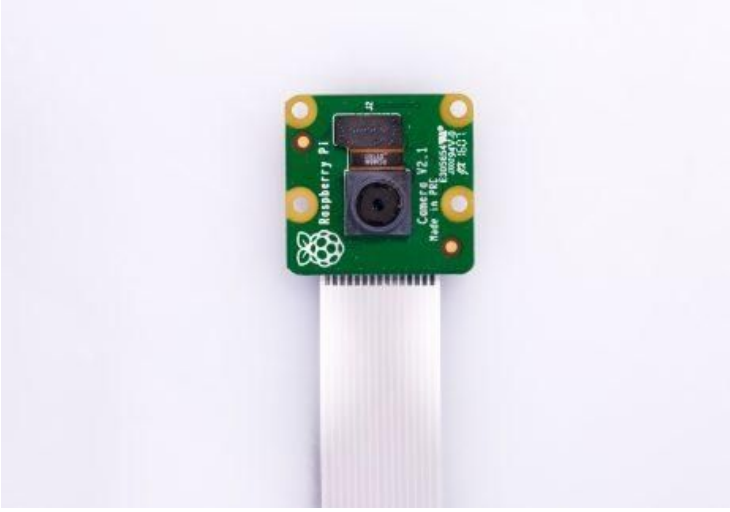

Figure 11 Raspberry Pi-Cam

- The v2 **Camera** Module has a Sony IMX219 8-megapixel sensor (compared to the 5-megapixel OmniVision OV5647 sensor of the original **camera**).
- The **Camera** Module can be used to take high-definition video, as well as stills photographs.

- The **camera** works with all models of Raspberry **Pi** 1, 2, and 3.

- Powerbank for 5V DC supply to Raspberry pi
  - Power banks can be defined as portable batteries that use circuit to control any power in and power out. They can charged up using a USB charger when power is available, and then used to charge battery powered items like mobile phones and a host of other devices that would normally use a USB charger.

Figure. 12: Power Bank

- 12V DC battery[12]

  - Figure 13: 12V DC Battery
  - A **battery** converts chemical energy into electrical energy by a chemical reaction. Usually the chemicals are kept inside the **battery**. It is used in a circuit to power other components. A **battery** produces **direct current** (**DC**) electricity (electricity that flows in one direction, and does not switch back and forth).

- Relay [8]

Figure 14: Relay 12V pack of 8

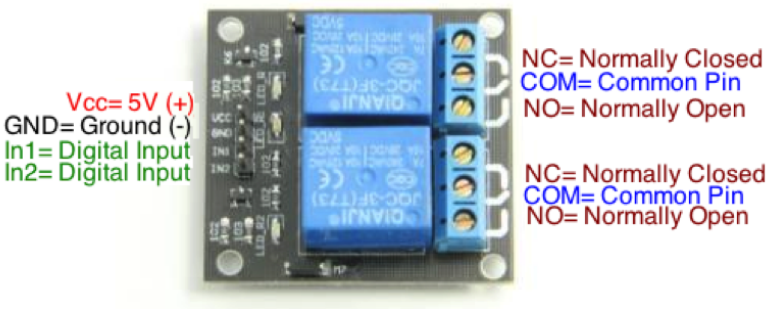

Figure 15. Relay 12V description [8]

  - A relay is an electrically operated switch of mains voltage. It means that it can be turned on or off, letting the current go through or not. Controlling a relay with the Raspberry pi is as simple as controlling an output such as an LED.

- Firebase Real- time NoSQL Database [10]

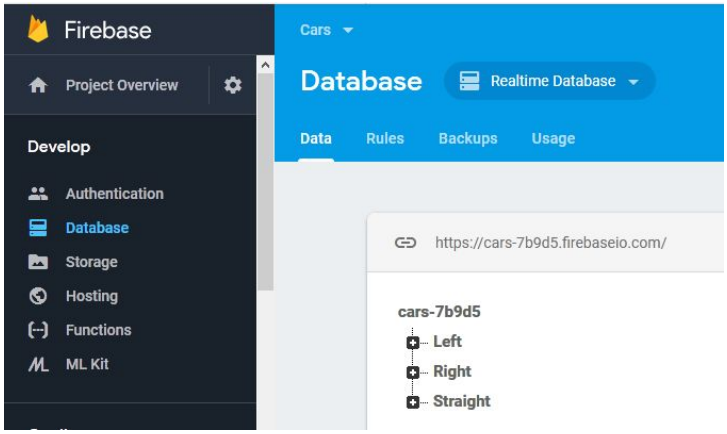

Figure 16. Firebase Database

- Firebase Cloud is a free cloud service from Google that allows app developers to send notifications, messages and data to users across a variety of platforms, including Android, iOS and web applications. It has many different features such as real time database, sql, etc.
- Store and sync data with our NoSQL cloud **database**.Data is stored as JSON and synchronized in real-time to every connected client.

3.5. Snapshots

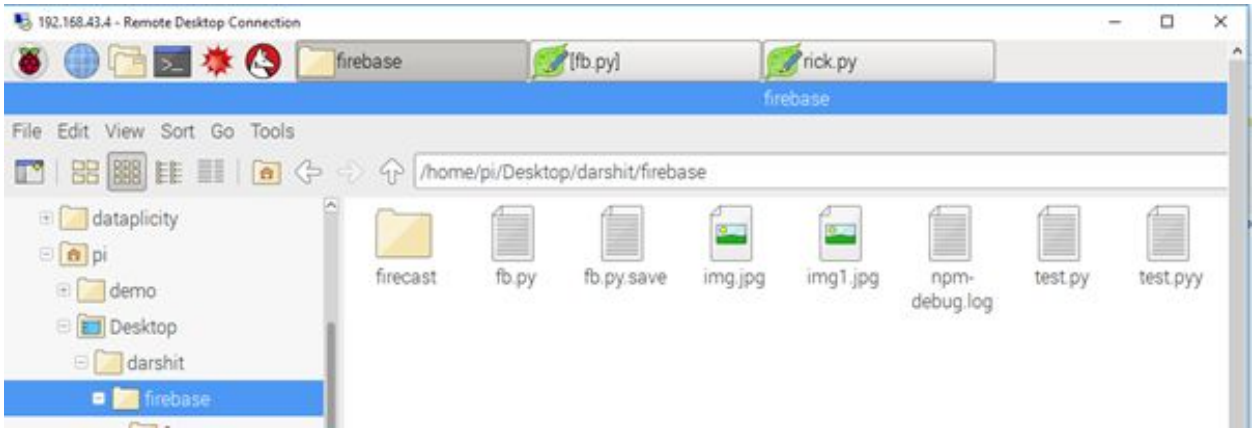

Figure 17. Project folder on Raspberry pi (Noobs OS is installed) [3]

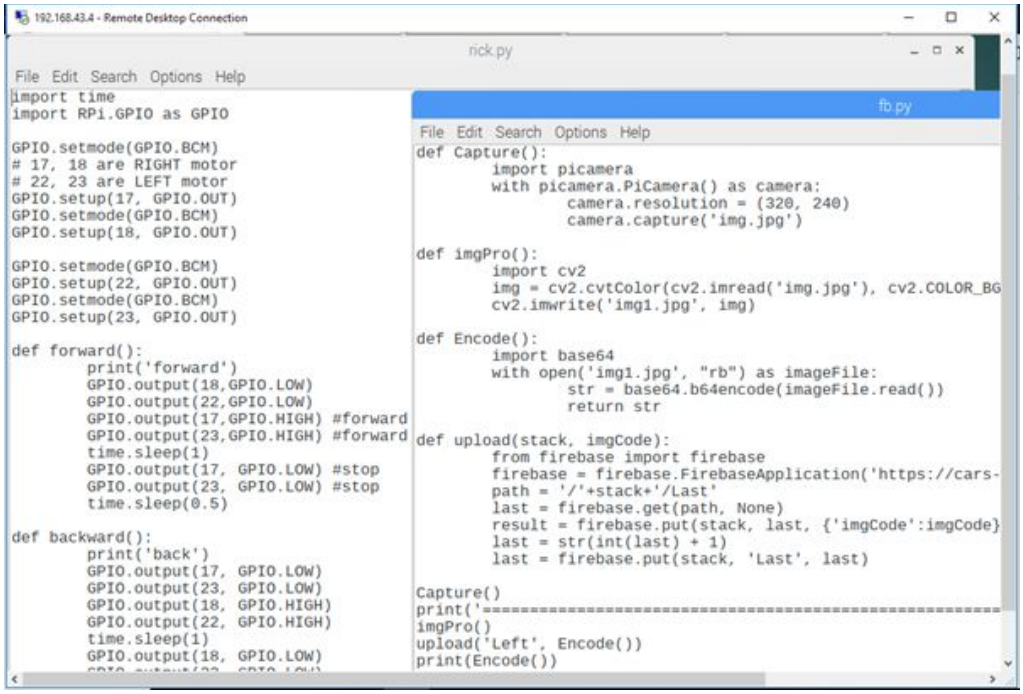

Figure 18. Project folder on Raspberry pi (Noobs OS is installed) [13]

- Python code for Image capture by raspberry pi , Image Processing and Image Upload on Firebase Cloud by put() method and get data from Firebase Cloud by using get() method

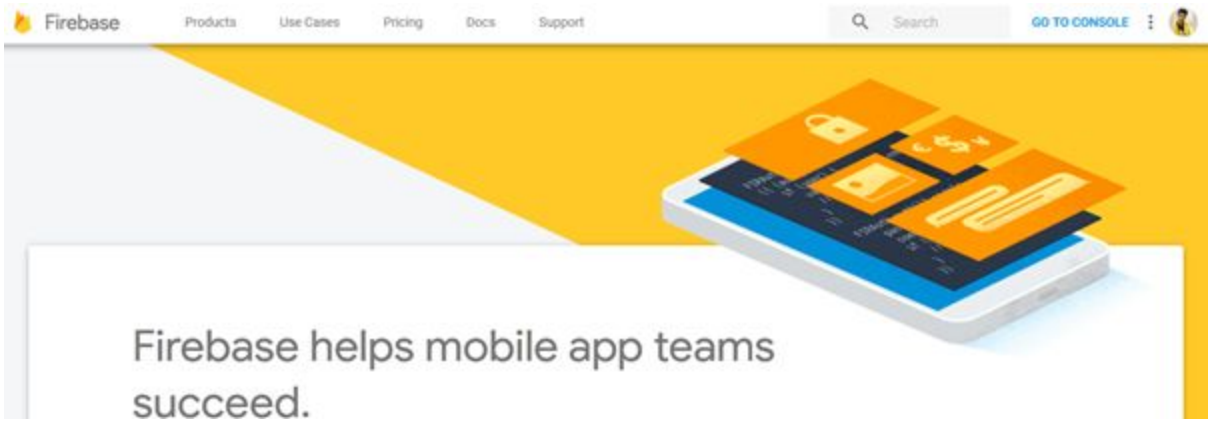

Figure 19. Create account on Firebase cloud [10]

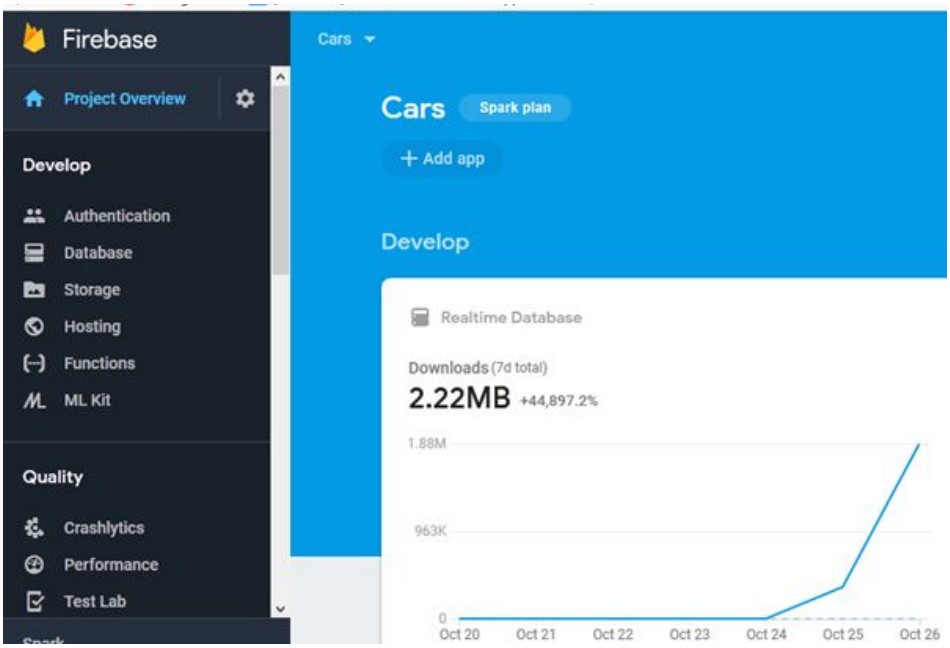

Figure 20. Create a Realtime NoSQL database on Firebase[10]

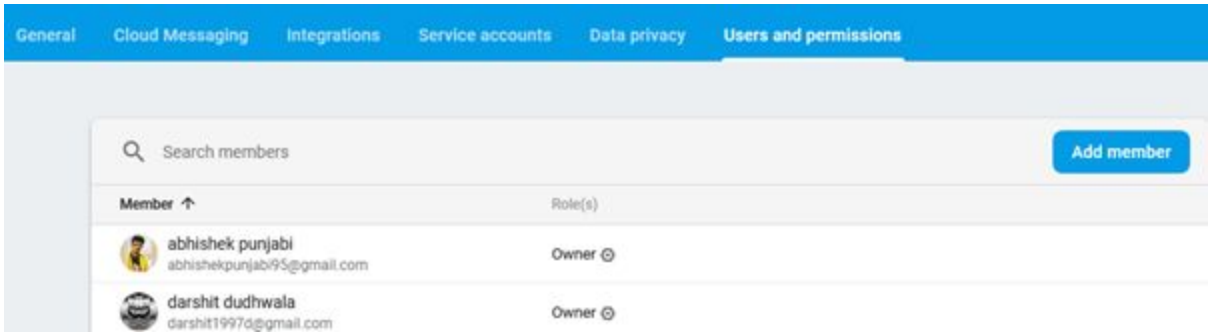

Figure 21. Give Permissions to developer[10]

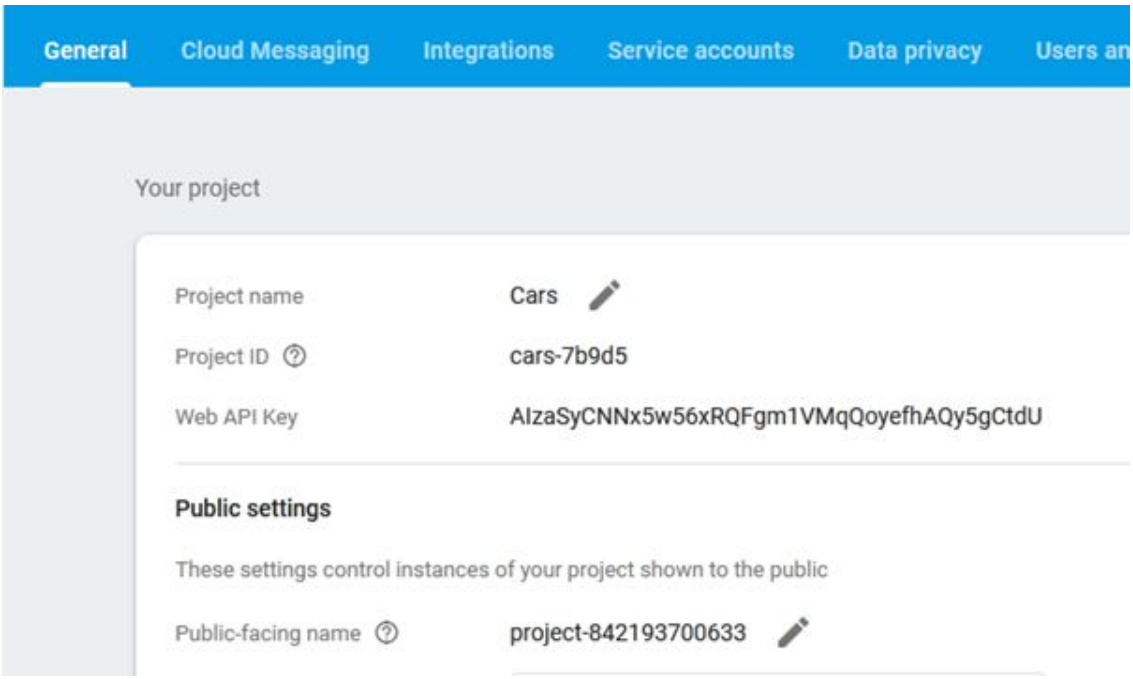

Figure 22. General Properties

- General Properties
  Project name Cars
  Project ID cars-7b9d5
  Web API Key AIzaSyCNNx5w56xRQFgm1VMqQoyefhAQy5gCtdU

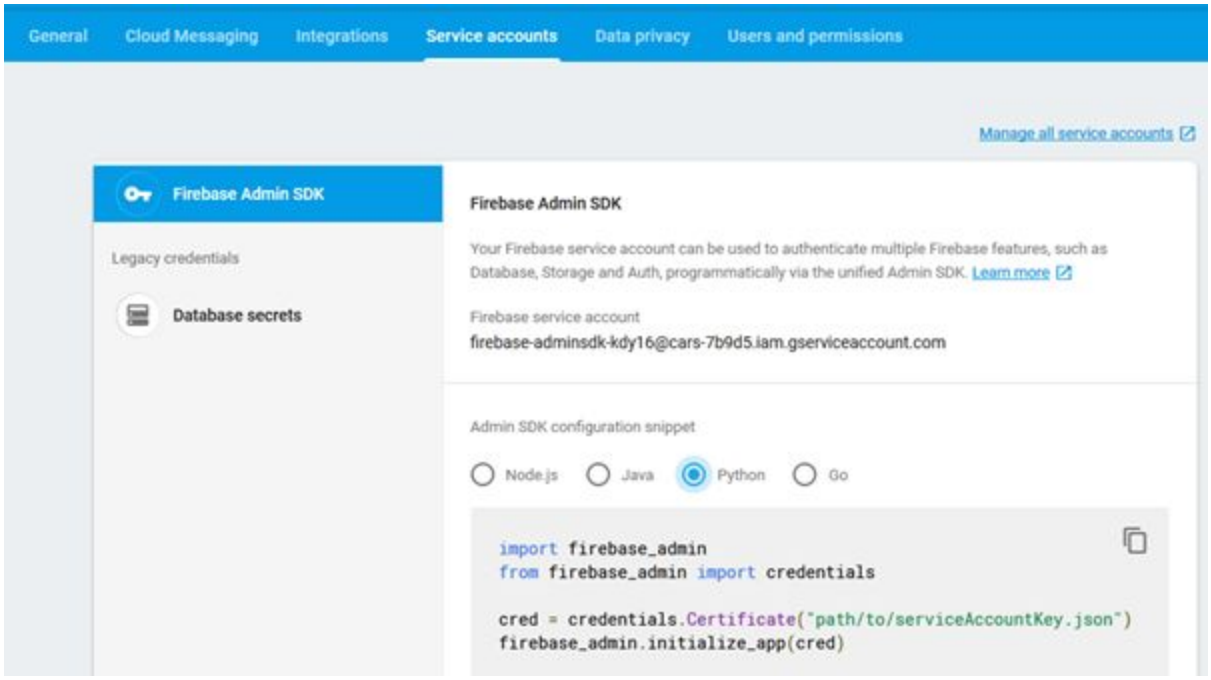

Figure 23. ServerKey

- ServerKey
  AAAAxBaoBxk:APA91bGFVsd7LlHhfdD9Hw7VI6T6S6b1Nbi2mXgQPzjJVUi
  MlCHWpXRU-qbqN7sKC4V7JHeudJsiOQEQvmnz2x0tZOgRc1AAZ6XLI5Anz
  4f6o2JLHb3ZmqIZPkpERTzKmioY75U9LRSp
  Legacy Server Key AIzaSyBukuvagU1tPLonW7yszyf5PyV_Yui0L58
  Sender ID 842193700633

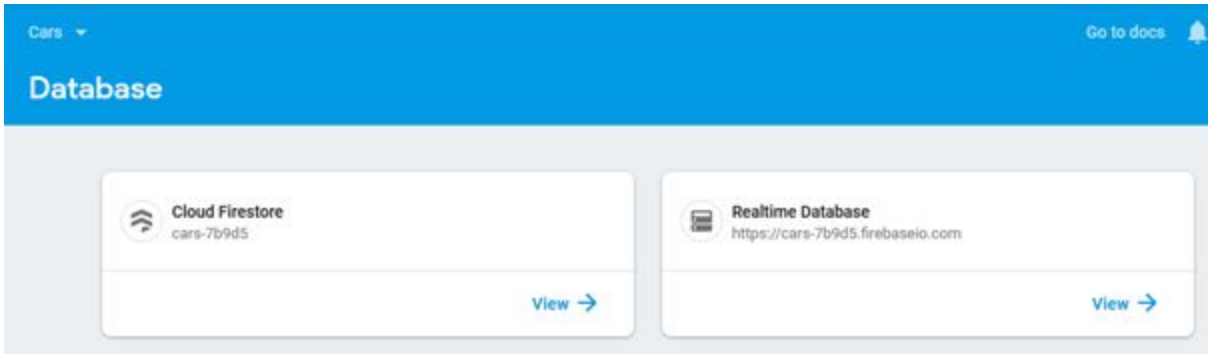

Figure 24. Firebase Realtime Database[10]

- Firebase Realtime Database
- https://cars-7b9d5.firebaseio.com/

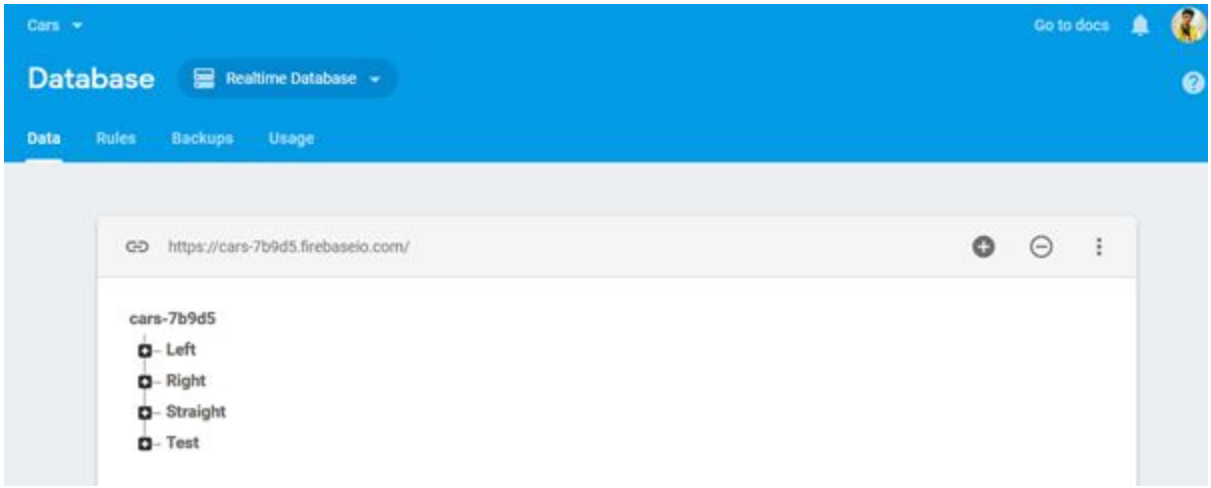

Figure 25. Training dataset

- Training dataset have 3 stacks Left, Right and Straight as Training Set and 1 stack as testing set Test.

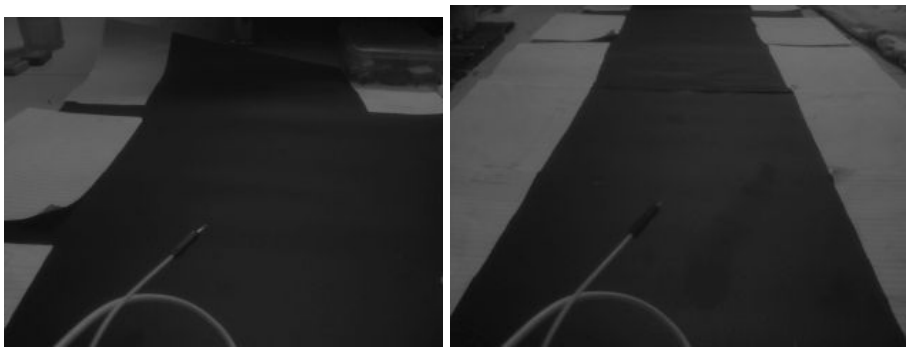

Figure 26. Image Capture by Raspberry pi camera [7]

- Image capture by Raspberry pi camera [7]
- Convert this image into gray scale image (binary) format using numpy and pandas library

Figure 27. Autonomous car Front view having raspberry pi camera

Figure 28.Using scikit library and SSID algorithm use for image comparison.[1]

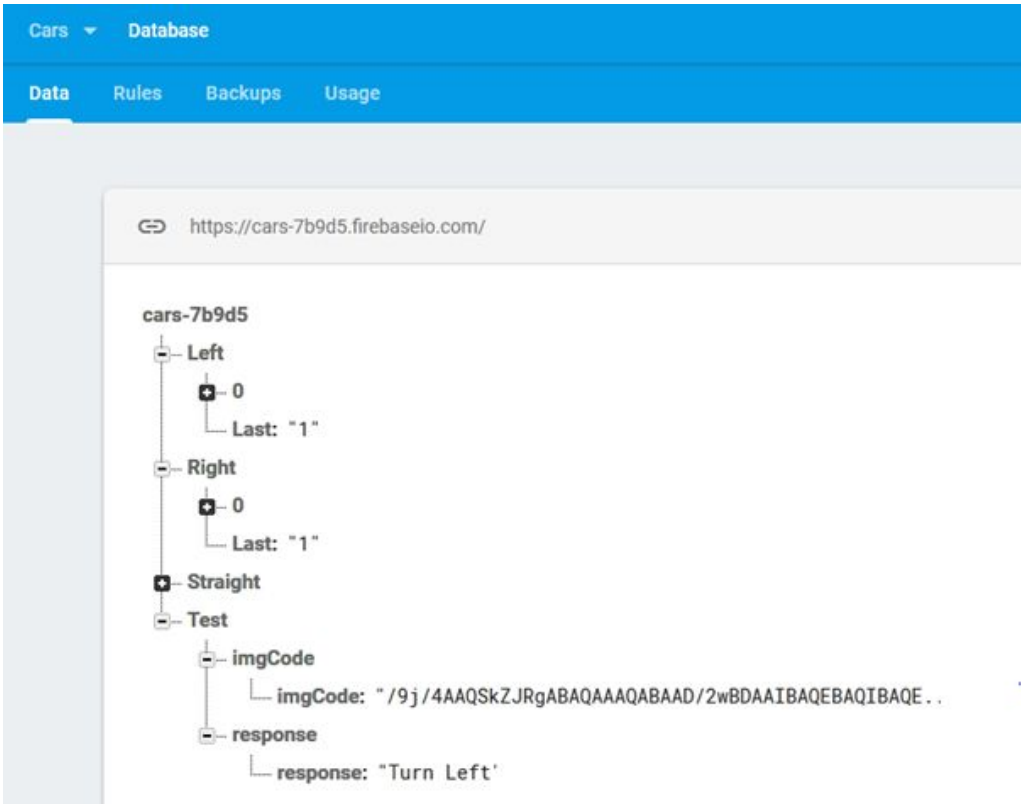

Figure 29. Test image uploaded on Firebase[10]

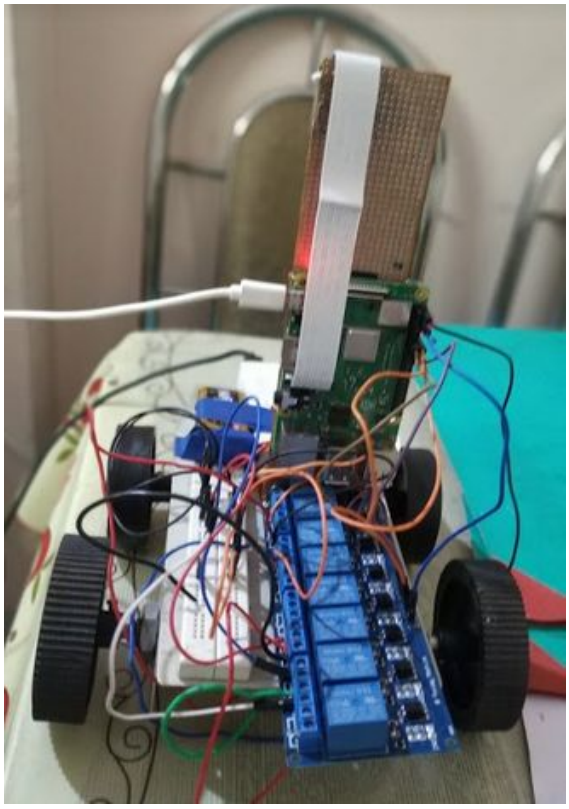

Figure 30. Backside of Project

- The data is fetch from Firebase using get() method in python and passed the code to Relay to move the motors and accordingly the Car moves Forward, Left and Right.

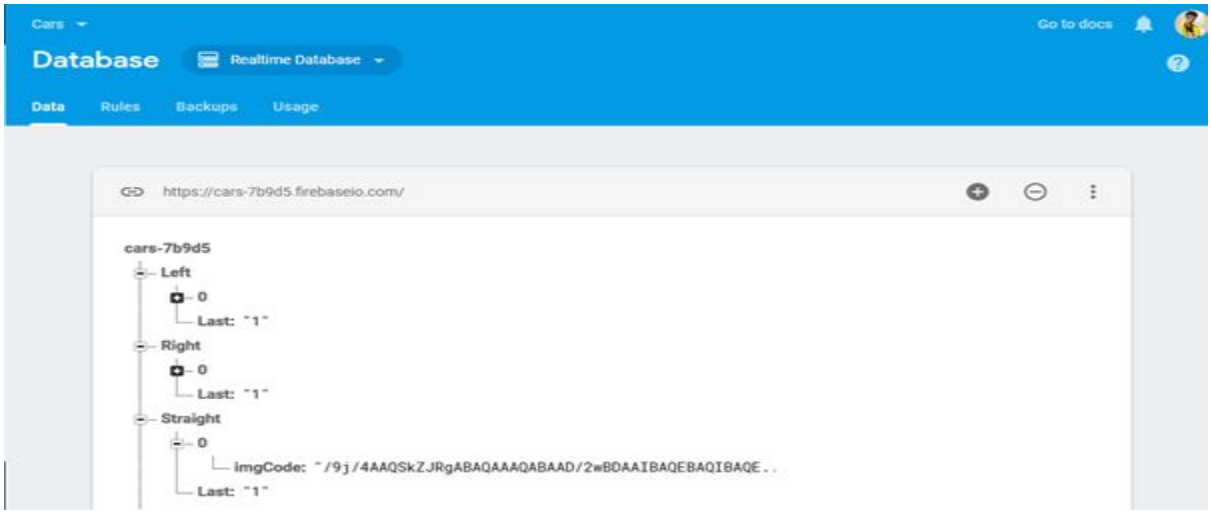

Figure 31. Data is send and retrieve in JSON format.[13]

- After code being executed the image data will be added to the respective stack direction on Firebase Realtime database and now considered as training set.

4. Conclusion

There is a huge market for home automation and its appliances. Nowadays people are moving with the trend of technology. Automation devices provide great comfort and ease in our lifestyle. In this age of technology our cars and other automobiles should also be much more innovative to provide comfort while driving.

According to "Association for Safe International Road Travel". Nearly 1.3 million people die in road crashes each year, on average 3,287 deaths a day. An additional 20-50 million are injured or disabled. This is a major disadvantage for World's economy and human life. No matter how much we educate and increase rules, the increasing number of vehicles and traffic problems have only increased the number of accidents every year.

In India one precious human life is lost in every four minutes. Delhi the capital of India has highest number of road crash deaths. For a developing country it's a major setback. . We as a team wants the number to be reduced. This system will surely reduce the accidents that are occurred due to distractions faced by driver while driving. This system is able to detect the path to be travelled ensure safety of the people as it only follows the path of road. Artificial intelligence and machine learning helps this machine to develop better.

The objectives of this project is completed. The problem in easy travelling by autonomous car is achieved. The autonomous car will predict the direction and move on given road.

5. Future Implementation

- This proposed system can further be modified and the concepts of Social Internet of Things can be integrated. The team has good views on it and surely will further implement some of the new concepts in near future.
- Unlock the car by face recognition.
- Can be used for both public and private transport.
- In public sector like autonomous trains and drones, improves connectivity and punctuality.
- In private sector like autonomous taxis, trucks, buses and other vehicles this enables the user keep track of their vehicles and prevents accidents. Include the face detection and predict the mood(state of mind) of user. Self-driven car. User will only say or select the destination. The car will detect the best path according to distance, traffic and type of road. User will reach the destination without driving the car.
- There would be almost zero on road accidents in future with help of this technology.
- Security of vehicle will be ensured.

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       Path Planning has been proposed based on combined fuzzy image processing and bacterial algorithm. Learning: vehicle follows to reach its destination avoiding obstacles. http://downloads.hindawi.com/journals/jr/2018/1969834.pdf
    B. Autonomous Cars Self-Driving the New Auto Industry Paradigm
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