A Project Report on

Self Driving Car

Submitted in partial fulfillment of the requirements for the award of the degree of

Bachelor of Engineering

in

COMPUTER ENGINEERING

by

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Approval Sheet

This Project Report entitled ***"Self Driving Car"*** Submitted by ***" Atharva Muley" (15102029), "Vinit Jain" (15102023), "Aditya Shetty" (15102027), "Karan Bawari" (15102002)*** is approved for the partial fulfillment of the requirenment for the award of the degree of ***Bachelor of Engineering*** in ***Computer Engineering*** from ***University of Mumbai***.

Prof. Amol Kalugade
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Place: A.P.Shah Institute of Technology, Thane
Date:

CERTIFICATE

This is to certify that the project entitled ***"Self Driving Car"*** submitted by ***"Atharva Muley(15102029), "Vinit Jain" (15102023), "Aditya Shetty" (15102027), "Karan Bawari" (15102002)*** for the partial fulfillment of the requirement for award of a degree ***Bachelor of Engineering*** in ***Computer Engineering***,to the University of Mumbai,is a bonafide work carried out during academic year 2018-2019.

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Declaration

We declare that this written submission represents our ideas in our own words and where others' ideas or words have been included, We have adequately cited and referenced the original sources. We also declare that We have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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(Signature)

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Abstract

Self Driving Car, currently is the state-of-the-art technology. After years of research and avail-ability of large computing it has made us possible to take a big leap in Artificial Intelligence.SelfDriving Car is a concept which seemed impossible decades ago but is now something which isgaining popularity and momentum, and companies have started selling their Self Driving Carsin the market.The Autonomous Car makes commuting more comfortable and safe. This willsubstantially decrease the number of fatalities caused every year due to human errors.It usesthe concept of Convolution Neural Network which performs the task of Image Recognition. Itmaps raw pixels from a single front facing camera directly to the steering commands. Basedon what car is perceiving the CNN computes the steering command.Compared to individualexplicit decomposition, CNN based approach provides better performance.Lane detection, pathplanning and control will be optimized simultaneously by our system.

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List of Abbreviations

CNN:	Convolutional Neural Network
ANN:	Artificial Neural Network
IDE:	Interactive Development Environment
OS:	Operating System
CV:	Computer Vision
IP:	Image Processing
Conv2D:	2-Dimensional Convolutional Layer

Chapter 1

Introduction

When it comes to image recognition, Convolutional Neural Networks (CNN) performs really well. CNN are used in various classification tasks like images, audio and words.An input image can be represented as a cuboid having depth, width and height.CNN substantially reduces the complexity of the traditional Artificial Neural Network. It learns the patterns in the image and stores it into feature maps. These feature maps once trained can be then used for predicting the steering angles.

Chapter 2

Objectives

The purpose of this project is to develop a Self Driving Car, by incorporating the state-of-the-art technologies. The concept when made available to the real world will significantly improve the way commuters travel. The Autonomous car will also help the disabled to commute from one point to another, independently.This will also cut the travelling hours in night, during which drivers generally prefers to sleep.This will also help decreasing the number of fatalities caused every year due to negligence of the driver, drunk driving and human error.

Chapter 3

Literature Review

The core part of our system is Convolutional Neural Network. It is method used for Image Recognition, what is classified as Deep Learning.It is inspired from our biological brain, and has similar workings. The CNN is a subset of Supervised Learning Algorithms which are trained using desired output/target values. While training the network tries to output a solution. The difference between the expected value and the output value is called error. The error is back-propagated to the network, where the weight updating takes place and network is said to learn the current input. The input to the CNN is an Image. Image is a multidimensional array. The array contains corresponding values for each pixel. A coloured image has 3 channels namely Red, Blue, Green.In our system the CNN maps raw pixels from a single front facing camera directly to the steering commands. Compared to individual explicit decomposition, CNN based approach provides better performance.

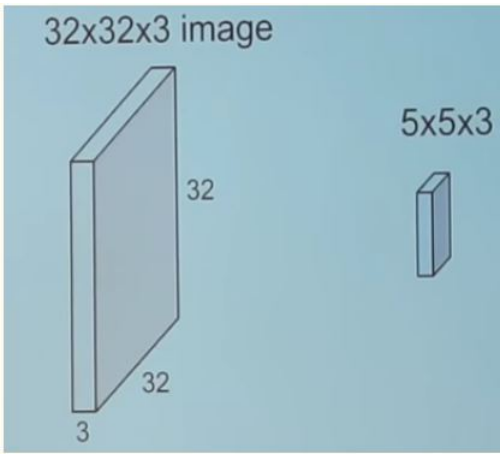


Figure 3.1: Basic working of a Convolutional layer

3.1 Convolutional Neural Network

3.1.1 Normalization Layer

Normalization of the image is a Image Processing technique in which we adjust the range of pixel intensity values. This step is performed to remove noise from data and convert all the intensities of the pixel in range -1 to 1.

$$x = \frac{x}{127.5} - 1$$

where x is the value for every individual pixel.

3.1.2 Convolution Layer

Convolution Neural Network (CNN) was developed by Yann LeCun, after inspiring from biological model for Image Recognition. In CNN every Network Layer acts as a feature detector which finds the pattern or feature in the input data. The patterns or features becomes more complex as move through subsequent CNN layers. The convolution is the mathematical operation in which we slide the kernel over the image by predefined position. In convolving we take a H*W*D sized kernel which we slide over the complete image and along the way we take dot product between the kernel and sub-parts of the image.

Kernel: The values of the kernel is initialized randomly.The height(H), width(W), depth(D) are the dimensions of the kernel.

Stride: It is the amount by which the kernel shifts during convolution. It is generally set in such a way that it outputs a Integer.

No of Filters: The number of kernels include in a Convolutional layer.

3.1.3 Dropout

The Dropout layer is a regularization technique which prevents over-fitting of the Artificial Neural Network by randomly selecting neurons during training and setting their value to zero. By avoiding training all nodes on all training data, dropout decreases over-fitting. The method also significantly improves training speed

3.1.4 MaxPooling

The main function of pooling layer is to reduce spatial size and amount of parameters and computations in network. Pooling layer operates on each feature map independently. In MaxPooling we specify the pool size of the kernel. The kernel is slide over the feature map, and the maximum of all the values are chosen from these.

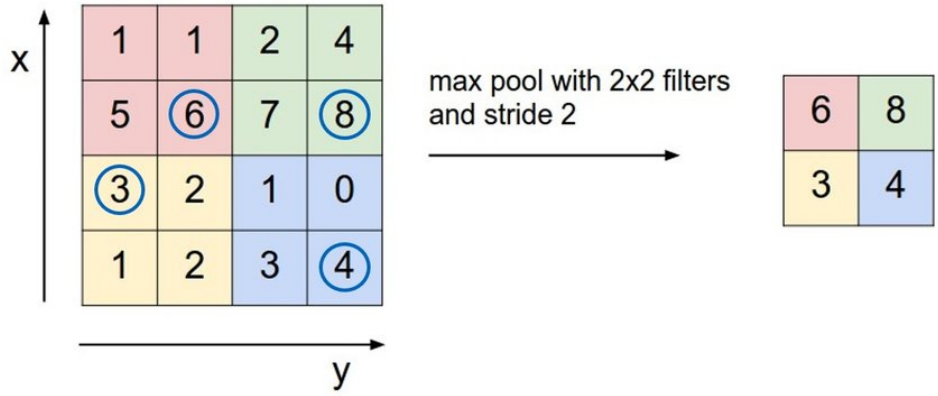


Figure 3.2: Max Pooling

3.1.5 Flatten

This layer flattens accepts multi-dimensional inputs and outputs one-dimensional data.The flattening step is needed so that you can make use of fully connected layers after some convolutional layers

3.1.6 Fully Connected Layer

The output of flattening layer is input to the fully connected layer. There are generally multiple fully connected layers. The number of layers usually depends and the complexity of the problem and number of data-points to consider.

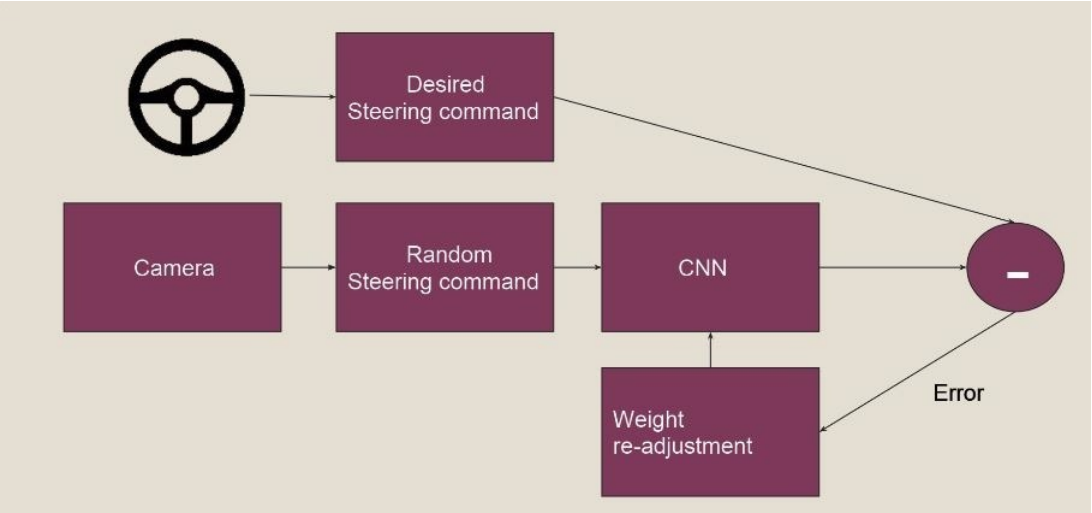
Chapter 4

Problem Definition

Driving in traffic these days is very tiring. There are also many fatalities caused per year due to human error. This project aims to develop and implement a self-driving car that is capable of sensing its environment and driving without any human input.The car should also able to take left or right turn when needed and also should be able to stop when an obstacle is encountered.

Chapter 5

Design



Conceptual representation of the proposed System

Chapter 6

Activity Diagram

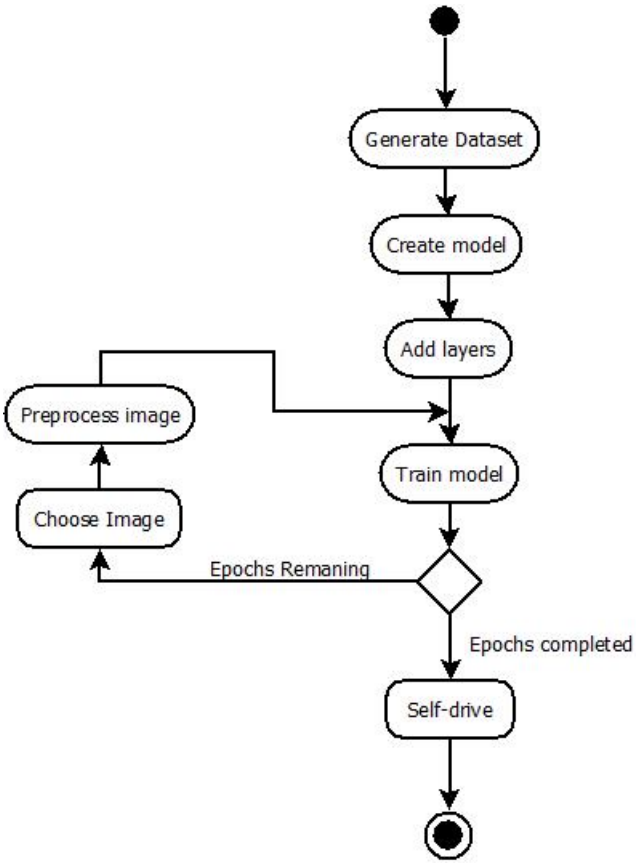


Figure 6.1: Activity Diagram

Chapter 7

Technology Stack

- Python (Programming Language)
- Anaconda or Miniconda (Virtual environment for python libraries)
- Jupyter Notebook (IDE for coding)
- Spyder (IDE for coding)

Chapter 8

Use Case Diagram

Use Case Diagram

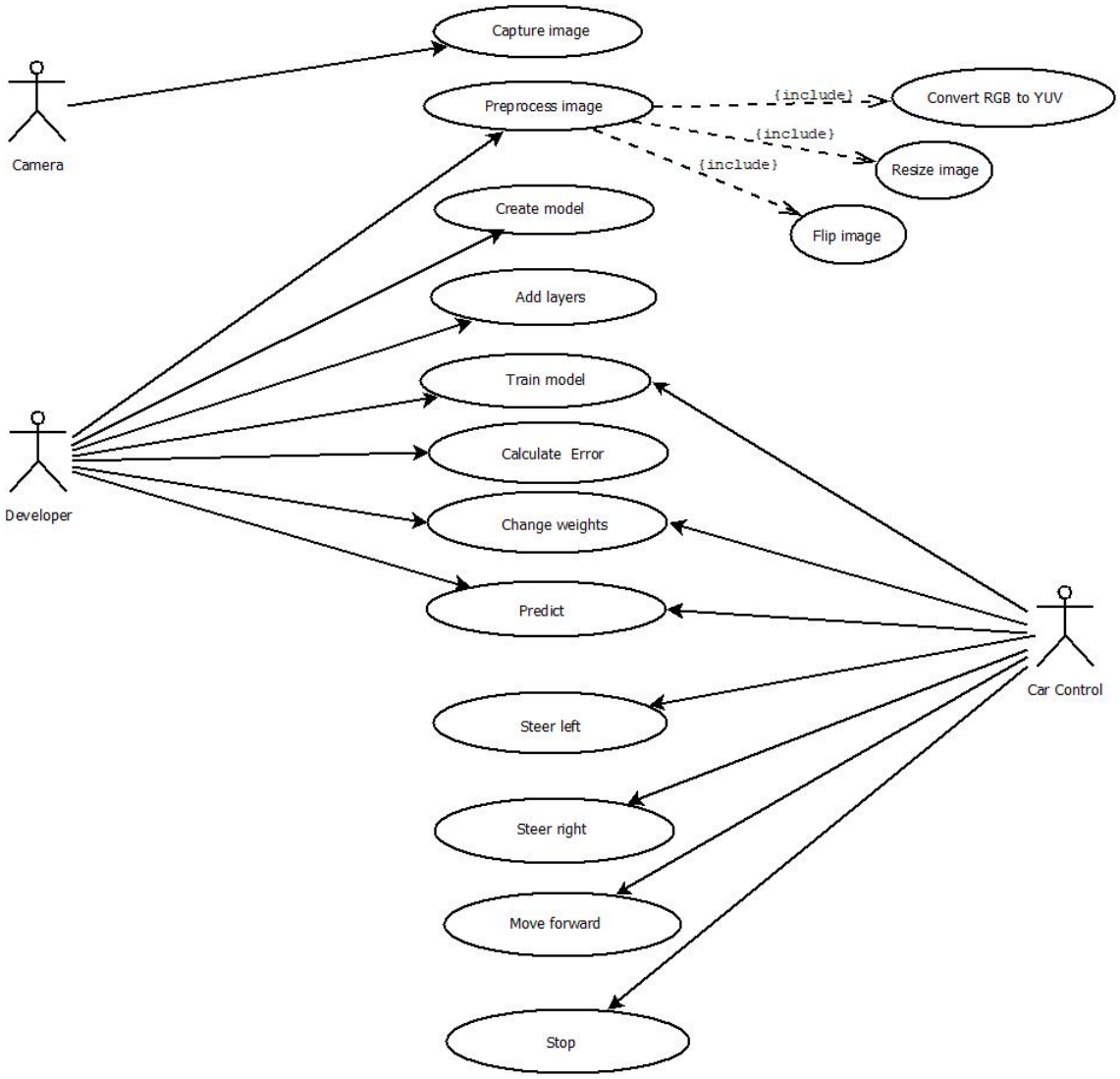


Figure 8.1: Use Case Diagram

Chapter 9

Dependencies

- Keras (TensorFlow Backend)(for CNN)
- Numpy (Powerful n-Dimensional array object)
- Scikit-learn (Creating train, test sets)
- OpenCV (Image Processing)
- Pandas (for reading CSV files)
- SocketIO

Chapter 10

Reading

After compiling the model following is the summary of the model and number of parameters involved.

Layer(Type)	**Output Shape**	**Parameter #**
$lambda_1(Lambda)$	**(None,66,200,3)**	**0**
$conv2d_1(Conv2D)$	**(None,31,98,24)**	**1824**
$conv2d_2(Conv2D)$	**(None,14,47,36)**	**21636**
$conv2d_3(Conv2D)$	**(None,5,22,48)**	**43248**
$conv2d_4(Conv2D)$	**(None,3,20,64)**	**27712**
$conv2d_5(Conv2D)$	**(None,1,18,64)**	**36928**
$dropout_1(Dropout)$	**(None,1,18,64)**	**0**
$flatten_1(Flatten)$	**(None,1152)**	**0**
$dense_1(Dense)$	**(None,100)**	**115300**
$dense_2(Dense)$	**(None,50)**	**5050**
$dense_3(Dense)$	**(None,10)**	**510**
$dense_4(Dense)$	**(None,1)**	**11**

Figure 10.1: Final Output in the simulator

Chapter 11

Conclusions and Future Scope

11.1 Summary

To develop and implement a self-driving car that is capable of perceiving its environment and driving without any human input. The car should also able to take left or right turn when needed and also should be able to stop when an obstacle is encountered.

11.2 Future Scope

Once the neural network model is working for the car driving simulator, we will move on to apply same model for hardware application. A remote controlled car will be used as the primary hardware. Processing part of the hardware will be handled by Raspberry Pi 3 equipped with Raspbian OS. A camera module will act as the sensor.

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