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"Jnana Sangama", Belagavi - 590018



A Project Report on

IS0602

**Steering Wheel Angle Prediction For Self-Driving Cars**

Submitted in partial fulfillment of the requirement

for the award of the degree of

BACHELOR OF ENGINEERING

IN

INFORMATION SCIENCE AND ENGINEERING

Submitted By

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2019-2020

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Certificate

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"Steering Whell Angle Prediction for Self-driving cars"

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in partial fulfillment for the requirements of the eight semester BE in Information Science & Engineering prescribed by The National Institute of Engineering, Autonomous Institution under Visvesvaraya Technological University, Belagavi. It is certified that all corrections or suggestions indicated for Internal Assessment have been incorporated. The Project report has been approved as it satisfies the academic requirements in respect of the project work prescribed for the eighth semester.

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Name of the Examinar Signature with Date

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ABSTRACT

Self-driving cars are one of the most increasing interests in recent years. Convolutional Neural Networks(CNNs) have been shown to achieve significant performance in various perception and control tasks compared to other techniques in the latest years. The automated system learns to drive on the local roads with no obstructions and also on the highways with the lane markings on it. This is because of the convolutional neural network (CNN) which is trained to map the pixels from the minimum training data provided by humans. It operates perfectly fine in the areas having hazy visuals like parking lots etc.

With human steering angle as the limited training signal, the system improvises and automatically learns to detect the road visibilities. Despite no explicit training for the detection of outline of the road, the system efficiently optimizes all processing steps simultaneously when compared to explicit decomposition of the problem.

It can be ensured that this will lead to better performance with smaller systems. The overall system performance maximizes by the optimization of system performance. The system learns to solve the problem with a minimum number of processing steps which results in smaller networks.

ACKNOWLEGEMENT

We would take pleasure in expressing our deep sense of gratitude to our institution.

The satisfaction that accompanies the completion of any task would be incomplete without naming a few people, whose constant guidance and encouragement made the work perfect. We would like to thank our respected **Dr. G. RAVI** for letting us to be a part of this prestigious institution and letting us to explore our abilities to the fullest.

We would like to extend our sincere gratitude to **Dr. P. Devaki, professor and HOD of ISE Department** for being a source of inspiration and instilling an enthusiastic spirit in us throughout the process of project making.

I’m thankful to our major project course instructor **Prajakta M** for helping us with his suggestions to do the project and sharing his knowledge and experience.

We wish to express our gratitude towards our project guide **Suhas Bharadwaj R** for their constant support, guidance, valuable knowledge and experience.

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Chapter 1

Introduction

1.1 Project Description

CNNs have revolutionized the computational pattern recognition process. Before widespread adoption of CNNs, most pattern recognition tasks were performed using an initial stage of manual feature extraction followed by a classifier.

A Convolutional Neural Network is a class of artificial neural networks that uses convolutional layers to filter inputs for useful information. The convolution operation involves combining input data (feature map) with a convolution kernel (filter) to form a transformed feature map. The filters in the convolutional layers (conv layers) are modified based on learned parameters(weights plus bias) to extract the most useful information for a specific task. Convolutional networks adjust automatically to find the best feature based on the task. The CNN would filter information about the shape of an object when confronted with a general object recognition task but would extract the edges of the road when faced with an edge recognition task. This is based on the CNN’s understanding that different classes of objects have different shapes but that different types of roads are more likely to differ in shape than in color.

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CHAPTER 1. INTRODUCTION

Convolutional networks are composed of an input layer, an output layer, and one or more hidden layers. This allows CNN to transform an input volume in three dimensions to an output volume

1.2 Project Purpose

The main objective of this project is basically to apply the concepts of Deep Learning and Convolutional Neural Network and simulating the working of self driving car so that, the car can drive autonomously without the human intervention. This allows the system to get a deep understanding about how to predict the steering wheel angle and maneuver itself according to the provided input

1.3 Existing System

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1.4 Proposed System

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Chapter 2

Literature Survey

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CHAPTER 2. LITERATURE SURVEY

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| --- | --- | --- |
| i3 | 2i3 | 3i3 |
|  |  |  |
| 1 | 2 | 3 |
| 8 | 16 | 24 |
| 27 | 54 | 81 |
| 64 | 128 | 192 |
| 125 | 250 | 375 |
| 216 | 432 | 648 |
| 343 | 686 | 1029 |
| 512 | 1024 | 1536 |
| 729 | 1458 | 2187 |
| 1000 | 2000 | 3000 |
| 1331 | 2662 | 3993 |
| 1728 | 3456 | 5184 |
| 2197 | 4394 | 6591 |
| 2744 | 5488 | 8232 |
| 3375 | 6750 | 10125 |
| 4096 | 8192 | 12288 |
|  |  |  |

Foot information

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CHAPTER 2. LITERATURE SURVEY

Table 2.1 { information message on top

|  |  |  |
| --- | --- | --- |
| i3 | 2i3 | 3i3 |
|  |  |  |
| 4913 | 9826 | 14739 |
| 5832 | 11664 | 17496 |
| 6859 | 13718 | 20577 |
| 8000 | 16000 | 24000 |
| 9261 | 18522 | 27783 |
| 10648 | 21296 | 31944 |
| 12167 | 24334 | 36501 |
| 13824 | 27648 | 41472 |
| 15625 | 31250 | 46875 |
| 17576 | 35152 | 52728 |
| 19683 | 39366 | 59049 |
| 21952 | 43904 | 65856 |
| 24389 | 48778 | 73167 |
| 27000 | 54000 | 81000 |
| 29791 | 59582 | 89373 |
| 32768 | 65536 | 98304 |
| 35937 | 71874 | 107811 |
| 39304 | 78608 | 117912 |
| 42875 | 85750 | 128625 |
| 46656 | 93312 | 139968 |
| 50653 | 101306 | 151959 |
| 54872 | 109744 | 164616 |
| 59319 | 118638 | 177957 |
| 64000 | 128000 | 192000 |
| 68921 | 137842 | 206763 |
| 74088 | 148176 | 222264 |
| 79507 | 159014 | 238521 |
| 85184 | 170368 | 255552 |
| 91125 | 182250 | 273375 |
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CHAPTER 2. LITERATURE SURVEY

Table 2.1 { information message on top

|  |  |  |
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| i3 | 2i3 | 3i3 |
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| 97336 | 194672 | 292008 |
| 103823 | 207646 | 311469 |
| 110592 | 221184 | 331776 |
| 117649 | 235298 | 352947 |
| 125000 | 250000 | 375000 |
|  |  |  |
|  |  |  |

Table 2.1: Long Table

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Chapter 3

System Requirement

**Software Requirements**

|  |  |
| --- | --- |
| Operating System | GNU/Linux, Windows 8,10, Mac OS |
| Programming Language | Python3 |
| Framework | Pytorch |
| Training Platform | Google CoLab |

**Hardware Requirements**

|  |  |
| --- | --- |
| Processor | Quad core Intel Core i7 Skylake |
| Primary Memory | 8 GB |
| Secondary Memory | 1 TB |

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Chapter 4

System Design

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CHAPTER 4. SYSTEM DESIGN

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Chapter 5

System Implementation

We have implemented our system based on Convolution neural network model architecture. The collected data is passed on to our model as training data. We train our model to minimize the mean squared error between the steering command output by the model and the values in the dataset. The network consists of 9 layers, including a normalization layer, 5 convolutional layers and 3 fully connected layers.

The first layer of the network performs image normalization. Normalization normalizes the data between 0–1 by dividing training data and testing data by factor. Training and validation set should be normalized with the same factor.

Next 5 layers are convolutional layers which help in feature extraction. We use strided convolutions in the first three convolutional layers with a 2×2 stride and a 5×5 kernel and a non-strided convolution with a 3×3 kernel size in the last two convolutional layers. Hyperparameters like depth, stride control the size of the output volume. When the stride is 1 then we move the filters one pixel at a time. When the stride is 2 then the filters jump 2 pixels at a time as we slide them around. This will produce smaller output volumes spatially. We follow the five convolutional layers with three fully connected layers leading to an output value of steering wheel.

The model is saved and then fed to simulator to make model run in simulator to run for itself.

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Chapter 6

Testing

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CHAPTER 6. TESTING

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Chapter 7

Deployment

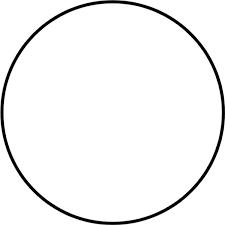


Figure 7.1: A gure caption beneath the gure for description of the depicted concept which sometimes can be very long

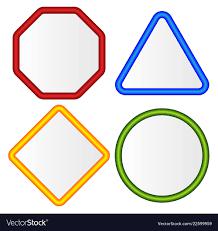


Figure 7.2: A gure caption beneath the gure for description of the depicted concept which sometimes can be very long

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CHAPTER 7. DEPLOYMENT

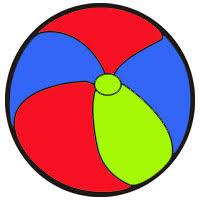


Figure 7.3: A gure caption beneath the gure for description of the depicted concept which sometimes can be very long

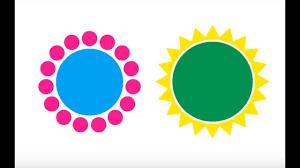


Figure 7.4: A gure caption beneath the gure for description of the depicted concept which sometimes can be very long

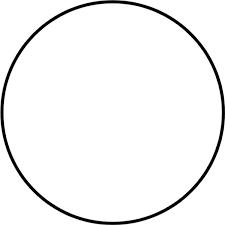


Figure 7.5: A gure caption beneath the gure for description of the depicted concept which sometimes can be very long

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Conclusion

We have successfully shown that CNNs are able tounderstand the entire learning process lane and road following without manual decomposition into road or lane marking detection, path planning, and control. A small amount of training data from less hours of driving was sufficient to train the virtual car to operate in diverse conditions, on highways, local and residential roads in sunny, cloudy, and rainy conditions[4]. The CNN is able to extract the meaningful and useful road features from a very sparse training signal(only steering). For example our autonomous system learns to detect the outline of a road without the need of explicit labels during training.

As can be seen, there are many areas we could explore to push this project further and obtain even more convincing results. Furthermore, we are going to take throttle into the model with the ambition of achieving higher levels of autonomous cars.

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Future Enhancement

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References

[1] Intro to Deep Learning with PyTorch by Facebook Artificial Intelligence,

URL https://www.udacity.com/course/deep-learning-pytorch--ud188

[2] Hands-On Machine Learning with Scikit-Learn and TensorFlow by Aurélien Géron.

[3] M. Bojarski, D. Del Testa, D. Dworakowski, B. Firner, B.Fleep, P. Goyal, L. D. Jackel, M.Monfort, U. Muller, and J. Zhang, “End to end learning for self-driving cars,”2016.

[4]

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