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Self-Driving Autonomous Car with Efficient and Adaptable Environment using Computer Vision

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Abstract—(Autonomous) Self Driving Car:
In the modern era of automobile technology, vehicles are moving towards implementing autonomous feature. This project is focused on two applications: an automated car, and a safer algorithm for generating autonomous feature in the machinery. The major application of automated driving is to avoid heavy traffic jam and accidents. The idea/inspiration in this concept/simulation has been taken from the Google car, defining the one aspect that is by offering a secure environment that can adapt to autonomous vehicles. Thus by taking intelligent decisions in traffic by pre-avoiding accidental conditions is achieved with the help of machine learning and neural network. Where a 9-Layer convolutional net is introduced in order to train the model to have an automated lane assist feature.

Secure Environment For Self Driving Car:

As we are moving towards autonomous technology, it's mandatory to understand the consequences of facing what's coming next. Since the inception of automobile industry becoming commercial in the late 1890s, cars have become increasingly safe and convenient. As of late, carmakers have moved towards building vehicles by introducing advanced driver-assistance systems and real-time active lane assist which is the basics of automated driving into their machinary. But the process of building a safe environment to adapt to autonomous vehicles is still a concept.

This is what we are trying to propose in this project. After the execution autonomous cars, the next major criteria is to build a safe environment. An autonomous car can make more advantageous, more secure, and less vitality serious. Furthermore, the concept of Green Light Optimal Speed Advisory (GLOSA) systems will be introduced in order to reduce travel time and CO_2 emission. All of this is achieved using Computer Vision & Machine Learning.

Index terms — accident prevention; machine learning technology; GLOSA; 9-layer convolutional net; computer vision

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1. INTRODUCTION

1.1. A. Understanding the project

In this project we have focused on two applications - automated car, and a safe environment for the autonomous vehicle. The self-driving car will work on simulation and will use computer vision and convolutional neural net for analyzing the environment. After the execution autonomous cars, the next major criteria is to build a safe environment. We will use Road side units (RSUs) along with Green Light Optimal Speed Advisory (GLOSA) systems to decrease the travel time and CO2 emission. An autonomous car collects the road information transmitted by an Road Side Units and then, it improves speed with a specific end goal to touch base at the crossing point when the light is green.

1.1.1. B. Perception approaches for Autonomous Entity (Deep Learning; Computer Vision)

The approach we are looking into is called as “end-end driving” or “Deep Learning”. One advantage of using neural network is that once the network is trained, it just has to load the parameters further. Which means the perception is faster. Late advance in PC vision has is completely driven by high-capacity models trained on larger datasets. The advancement in technology has allowed “image classification” (Like the CamVid) to create datasets with a great many marked pictures bolster preparing profound and exceedingly expressive models.

1.2. C. Behavioral Cloning

Cloning is the method of understanding and retrieving data from the dataset in order to represent or execute them as such on a required model. In this project we are using deep neural networks and 9-layer convolutional neural networks to clone driving behavior. We tend to train, validate and test the built model using Keras. Thus as a result the trained dataset will execute a steering angle to an autonomous vehicle.

The steps involved in behavioral cloning:

- Creating a program that can design, train and also validate a AI model that can thereby predict a steering angle from image/video data. (In our case we are using video data)

- Further we use the model to drive the vehicle autonomously around the first track in the simulator. The vehicle should be maintained on road for a complete circle to get the clear dataset of the lane.

2. II. RELATED WORK

2. 1. A. Mediated Perception Approach

The major industries working on autonomous driving systems are using the mediated perception approaches. In computer vision, researchers have studied; by understanding that car and lane detection are two major concepts of autonomous approach of vehicles. The Mediated Perception Approach holds different sub-parts for perceiving driving-significant articles, for example, paths, movement signs, and even eternal objects such as pedestrians.

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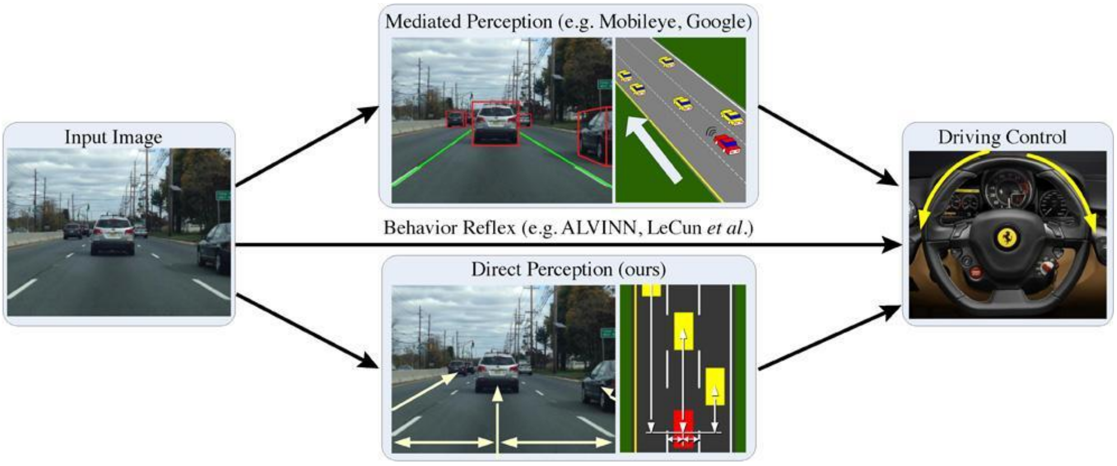

Figure 1. Example of Mediated Perception

The Mediated approach uses the input image to understand the lane conditions using several API's (in most cases) in order to control the car. Further an AI Program is used to train and execute the model. Computer vision is used in order to understand the lane elements with the help of bounding boxes and splines as not to coordinate affordance data we use for driving.

2. 1. B. Behavior reflex approaches

This is a real-time method of rendering both understanding and execution at the same time. This idea dates back to the late 1980s when programmers where using sensors to understand and detect an object in-front or on side. They were using neural system to build an immediate mapping from a picture to steering angles. To train the model, a human drives the car along the lane and a trained dataset is created. In spite of the fact that this thought is exceptionally exquisite, it can battle to manage movement to deal with traffic, understanding the objects on the lane (which might mismatch with the trained nodes) and thereby complicating the driving process.

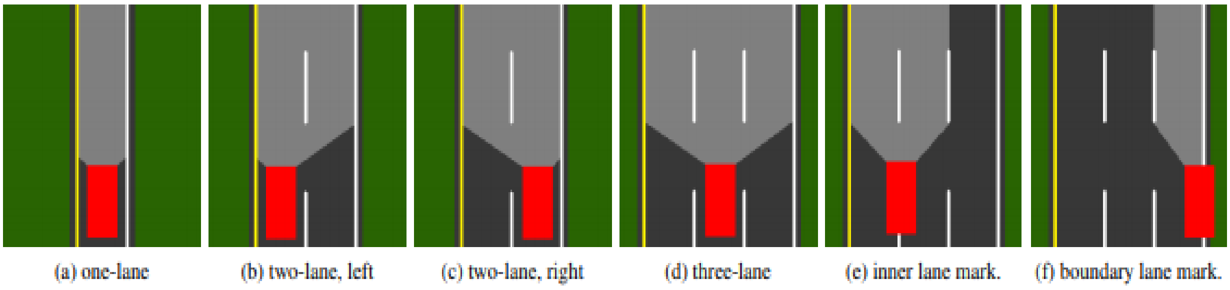

Figure 2. Example of Behavior reflex approaches

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3. III. PROPOSED METHODOLOGY

The system suggested by us comprises majorly of the behavioral cloning method. Unlike the previous systems seen, the system built by us uses various technologies such as computer vision in order to undertake several components from the detect image/video and execute the autonomous feature with a more efficient algorithm such as the 9-Layer convolutional net.

3.1. A. System Architecture

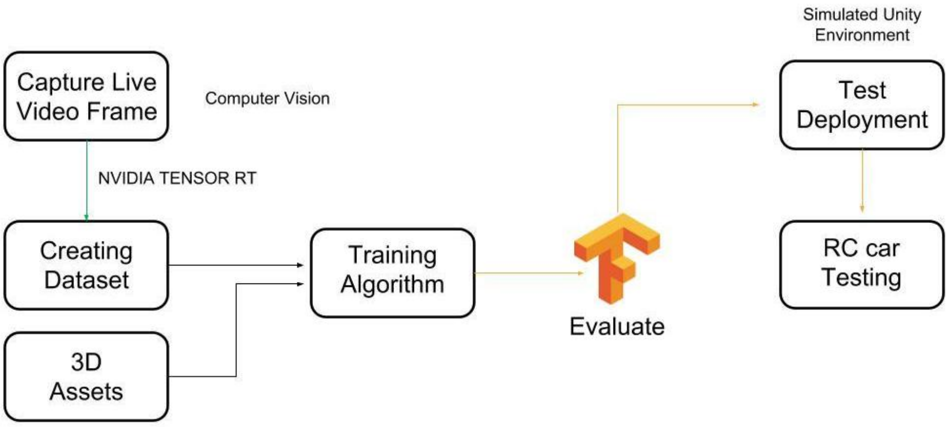

Figure 3. System Architecture

The system architecture uses the ConvNet procedures and estimates thirteen trained indicators for driving. Based on the generated dataset the current speed of the car, is controlled using a ML Algorithm. To maintain smooth driving, we are using lane assist AI Engine which tends to detect the objects in the lane and generates steering angles which is Further fed into the Neural Net. We have built the system in such a way that it can endure direct errors in the estimated indicators. The car is a continuous system, and the controller program tends to consistently correct the steering position. Even with some low level error estimations, the controller can provide a easily experience with no impacts.

3.2. B. TECHNICAL MODULE / IMPLEMENTATION:

3.2. C. MODULE 1: Simulated Environment & Pre-Trained Module:

A simulated environment of a city with real-life obstacles is created using Unity 3D+Vuforia is created. Further the training module is created using the simulator. No Machine Learning is invoked here. Also we are using certain prebuilt scripts which handles the Physics of objects, like gravity, momentum & acceleration.

Challenges:

- Understanding the behavior of every object present in the environment.

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- Making Computer Vision to understand and identify every individual asset present in the environment.

3.2. D. MODULE 2: Data Generation Mode

We are basically going to do what NVIDIA did in training their self-driving program. A 9 Layer convolutional net is made with the help of a real car and 360 degree camera. So the real environment captured by the 360 degree camera and which is further stored in a convolutional net. Basically what the camera is doing is to collect data of real-time environment and simultaneously storing every data in a CSV format.

Figure 4. Generated Program

3.2. E. MODULE 3: Training Program

The car is considered as the major asset in the entire simulated vectors. This major asset is trained by running the vehicle among the environment by manual usage. Further the computer vision algorithm keeps recording the objects and will identify every individual asset found in the environment with different key names. The Deep Learning Net is created with nodes of different understanding. Here we are using Tensor Flow and Computer vision.

Challenges:

- Overriding of the neural net.
- The vanishing Gradient Problem is a major threat to forming the deep learning net.

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Which might mismatch and update based on the error node.

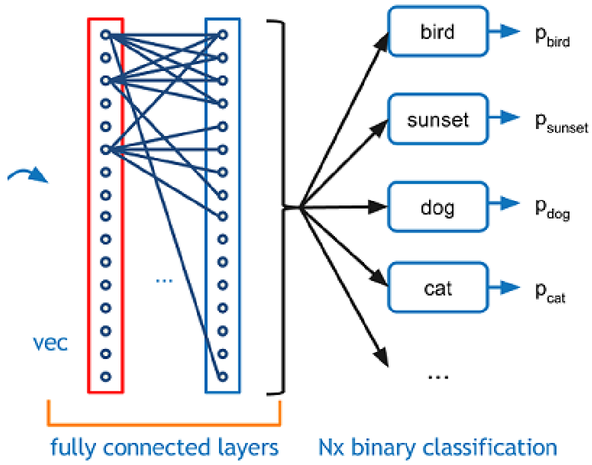

Figure 5. Convolutional Net

3.3. F. OBJECT DETECTION ALGORITHM

This built program uses Haar feature-based cascade classifiers for object detection. The Haar Feature- based cascade classifier is considered one of the majorly efficient algorithm for object detection. This method was proposed by Paul Viola and Michael Jones in their paper, "Rapid Object Detection using a Boosted Cascade of Simple Features" in 2001. It is a machine learning based approach where a cascade function is trained from a lot of positive and negative images. There by using a filter to convert the video/image into gray scale to identify the Edge, Line & Four Rectangle features.

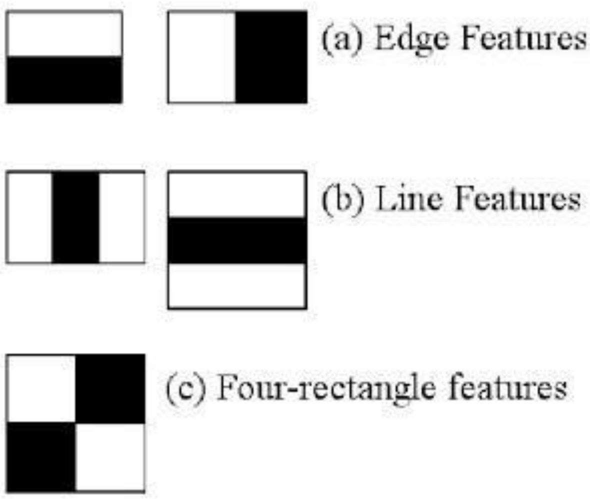

Figure 6. Haar Feature- based cascade classifier

4. IV. CONCLUSION

In this paper, our proposed method of autonomous driving paradigm based on direct perception and behavioral cloning tends to provide extremely safe access to generate non-accidental self-driving/autonomous cars. Our portrayal use a profound ConvNet design with the help of direct perception to assess the affordance for driving activities rather than real-time behavioral reflex which might end up producing an inefficient and unsafe method. With further enhancements in the current system and certain acceptance of law system in every country, this program can be embedded in several vehicle machineries, thereby reducing the level of traffic and thus create a better environment for automobiles.

This work is partially adapted or inspired from Google and NVIDIA's approach towards self-driving cars.

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