International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 02 | Feb 2020 www.irjet.net p-ISSN: 2395-0072

Autonomous Navigation System using Deep Learning

Sayali Khot[1], Divya Annaldas[2], Madhuri Naik[3], Martina D'souza[4]

[1,2,3]Student, Information Technology, Xavier Institute of Engineering, Mumbai, 400016 (India)
[4]Professor, Information Technology, Xavier Institute of Engineering, Mumbai, 400016 (India)

---***---

Abstract - *With the rising trend in research and development of autonomous vehicles, because of the complexity of the problem, seemingly endless applications, and capital gain. The Title "Autonomous Navigation System using Deep Learning", aims to simulate how self-driving cars will work in the real world. Important part of an autonomous system is training the vehicle in a simulation environment. Unity, the real-time 3D rendering platform, is used to efficiently create simulation environments and artificial intelligence is used to train the vehicle Convolutional neural networks (CNN) is used to create the model. Just like humans, an autonomous vehicle needs a "brain": this is the autonomous system, which comprises four key areas: Control, Planning, Perception and Coordination*.

***Key Words*: Unity, Convolutional Neural Networks, Neural Networks, Machine Learning, Artificial Intelligence.**

1. INTRODUCTION

An autonomous car is a vehicle that can guide itself without human assistance. This kind of car has paved the way for future systems where computers take over the art of driving. An autonomous car is also known as a driverless car, self-driving car or autonomous vehicle.

Self-driving Cars are the future of personal transportation. Recently Simulation has been useful for building and training vehicles. Simulation is used to compute sensor data and verify that the vehicle's self-driving software handles tricky situations appropriately.

The most important areas involved in virtual environment simulations are scenario library, modeling, simulation management, and intelligent reporting. Simulation plays an important role because the customers entrust their safety in the hands of the vehicle. The key challenges with training autonomous vehicles are

1. Data Collection
2. Structure Data
3. Educate the Car
4. Preparing for inevitable unforeseen situations

2. REVIEW OF LITERATURE

As of March 2018, 52 companies possessed permits to test autonomous vehicles on the roads of the State of California alone [3][4]. These technological changes may then foreshadow a repurposing of parking lots within buildings to accommodate new offices, or retail uses.

In this paper, the idea of simulation of self-driving cars using Unity is proposed. First, the CNN model parameters were trained by using data collected. The training data were road images paired with the time-synchronized steering angle which included left, right and center generated by manually driving. Second, the road tests the model to drive itself in the outdoor environment around oval-shaped and 8-shaped with the traffic sign lined track. The experimental results demonstrate the effectiveness and robustness of the autopilot model in lane keeping tasks. Vehicle's top speed is about 5-6km/h in a wide variety of driving conditions, regardless of whether lane markings are present or not [1].

3. PROPOSED METHODLOGY

To create Autonomous Navigation System we are using Unity, the real-time 3D rendering platform, to build the simulated environment and Artificial Intelligence to create the brain of the system.

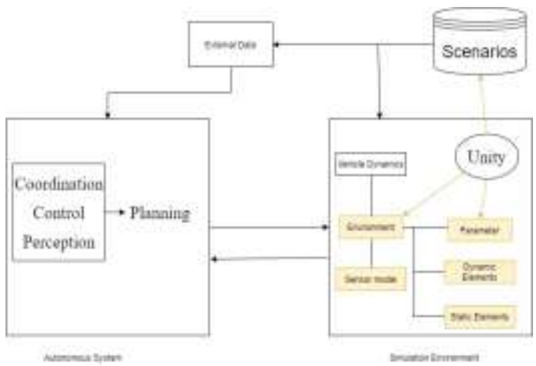


Fig -1: Simulated Environment with Unity

3.1 Creating the Model

In AI, model-based reasoning refers to an inference method used in advanced systems based on an actual model of the physical world. This approach is carried out such that the main focus of application development is developing the model. During the runtime, an "engine" combines this model knowledge with observed data to derive conclusions such as a prediction.

Finding Lane Lines: Identifying lanes of the road is a very common task that human drivers perform. This is important to keep the vehicle in the constraints of the lane and not let the vehicle go out of control. This is also one of the most important tasks for an autonomous vehicle to perform. Simple Lane Detection pipeline is possible with Simple Computer Vision techniques and procedures.

Deep Neural Network: A deep neural network is simply a neural network with more than two layers but with a certain level of complexity associated with it. Deep Feedforward networks are also known as multilayer perceptrons. These Multilayer perceptrons are the foundation of most of the deep learning models. Networks such as CNNs and RNNs are just some special cases of Feedforward networks. These networks are mostly used for supervised machine learning tasks where we already know the target function which can be called as our goal ie the result we want our network to achieve and are extremely important for practicing machine learning and form the basis of many commercial applications, areas such as computer vision.

Multiclass Classification: Classification problems having multiple classes with imbalanced dataset present a different challenge than a binary classification problem..

Classification tasks with more than two classes can be for e.g. classify a set of images of fruits which may be oranges, apples, bananas or pears. Multi-class classification makes the assumption that each sample is assigned to one and only one label and not more than that for example the label fruit can be associated with an apple or a pear but not both at the same time similarly it can be an orange or pear and not both at the same time.

MNIST Image Recognition: CNN is the most powerful supervised deep learning network amongst all. The MNIST(Modified National Institute of Standards and Technology database) dataset is one of the most common datasets used for image classification and accessible from many different sources. Tensorflow and Keras also allow us to import and download the MNIST dataset directly from their API.

Then Modified National Institute of Standards and Technology database consists of 60,000 training images and 10,000 testing images obtained from American Census Bureau employees and American high school students.

Convolutional Neural Network (CNN): Convolutional Neural Network have revolutionized the computational pattern recognition process. Most pattern recognition tasks were performed using an initial stage of hand-crafted feature extraction followed by a classifier before CNN. The important breakthrough of CNNs and an accomplishment could be that features are now learned automatically from training examples. The CNN approach especially becomes robust when applied to image recognition tasks because the convolution operation captures the 2D nature of images. With the help of convolution kernels which are used to scan an entire image, relatively few parameters need to be learned compared to the total number of operations [2].

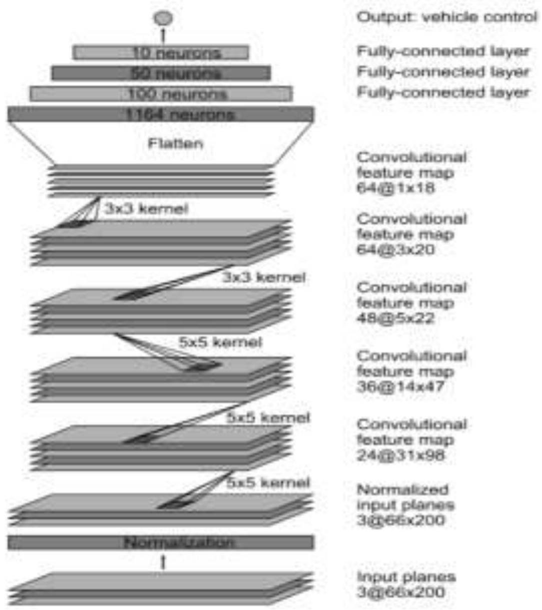
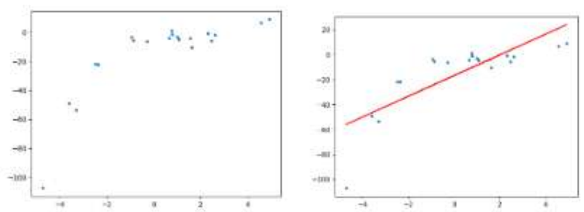


Fig -2: CNN architecture.

Source: Adapted from [8]

Polynomial Regression: Linear regression requires the relation between the dependent variable and the independent variable to be linear. The linear models cannot be used to fit non-linear data. We cannot generate a curve that best captures the data.



As we can observe from the above graphs, straight line is unable to capture the patterns in the data. This is an example of under-fitting.

To overcome under-fitting, the complexity of the model has to be increased. In order to generate a higher order equation, powers of the original features can be added as the new features. The linear model,

$$Y=\theta_0 + \theta_1x$$

can be transformed to

$$Y=\theta_0 + \theta_1 x + \theta_2 x^2$$

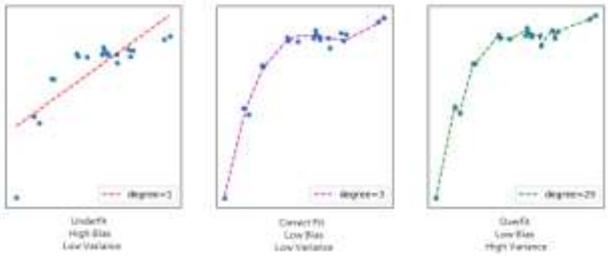


Fig -3: Summary of overfitting and underfitting

Source: Adapted from [9]

Behavioral Cloning: It is a method by which human sub-cognitive skills can be captured and reproduced in a computer program. The actions of the human subject are recorded along with the situation that gave rise to the action as the human subject performs the skill. The records are logged and then they are used as an input to a learning program. As a result, the learning program is able to output a set of rules that reproduce the skilled behavior. Behavioral Cloning can be used to construct automatic control systems for tasks which are of higher complexity and for which classical control theory is inadequate and insufficient and it can also be used for training.

3.2 Creating the Virtual World

Computer program which can be a game or a dedicated device that simulates some aspects of a real life situation such as flying an aircraft or experiencing a rollercoaster and can be manipulated to observe the outcomes of different assumptions or actions, without exposing the experimenter to any danger or risk or injury.

Figure 4: Unity Simulator

3.3 Training the Model using Simulator

We have used convolutional neural networks (CNNs) for mapping the raw pixels from a front-facing camera to the steering commands for the autonomous car with the training commands given properly to the car in automotive application. This powerful end-to-end approach means that with minimum training data from humans, the system learns to steer which includes changing the steering angles as required, with or without lane markings, on both local roads and highways. The system can also operate in areas such as parking lots or unpaved roads which have bad lighting situations.

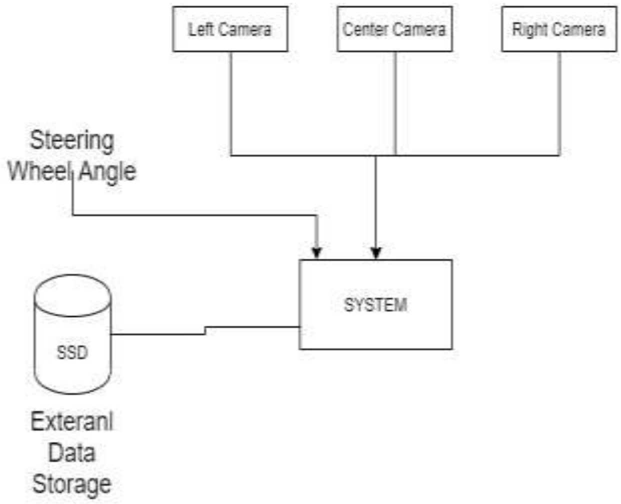


Fig -5: High-level view of the data collection system

Training Details

- Data Selection: The first step to training our project's neural network is selecting the frames. The collected data consists of road type, and driver's activity which involves staying in a lane, switching lanes and turning. To train a CNN to do lane following, we simply select data where the driver is staying in a lane, and discard the rest so we can focus on relevant data. To remove a bias towards driving straight the training data includes a higher proportion of frames that represent road curves so it is ensured that it is proportionate date [2].

- Augmentation: The final sets of frames are selected then the data is augmented by adding artificial shifts and rotations to teach the network how to recover from a poor position or orientation so that it delivers accurate results. The magnitude of these perturbations is chosen randomly from a normal distribution which has to be noted down. According to the results, we can see that the distribution has zero mean, and the standard deviation is twice the standard deviation that we measured with human drivers. Artificially augmenting the data does add artifacts as the magnitude increases which is undesirable.

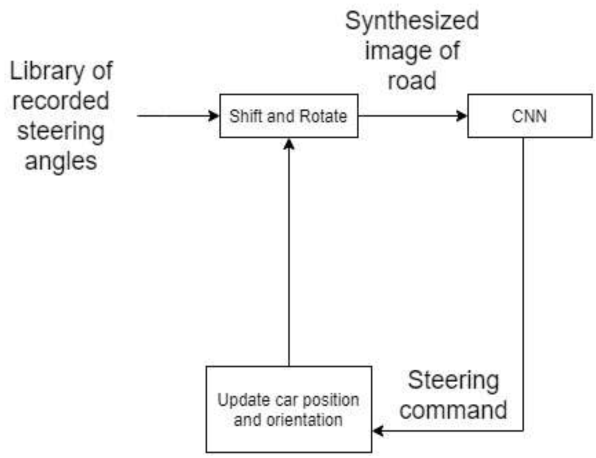


Fig -6: Block diagram of drive simulator

4. CONCLUSIONS

A virtual environment is created on unity for running the car. We have learnt Convolutional Neural Networks and built a model using CNN. We have built our own dataset by manually driving the car and recorded the steering angle of the car, i.e. left, right and centre. The dataset has also recorded the speed and throttle of the car. After the collection of the training dataset we have created a CNN model. The CNN model detects path and is able to run on car successfully on the simulator created on Unity within the lanes.

After running the car on the lanes without any obstacles, we have added obstacles for the car and then trained the car to detect and take turns based on those obstacles. Now Our Trained Car can successfully avoid obstacles and run in the given lane on its own in the designed Unity Environment thereby showing the functionality of our Simulator.

REFERENCES

[1] Truong-Dong Do ; Minh-Thien Duong ; Quoc-Vu Dang ; My-Ha Le, "Real-Time Self-Driving Car Navigation Using Deep Neural Network", 2017

[2] End to End Learning for Self-Driving Cars 2016,https://images.nvidia.com/content/tegra/automotive/images/2016/solutions/pdf/end-to-end-dl-using-px.pdf

[3] State of California, Department of Motor Vehicles (2018) Permit holders, https://www.dmv.ca.gov/portal/dmv/detail/vr/autonomous/permit.

[4] Wakabayashi D (February 26, 2018) California scraps safety driver rules for self-driving cars. NY Times,https://www.nytimes.com/2018/02/26/technology/driverless-cars-california-rules.html

[5] Marshall A (November 22, 2017) https://www.wired.com/story/city-planning-curbs

[6] N. Deepika ; V. V. Sajith Variyar, "Obstacle classification and detection for vision based navigation for autonomous driving", 2017

[7] Nicolas Gallardo ; Nicholas Gamez ; Paul Rad ; Mo Jamshidi, "Autonomous decision making for a driver-less car", 2017

[8] https://devblogs.nvidia.com/deep-learning-self-driving-cars/

[9] https://towardsdatascience.com/polynomial-regression-bbe8b9d97491