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# SELF DRIVING CAR USING ML AND RASPBERRY PI FOR LANE DETECTION AND LANE FITTING

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***Abstract:*** *Self-driving cars have emerged as a promising technology for revolutionizing the transportation industry. In this research, we propose a system that utilizes a Raspberry Pi and a Raspi 5MP camera to develop a self-driving car model. The core of our approach lies in training a Convolutional Neural Network (CNN) using collected data from the car's track runs. Images captured by the camera are simultaneously paired with corresponding steering angle values, which are stored in a log file for data collection. To ensure balanced data, the number of images for each steering angle is limited to 300, with excessive images being deleted. The trained model is evaluated using 10 epochs, with 100 images used for both training and validation in each epoch. Training losses and validation losses are recorded and plotted to assess the model's accuracy. Once the model is trained, it is imported into the Raspberry Pi and implemented for real-time self-driving. The results demonstrate the effectiveness of our approach, as the self-driving car successfully navigates the track based on the model predictions. This research contributes to the field of self-driving cars and demonstrates the feasibility of using affordable hardware and CNNs for autonomous driving applications.*

***Keywords:*** Convolutional Neura006C Network, Raspberry Pi, Epoch, Training Losses, Validation Losses.

## I, INTRODUCTION

Self-driving cars have gained significant attention in recent years due to their potential to revolutionize transportation, improve road safety, and enhance the overall driving experience. These autonomous vehicles rely on advanced technologies, such as computer vision and machine learning, to perceive and interpret the surrounding environment. In this research, we present a novel approach to developing a self-driving car using a Raspberry Pi and a Raspi 5MP camera, coupled with a Convolutional Neural Network (CNN) for training and inference. The Raspberry Pi, a versatile and affordable single-board computer, provides a powerful platform for implementing various applications, including autonomous vehicles. In our project, we leverage the capabilities of the Raspberry Pi to build a self-driving car system that can navigate a predefined track.

The Raspi 5MP camera serves as the primary sensory input, capturing real-time images of the car's surroundings.

The key component of our self-driving car system is the CNN model, which learns to interpret the captured images and predict the appropriate steering angles. To train the model, we collect data by running the car on the track, simultaneously capturing images, and storing corresponding steering angle values in a log file. To ensure a balanced dataset, we limit the number of images for each steering angle to 300, eliminating excessive images. This step helps prevent bias towards certain steering angles and promotes a more robust and accurate model. The training process involves dividing the collected dataset into training and validation sets.

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We employ a multi-epoch training approach, where each epoch consists of training the model with a subset of the data and evaluating its performance on the validation set. During training, we monitor and record the training and validation losses, which serve as indicators of the model's convergence and generalization ability. Once the model is trained, we import it into the Raspberry Pi, enabling real-time inference on the captured images. The model predicts the steering angles, providing the necessary control signals for the self-driving car to navigate the track autonomously. By integrating the Raspi camera, trained model, and Raspberry Pi, we create a cost-effective and practical self-driving car system. This research aims to demonstrate the feasibility and effectiveness of utilizing a Raspberry Pi, Raspi camera, and CNNs for self-driving car applications. By leveraging these technologies, we seek to contribute to the advancement of autonomous driving and explore the potential of affordable hardware solutions in this field.

## II. RELATED WORK

Convolutional Neural Networks (CNN) are by far the most often used deep neural network topologies. They typically have an input layer, one or more convolution and pooling layers, a complete connection layer, and an output layer at the top [1].

Although the architectures of convolutional neural networks may vary, the convolution layer is the fundamental element of these networks. Specifically, a neighborhood region of the input picture is convolved with the convolution kernel (i.e., filter matrix). Recent image classification challenges including computer images and general images have shown amazing results using the convolutional neural network. Many self-driving car technologies may be simply developed to enable convolutional neural networks for obstacle detection, scene categorization, and lane identification since they rely on picture feature representation. The application of this kind of neural network for image processing is due to its high precision in the convolution function's ability to extract distinguishing characteristics from photos. It employs many hidden layers and a 2D input to extract high-level characteristics. Based on the spatial arrangement of the input pixels, it analyzes the input and finds interesting patterns within the pictures. CNN is simple to implement since no preprocessing is needed. They are utilized in AVs for pedestrian recognition and path planning. [2].

In [3], Introduction to Open CV basics, installation of Open CV and its libraries and how to read/write images and videos in open CV. creating a GUI and performing simple picture filtering. utilizing thresholding and contouring as picture pre-processing techniques for object segmentation and detection. Lastly, image processing employing algorithms for object recognition and machine learning.[4]

## III. METHODOLOGY

### 3.1) HARDWARE IMPLEMENTATION

#### 1) Raspberry pi

The model is built around raspberry pi, as its main processing unit. The raspberry pi is connected to pi camera, L298N driver module using jumper wires. It is powered by power bank, which provides raspberry with 5V 2.5 Amp power supply.

#### 2) L298N Motor driver

The IC L293D can be used to run 2 motors at same time. It can control and give direction to the motors. It also has thermal shutdown feature.

#### 3) Pi Camera

Pi camera of 5MP is used to capture data in form of images of the lane.

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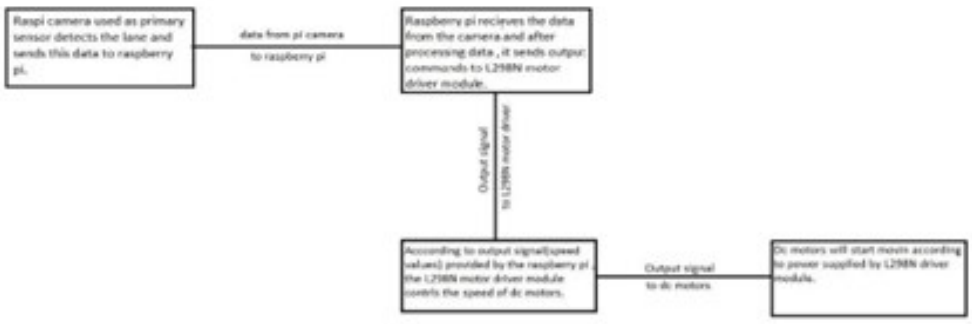


**Figure 1:** System Architecture

### 3.2) DATA COLLECTION

Data collection is a critical step in the development of a self-driving car project. It involves capturing and storing various types of data that include track images. Data collection is performed on track layout by running car using Xbox 360 controller. As the car moves it captures images and steering value for that image simultaneously, this is stored in log file. The steering value is recorded as the movement of axis 2 of the controller.

**Figure 2.a** Right turn

**Figure 2.b** Left turn

**Figure 2.c** Straight

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The captured data is unbalanced, which means that there are more images for certain steer angle than other. This may cause car to steer in on direction more often. To balance the data, we put a limit of 300 images for each steering value.

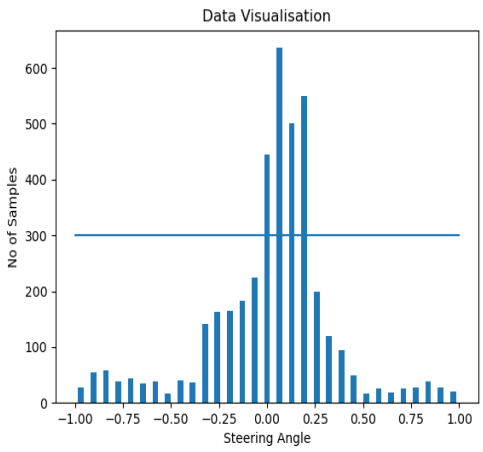


**Figure 3.a** Unbalanced Data

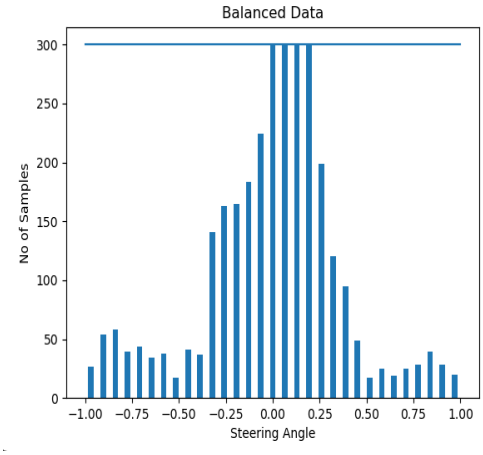


**Figure 3.b** Balanced data

### 3.3) Training

Training process begins by importing balanced data. Data augmentation is performed on the imported data. Data augmentation is often used in training neural network models because it can help to improve the model's performance in number of ways. It performs rotation, flip, translation, color space, cropping techniques on data. Data Augmentation is like imagination or dreaming. Humans imagine different scenarios based on experience. Imagination helps us gain a better understanding of our world.

#### 3.2.1) DATA AUGMENTATION TECHNIQUES

**1) FLIP**

Horizontal axis flipping is much more common than flipping the vertical axis. This augmentation is one of the easiest to implement and has proven useful on datasets.

**2) ROTATION**

Rotation augmentations are done by rotating the image right or left on an axis between 1° and 359°. The safety of rotation augmentations is heavily determined by the rotation degree parameter.

**3) TRANSLATION**

Shifting images left, right, up, or down can be a very useful transformation to avoid positional bias in the data.

**4) COLOR SPACE**

Digital image data is usually encoded as a tensor of the dimension (height × width × color channels). Performing augmentations in the color channels space is another strategy that is very practical to implement. Very simple color augmentations include isolating a single-color channel such as R, G, or B. An image can be quickly converted into its representation in one color channel by isolating that matrix

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and adding 2 zero matrices from the other color channels. Additionally, the RGB values can be easily manipulated with simple matrix operations to increase or decrease the brightness of the image.

**5) CROPPING**

Cropping images can be used as a practical processing step for image data with mixed height and width dimensions by cropping a central patch of each image. Additionally, random cropping can also be used to provide an effect very similar to translations.

Training module utilizes 10 epochs, each epoch takes 100 images for training and validation. The training losses and validation losses for each are printed and these values are stored, which then are used to plot a graph between training and validation losses.

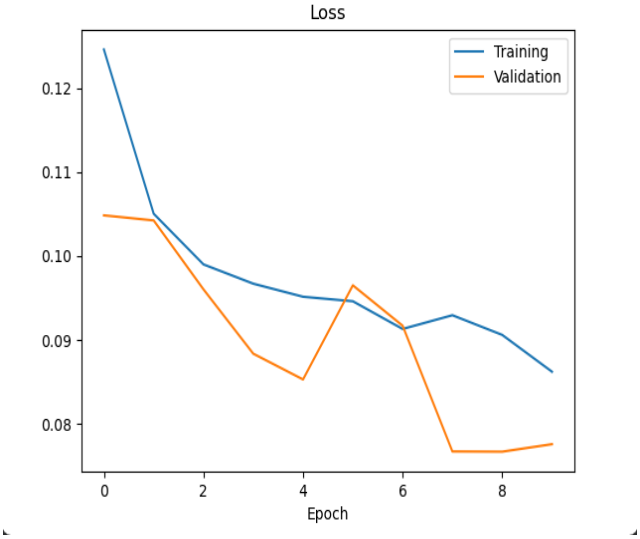


**Figure 4:** Training loss V/s Validation loss

If the validation line follows the training line closely, the model is said to be well trained.

### 3.4) Implementation

The trained model is then imported into raspberry pi. For working of the model required libraries are installed, TensorFlow, NumPy, Pandas, OpenCV, Matplotlib, Sci-kit namely. A main program module imports all necessary libraries and starts the camera for image processing. It processes the given data using gaussian blur and RGB2YUV function to convert image into black and white. Based on processed image the model predicts the steering value, this steering value are used to determine speed of left-side wheels and right-side wheels. Using this car can fit into track and follow it.

## IV. CONCLUSION

This paper demonstrates the use of convolutional neural networks for the process of training the car to detect lane. Data collection is performed using an Xbox controller. This collected data is then balanced to avoid overfeeding of single steering value. The balanced dataset is then augmented using various image augmentation techniques such as flip, translation, cropping. Furthermore, gaussian blur and RGB2YUV techniques are applied to model during actual implementation. The car follows the path by predicting the

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steer values, these steer values determine the motor speed, providing the car to make turns as per the demand. The current model is limited by use of raspi camera as its primary sensor. The approach used in this paper can be enhanced by use of multiple sensors like Lidar, infrared, ultrasonic. Using cameras with night vision will provide with diverse dataset which in turn will help with more accurate model.

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