School

of

Electronics and Communication Engineering

Mini Project Report

on

LANE DETECTION OF SELF DRIVING CAR

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CERTIFICATE

This is to certify that project entitled **" Lane Detection Of Self Driving Car"** is a bonafide work carried out by the student team of **" Omkar Bhangari (01FE21BEC150), Shreyas Salotagi (01FE20BEC096), Alena Agnes Alex (01FE21BEC351), Puneet (01FE20BEC030) "**. The project report has been approved as it satisfies the requirements with respect to the Minor project work prescribed by the university curriculum for BE (V semester) in School of Electronics and Communication Engineering of KLE Technological University for the academic year 2023-24.

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-The project team

ABSTRACT

Lane line detection is a critical aspect of modern driving safety systems, especially in the context of autonomous vehicles and driver assistance technologies. To address the challenges of real-time performance and accuracy in lane detection, a sophisticated algorithm leveraging advanced Hough transform techniques is proposed. This algorithm, implemented using Python and image processing libraries, follows a systematic approach to enhance the detection of lane lines in roadway images.The first step involves converting the RGB frame captured by the vehicle's camera into a grayscale image. This conversion simplifies the image data while retaining essential features relevant for lane detection. Subsequently, a Gaussian blur is applied to the grayscale image to reduce noise and smooth out any irregularities, ensuring cleaner edge detection results.Edge detection is performed using the Canny algorithm, which identifies areas of significant intensity change within the Gaussian blurred image. These identified edges often correspond to potential lane lines on the road surface. However, to improve efficiency and accuracy, it's essential to focus on the region of interest within the image, corresponding to the lane the vehicle intends to navigate.Through region of interest extraction, the algorithm isolates the relevant portion of the image containing the lane of interest. This step helps in concentrating computational resources on the critical areas, thereby enhancing the detection performance. Finally, a masking operation is applied to further refine the region of interest, eliminating irrelevant information outside the lane boundaries.By implementing this comprehensive approach to lane detection using Python and image processing techniques, the algorithm aims to facilitate safer driving conditions. By assisting drivers in staying within their lanes and potentially preventing accidents caused by negligence or fatigue, it contributes to overall road safety and enhances the capabilities of autonomous vehicles.

Contents

List of Figures

Chapter 1

Introduction

The automotive industry is a rapidly evolving sector, as is well known.People are moving from manual to autonomous vehicles these days.The safety of the driver and other occupants of the vehicle depends on the development of autonomous vehicles. Uncertainty in lane tracking is one of the many factors that can cause accidents.The two most significant innovations in the development of autonomous vehicles are the lane-keeping and tracking algorithm and the collision assistant.Our focus in this project is on detecting curved lanes and using prediction "Image Processing" to determine where lanes might be placed. We will use a variety of image processing techniques to implement Lane detection and prediction in this project. We use a variety of functions and algorithms in our techniques.

1.1 Motivation

There will be more cars in the world of today, which could result in an increase in unintentional collisions on the roads. Our goal is to develop a solution for the technology that will be utilized in the upcoming autonomous vehicle era. The vehicles that operate autonomously and make decisions without human intervention

In technical terms, we could say that their programming will be done. Any machine needs to complete tasks successfully and efficiently in order to operate as intended. In this sense, the vehicle ought to be aware of every potential accident scenario and have mechanisms in place to minimize the risk of any harm coming to human life. either due to human or mechanical causes.

1.2 Objectives

1. To comprehend the fundamentals of lane detection image processing methods.
2. To develop the capability for identifying lanes in road images for applications such as autonomous driving, utilizing fundamental principles of mathematics
3. To design and develop the algorithm to predict the lane.
4. Predict the vehicle's path on the lane.
5. Avoid running into other lanes in any condition.
6. Avoid getting onto the pedestrian path .

1.3 Literature survey

For the purpose of our research, we consulted various literature surveys, and the results we arrived at are as follows:

1. **Autonomous Lane Detection:**
   With the help of lane departure detection, which combined LiDAR and RGB camera data for lane prediction, the authors of the given paper use ego-lane detection to detect the current lane and its boundary. For example, this allows autonomous driving cars to stay in the current lane. 3D LiDAR points were used to predict the height and angle of the ground plane, and the image was re-projected to the bird's eye view using the predicted ground plane parameters.

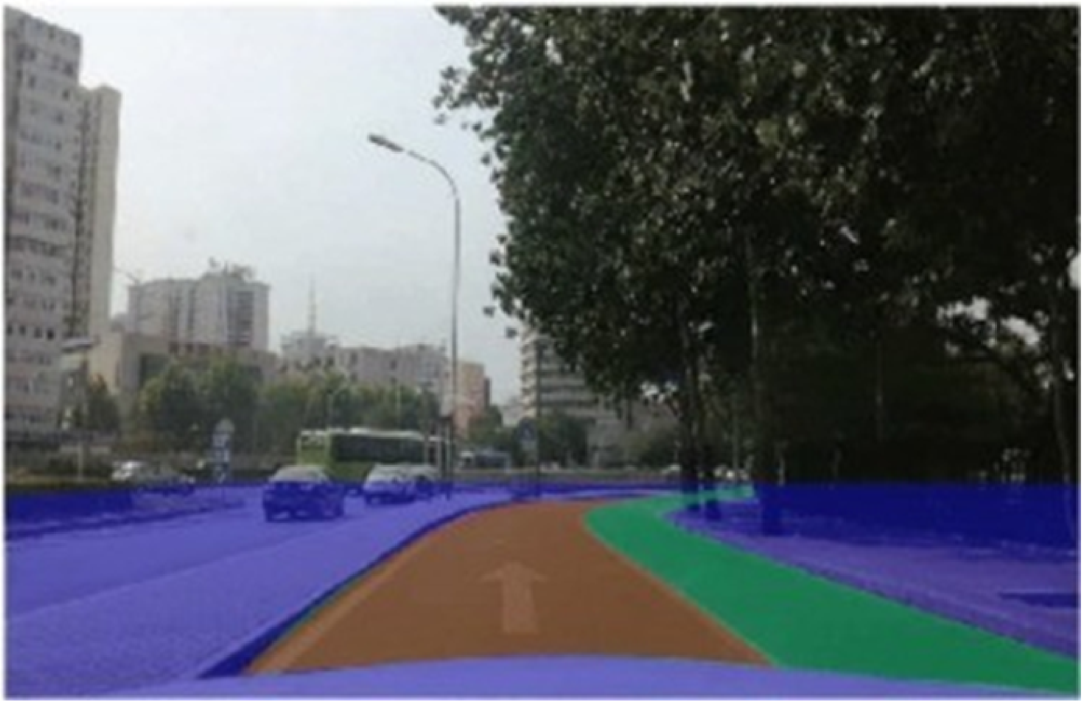

Figure 1.1: Autonomous lane detection

2. **Real-Time Lane Detection Networks for Autonomous Driving (Ze Wang, Weiqiang Ren, Qiang Qiu)**
   In this paper, they proposed a two-stage lane detection process: lane edge proposal and lane line localization, using a deep neural network-based technique called LaneNet. The first stage classifies lane edges pixel-by-pixel using a lane edge proposal network, and the second stage detects only lane lines, which creates additional challenges in suppressing the false detection of similar lane marks on the road, such as arrows and characters.

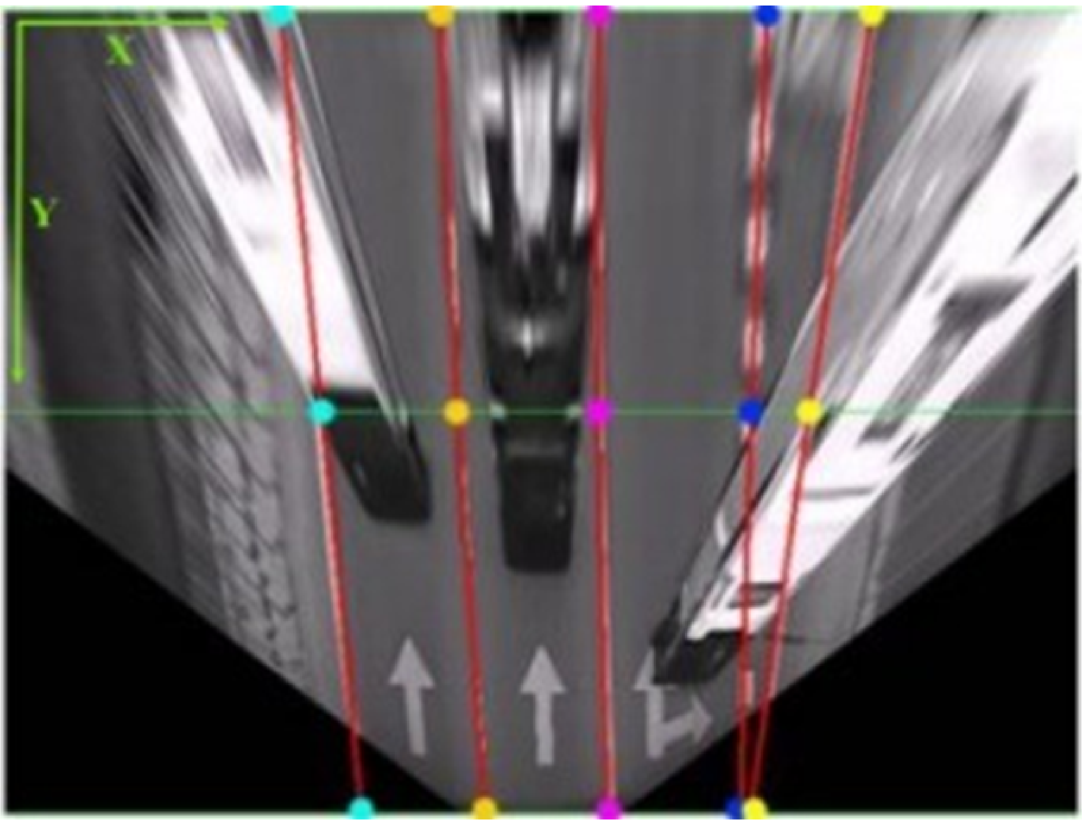

Figure 1.2: localisation of lane points

3. **End-to-End Deep Learning of Lane Detection and Path Prediction for Real- Time Autonomous Driving (Der-Hau Lee,Jinn-Liang Liu)**
   A three-task convolutional neural network (3TCNN) with two regression branches consisting of bounding boxes and Hu moments and one classification branch with object masks for lane detection and road recognition was proposed in this paper. The Hu-moment regressor uses the local and global Hu moments of segmented lane objects for lane localization and road guidance, respectively. In order to create an integrated model (3TCNN-PP) that can predict driving paths with dynamic estimation of lane centerline and path curvature for real-time autonomous driving, we next suggest lateral offset and path prediction (PP) algorithms based on 3TCNN.Additionally, we create a CNN-PP simulator that can be used to test and train CNNs using synthetic or real-world traffic images, measure their dynamic errors, and see how well they perform qualitatively. According to simulation results, 3 TCNN-PP performs better than a prior CNN-PP and is comparable to related CNNs. For additional study on NN-PP algorithms of autonomous driving, visit our website for the code, annotated data, and simulation videos of this work.

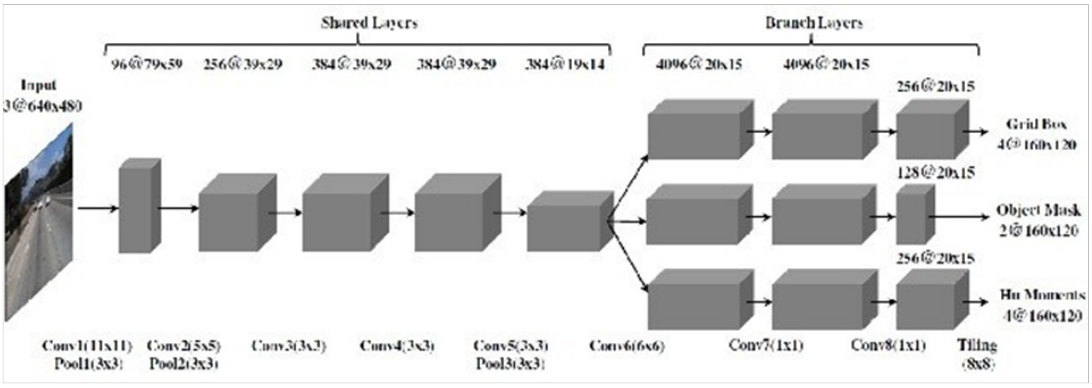

Figure 1.3: CNNNeuralNetwork

1.4 Problem statement

To design an algorithm to detect lanes on a structured road and move forward in the desired lane thereby assisting the driver to move in his lane with just the lane detect algorithm.

1.5 Application in Societal Context

Accidents involving vehicles rank among the top causes of death.One of the main causes of serious accidents is poor driver assistance. We must give the driver better lane assistance.Therefore, every autonomous vehicle should have a lane detection and prediction algorithm installed in order to solve this issue.In order to help the driver drive more precisely and effectively, the autonomous vehicle uses a lane detection and prediction algorithm to help it find lanes and stay inside their boundaries.Prediction algorithms, on the other hand, assist the system in determining the potential location of the curve, which ultimately lowers the risk of an accident.

1.6 Organization of the report

- Chapter 1 discusses about the motivation behind choosing our problem statement, the objectives of our final design, the literature survey where we came across many research papers involving lane detection and lastly we discuss our problem statement and its application in the societal context.
- Chapter 2 is about system design, where we describe the functional block diagram step by step. We also talk about design alternatives to lane detection problems. Later We introduce the final design which is based on image processing and Hough transform.
- Chapter 3 is about the implementation of the final design, which includes the Algorithm, and flowchart of the entire process.
- Chapter 4 is all about the optimization involved in our design, we list the ways of optimization and justify the chosen optimization technique.
- Chapter 5 is about the discussion of our results,i.e analyzing the results after each step of the process.
- Chapter 6, here we talk about the conclusion that we draw from our project and its functioning, we also talk about the future scope that it holds, and lastly we present the plagiarism report.
- References

Chapter 2

System design

System design is covered in Chapter 2, where we provide a step-by-step description of the functional block diagram. We also discuss design alternatives for the problem of lane detection. We view the finished design, which is based on the hough transform and image processing.

2.1 Functional block diagram

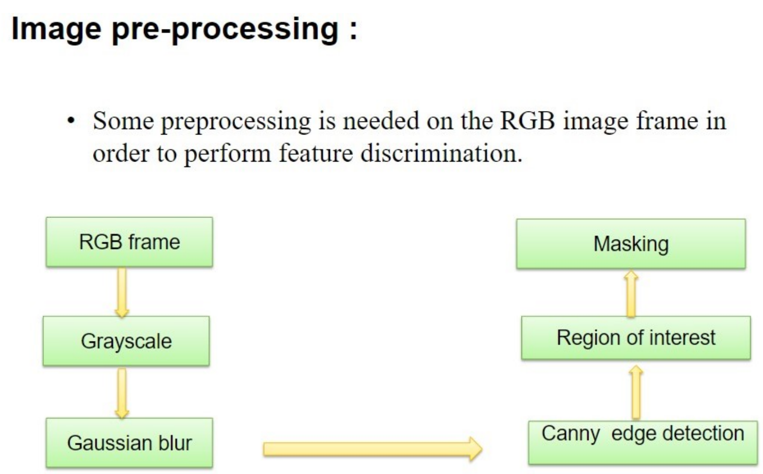

Figure 2.1: Functional block diagram

In the figure (2.1) we can see that in the function block the RGB frame undergoes gray scaling The gray scaled image undergoes Gaussian blur to reduce noise of the image.The gaussian blurred image undergoes canny edge detection to extract the dark edges from the gaussian blurred image ,then the region of interest,i.e the lane the driver wants to move in is extracted.Finally, the region of interest is masked.

PROCEDURE:

1.RGB TO GRAY SCALE:
RGB is a 255x255x3 matrix of color and Grayscale is a 255x255x1 matrix of gray. RGB has 3 channels namely Red green and blue which consist more data to process.So to reduce the time of processing each frame we convert the the 3 channel image to single channel called gray scale image(0-255). Algorithms like canny edge detection needs input image to be in gray scale, hence we convert RGB to Gray scale.

2.GAUSSIAN BLUR:
The gray image is given to the gaussian blur where it acts as a low pass filter which will reduce the high frequency components and also reduces the noise in the image .

3. CANNY EDGE DETECTION:
Canny edge detect the edges by fixing the MIN MAX thresh- old value. Canny edge detector uses a filter which is based on the gaussian derivative in order to compute the intensity of images.Sudden change in the gradient or intensity in the adjacent pixels which will reflect the edges in the image .

4. REGION OF INTEREST(ROI):
Region of interest is region where we are the extracting the desired part of the complier and athe given input image .We are considering a MASK(Black) image which has same dimension as the input frame .To mention the ROI we are considering as polygon(triangle) for our Lane extraction .we considering 3 co-ordinates.Two points are present at the bottom edge of the image and remaining one at the center of Image .Fill polyfunction is introduced to the marked Co-ordinates ,To figure out the ROI we are doing the BITWISE AND between the MASK and the ROI Image.

5. HOUGH TRANSFORMATION:
The transformation allow us to dis- criminate features byusing analytical equations.It has been generalised in order to detect arbi- trarily complex shapes of the lane. After getting our region of interest we use the coordinate axes of every point of the lane (x1,y1) of the image space generates a hyper-curve in the para-metric space having radian and resultant distance of of the axes. The parametric space identifies uniquely a curve in the image space.

2.2 Design alternatives

For the aim of Lane Detection our other approach was by employing the Lanet Architecture.There are numerous lane detection algorithms, architectures to reach the desired quality of lane detection, they are by making use of RANSAC algorithm ,Lane Boundaries Projective Model,. Bilateral Filter and many more.

2.3 Proposed design

We select one of the optimal solutions based on its working and ease of the implementation.

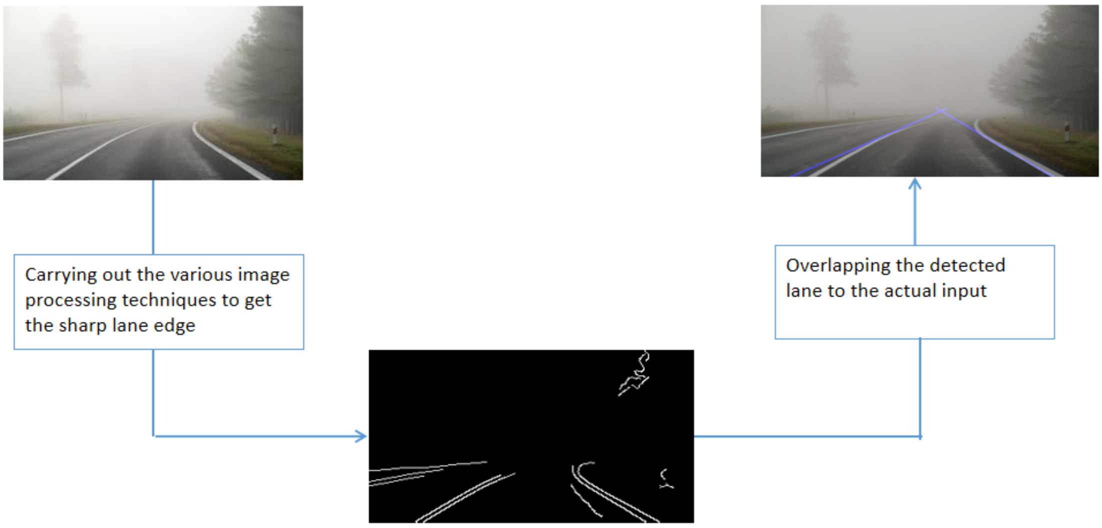

Figure 2.2: Proposed design

The proposed design is based on image processing and improved Hough transform method.The significance of Hough transform is that it tolerates the gaps in the boundary of feature descriptions and its working is not hindered by any unwanted image signal.

Chapter 3

Implementation details

Chapter 3 is about the implementation of the final design, which includes the Algorithm, and flowchart of the entire process.

3.1 Algorithm

Step-1. Any image or video which has structure (lane) in it can be given as the input for the algorithm.
Step-2. Conversion from RGB to grayscale and finding the region of interest using canny edge detection is our implementation in this field work.
Step-4. For masking layer on straight road, we use the probabilistic Hough transform form it's previous version of Hough transform which was niche and less accurate. So, the update Hough transform is used for detection and prediction.
Step-5. The Hough transform also detects curve lanes.

3.2 Flowchart

This section consists of flowchart that depicts the procedures involved in image processing ,i.e as an input ,a structured road image is chosen ,which undergoes gray scaling ,the gray scaled image further undergoes gaussian blur technique for the image noise reduction,this image undergoes canny edge detection where the sharp edges are retained while other light edges are made invisible , the output is masked with region of interest and the Hough transfrom overlaps the detected lane line with the input image and gives the final output.

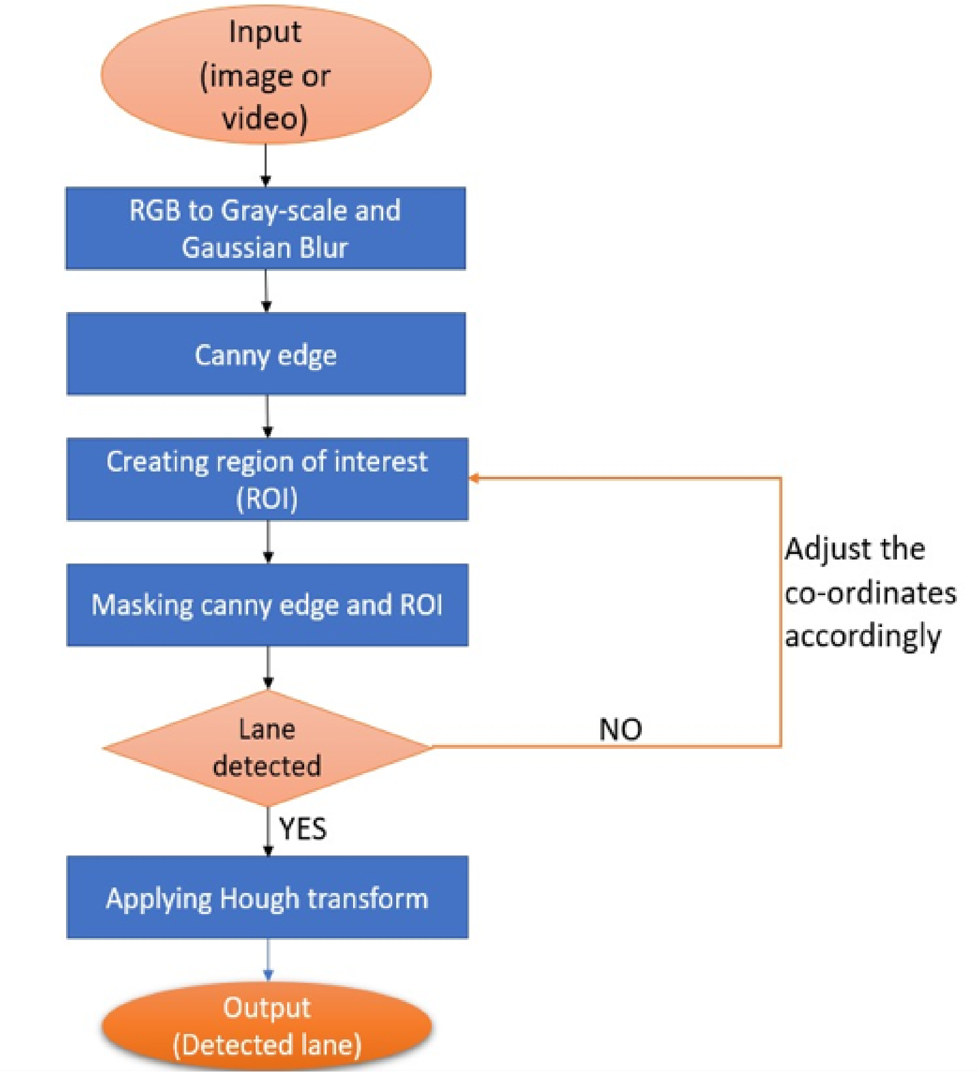

Figure 3.1: Implementation Flow Chart

Chapter 4

Optimization

Chapter 4 is all about the optimization involved in our design, we list the ways of optimization and justify the chosen optimization technique.

4.1 Introduction to optimization

Our project deals with the irregularity in the lanes of the road. For the detection of our lane, we are converting it into different techniques of image conversion. OpenCV libraries are used for the conversion of road images. We are finding the region by converting the images frame into different ways for neglecting the disturbances and errors may occur while applying Hough transform.

4.2 Types of Optimization

(1) Canny edge detection for finding Region of Interest
(2) Conversion of RGB scale to grayscale for making the detection of roads easy.
(3) Using Hough Transform for the detection of the straight lane.
(4) Incase after Hough Transform multiple lanes is detected, we can make the coordinates for the averaged out single line and find the average of the slope of multiple lines and make one line.

4.3 Selection and justification of optimization method

We choose our optimization technique because the system will work more efficiently when it is in the hands of advanced AI just like our current marvelous projects are unmanned, just like satellites, internet, defence and medical systems. Now, the safety of roads can be ensured by using Machine learning / Deep learning as our new way to make cars learn by themselves and make important updates in their algorithm so as to enhance their performance and efficiency which may ultimately lead to better sustainable Revolution in Transportatio.

Chapter 5

Results and discussions

5.1 Result Analysis

The machine can effectively capture the road lane and obscure any upcoming layer on any given road. The formation of a virtual lane on the screen corresponds with the car's speed. The ability of a driver to predict the lane of travel is neither slow nor fast enough to overpredict the lane, which could result in an incorrect lane assumption. The detection range on a road extends to the road's vanishing point, making it appropriate for drivers to anticipate the end of the road in ambiguous land terrain. The algorithm is fundamental, and there is room for improvement to enable the autonomous safety system to be upgraded and overcome issues that have been brought up in reports.Effective lane detection has been achieved in the given image through the use of advanced image processing techniques. The lanes have been precisely identified and defined on the road surface through meticulous algorithmic processing. This achievement demonstrates how well cutting edge image processing techniques work for tasks like lane detection in practical applications. These developments have a great deal of potential to improve traffic safety and make autonomous driving technologies possible.

Figure 5.1: Lane detected of straight road

As the Probabilistic Hough transform was offering overfitting, so we come up with Hough tansform as our choice of detection of the lane.

1. Input image:
Firstly we take an image of structured road as input image. In the image there are multiple lanes and real time image from the vehicle is captured such that we have a clear visiblity of the lane ahead.

Figure 5.2: Input image of a curved road .

2. Grayscaling:
The further step involves the conversion of the input image from RGB scale to grayscale, wherein the individual pixels of the image are assigned gray values, resulting in a grayscale representation. This transformation simplifies the computational complexity by reducing the dimensionality of the image data, thereby facilitating subsequent processing stages

Figure 5.3: Gray scaled image

3. Gaussian Blur:
Following grayscale conversion, the input image is subjected to Gaussian blur, an essential technique in image preprocessing. Gaussian blur effectively reduces noise by convolving the image with a Gaussian kernel, smoothing out unnecessary details while preserving important features. By blurring the image, high-frequency noise is attenuated, resulting in a cleaner representation that enhances the accuracy of subsequent processing steps. This noise reduction step significantly improves the overall quality and robustness of the image processing pipeline.

Figure 5.4: Gaussian blurred image

4. Canny Edge Detection:
Following Gaussian blur, the image progresses to Canny edge detection, a critical step in lane detection algorithms. Canny edge detection enhances the image by highlighting sharp edges while suppressing noise. This technique employs thresholding to identify significant intensity changes, effectively isolating lane boundaries from the background. By specifying minimum and maximum threshold values, Canny edge detection ensures precise detection of edges, crucial for accurate lane detection in subsequent processing stages.

Figure 5.5: Image after canny edge detection

5. Masking:
In the masking region, the lane detection points are plotted to prevent overfitting of predicted lanes. This step is crucial for ensuring that only relevant areas of the image contribute to lane detection. The canny edge detection and region of

interest (ROI) are masked, focusing the algorithm's attention on the specific area where lane boundaries are expected. By masking out extraneous information, the algorithm improves accuracy and reliability in identifying lane markings.

Figure 5.6: Region of interest

The canny edge detection and ROI are masked in this step

Figure 5.7: Masking of unwanted objects.

Utilizing advanced image processing techniques, the lane on the road is successfully detected. Through the application of masking colors and precise algorithms, the trajectory of the lane is highlighted, facilitating accurate identification. This process enables efficient navigation and analysis tasks within the detected lane, contributing to safer driving experiences and enhanced roadway management..

Figure 5.8: Image after Hough transform

Results from different test case:

Our algorithm underwent rigorous testing across various weather conditions and road geometries, including curved segments. By subjecting it to diverse scenarios, encompassing rain, fog, and bright sunlight, we ensured its robustness and adaptability. Similarly, our evaluation extended to roads with sharp bends and gentle curves, reflecting real-world driving environments. This comprehensive testing regimen validated the algorithm's effectiveness across a spectrum of conditions, affirming its reliability and versatility in lane detection tasks.

Case 1: Night Time

We purposefully included night-time prediction as a crucial test condition in our extensive testing protocol to assess our algorithm's performance in difficult low-light conditions. We carefully investigated how our system handled the special difficulties presented by darkness through painstaking analysis, an important factor in guaranteeing the dependability and safety of autonomous driving systems. The test results offer significant insights into the algorithm's performance and its capacity to sustain precise lane detection capabilities in spite of visibility constraints. This extensive evaluation process demonstrates our dedication to creating solutions that are reliable and perform well in a variety of environmental settings, improving road safety and boosting public trust in autonomous driving technology .The results are as follows:

Input image:

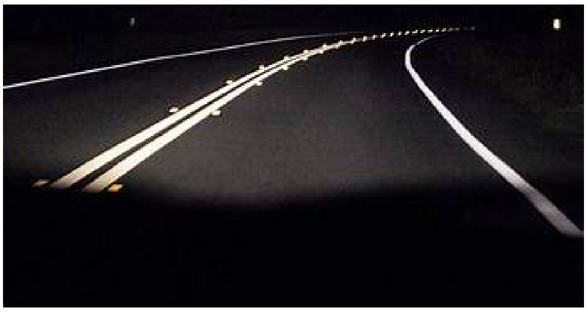

Figure 5.9: Input image at night time.

Result:

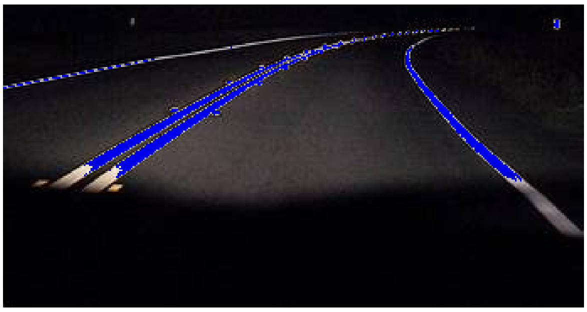

Figure 5.10: Result of the lane detected

Case 2: Rainy Weather condition

We examined our lane detection algorithm's performance under a variety of weather scenarios, including rainy ones, in a comprehensive evaluation. Our system demonstrated its robustness and effectiveness in the face of rain, accurately detecting lane markings in spite of low visibility and possible precipitation-induced image distortions. After careful examination, we found that the algorithm produced reliable results most of the time, greatly improving driving safety even in inclement weather. These results highlight the resilience and adaptability of our methodology, confirming its appropriateness for practical implementations in a range of environmental contexts.

Input image:

Figure 5.11: Input image of a rainy road

Result:

Figure 5.12: Result of lane detected

Case 3: Bright sunny day condition

During our exhaustive testing procedure, we examined in detail how well our lane detection algorithm functioned in bright sunny conditions,a critical test condition that reflects ideal lighting conditions. After conducting thorough analysis and testing, we found that our algorithm was able to reliably identify lane markings even in the face of difficulties caused by bright sunlight and high contrast environments. Our system was able to delineate lane boundaries with minimal errors, resilience, and precision even in the face of potentially overwhelming brightness. These striking outcomes highlight the dependability and efficiency of our method, confirming its applicability for practical implementation and improving traffic safety in a range of lighting scenarios.

Input image:

Figure 5.13: Input image on a bright sunny day

Result:

Figure 5.14: Result of lane detected

Chapter 6

Conclusions and future scope

6.1 Conclusion

The model built is successfully detecting the lane and predicting the Future aspects of the road by using Hough transformation for straight and curved lane prediction, altHough it could be performed more efficiently with Ideal cases but the Data sets we provided are typical examples of different kind of turns with different weather conditions.

6.2 Future scope

We choose our optimization technique because the system will work more efficiently when it is in the hands of advanced AI just like our current marvelous projects are unmanned, just like satellites, internet, defence and medical systems. Now, the safety of roads can be ensured by using Machine learning / Deep learning as our new way to make cars learn by themselves and make important updates in their algorithm so as to enhance their performance and efficiency which may ultimately lead to better sustainable Revolution in Transportation.

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