KLE Technological University

Creating Value
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School

of

Electronics and Communication Engineering

Mini Project Report

on

Curved lane detection

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CERTIFICATE

This is to certify that project entitled **" Curved lane detection "** is a bonafide work carried out by the student team of **"Abhishek Kusanur(01fe19bec168),Ashutosh Singh(01fe19bec169),Siddalingeshwar P(01fe19bec166),Sadashiv D(01fe19bec168)"**. The project report has been approved as it satisfies the requirements with respect to the mini 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 2021-2022.

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-The Project Team 07

ABSTRACT

In autonomous driving model, the safety of driver is at most priority. There will be more cars on road, which will exaggerate the chances of unwanted accidents on the road. Based on this fact we hence come up with our objective of lane detection and prediction. The Lane detection is essential for many aspects of driving and helpful in many other aspects, such as lane-based navigation and safety assistance. Although lane detection is challenging especially with complex road conditions that changes with different terrain and location, steady progress has been witnessed in this area in the past several years. So our ambition is to come up with the best solution in solving this problem of lane detection using the kalman filter, as the filter is sophisticated in finding the possibility of future points with reference to the past given data. The filter is very robust in prediction. We are using modern techniques of computer vision using different Python libraries and processing the input video and building an algorithm which is suitable for the lane detection on road lanes.Our model is able to show the possible lane on each frame using masking layer on the frame having straight and curved lane.

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Chapter 1

Introduction

As we know the automobile industry is one of the fast changing sector.Nowadays people are switching from manual vehicle to autonomous vehicle.The development of autonomous vehicles is needed for the safety of driver and passengers of the vehicle. Accidents can happens for various reason, uncertainty in lane tracking is one of the reason .The two most important innovation in development of autonomous vehicle is collision assistant and lane keeping and tracking algorithm .In this project our concentration is on the lane detection which are curved and predict the possible placement of lane through the help of prediction algorithm called "KALMAN FILTER".

In this project we are going to implement prediction and detection of Lane through various image processing techniques. Our techniques include various algorithm and functions.

1.1 Motivation

In today's coming world there will be more cars, which may lead to more unwanted accidents prone to roads. Our ambition is to create a solution for the technology used in coming era of autonomous vehicles. Those vehicles which functions without any human interfere and take decisions all by itself or in technical terms we can say that how they will be programmed. In order to make any machine function properly, it should perform task successfully and efficiently. In that way the car should know every possible aspects of accidents and way to redundant the possibilities of any harm to human life. Either by mechanical or human factors.

1.2 Objectives

1. To understand basic image processing techniques for lane detection.

2. To understand the basic mathematics behind the Kalman filter and applying it for the lane detection.

3. To design and develop the algorithm to predict the lane.

4. Simulate the proposed methods on suitable simulation tool.

1.3 Literature survey

we refer to different literature surveys for our research purpose and we come with the following conclusion.

1. **Autonomous Lane Detection**
In the given paper they uses Ego-lane detection detects the current lane and its boundary and is mainly applied online, e.g., so that autonomous driving cars can stay in the current lanewith

the aid of lane departure detection combined LiDAR and RGB camera data for lane prediction, where the 3D LiDAR points were used to predict the height and the angle of ground plane and the image was re-projected to the bird's eye view using the predicted ground plane parameters

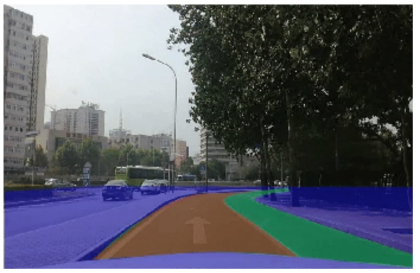

Figure 1.1: CNN Nueral network

2. **Real-Time Lane Detection Networks for Autonomous Driving (Ze Wang, Weiqiang Ren, Qiang Qiu)**
In this paper,they proposed a deep nueral network based method called LaneNet to breakdown the lane detection into two stageslane edge proposal and laneline localization First stage uses a lane edge prposal network for pixel-wise lane edge classification and lane line localization in the second stage detects thelane linesonly,which introduces more difficulties on supressing the false detection of similar lane markson the road like arrows and characters.

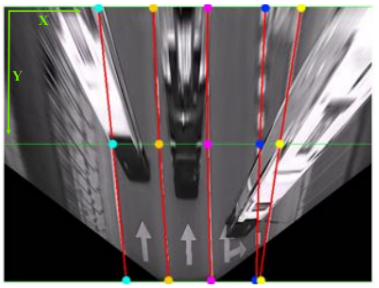

Figure 1.2: Localisation of lane points

3.**Highly Curved Lane Detection Algorithms Based on Kalman Filter (Byaamba Dorj,Sabir Hossain,Deok-Jin Lee)**
This paper presents a cutting edge curve lane detection algorithm based on the Kalman filter for the self-driving car. It uses parabola equation and circle equation models inside the Kalman filter to estimate parameters of a using curve lane. The proposed algorithm was tested with a self-driving vehicle. Experiment results show that the curve lane detection algorithm has a high success rate. The paper also presents simulation results of the autonomous vehicle with the feature to control steering and speed using the results of the full curve lane detection algorithm.

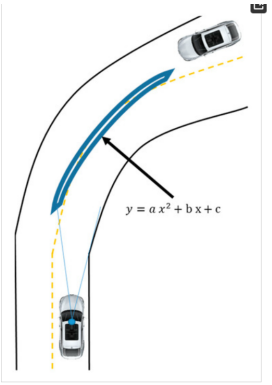

Figure 1.3: Parabola model of road turning

4. **End-to-End Deep Learning of Lane Detection and Path Prediction for Real-Time Autonomous Driving (Der-Hau Lee,Jinn-Liang Liu)**
In this paper they proposed an end-to-end three-task convolutional neural network (3TCNN) having two regression branches of bounding boxes and Hu moments and one classification branch of object masks for lane detection and road recognition. The Hu-moment regressor performs lane localization and road guidance using local and global Hu moments of segmented lane objects, respectively. Based on 3TCNN, we then propose lateral offset and path prediction (PP) algorithms to form an integrated model (3TCNN-PP) that can predict driving path with dynamic estimation of lane centerline and path curvature for real-time autonomous driving. We also develop a CNN-PP simulator that can be used to train a CNN by real or artificial traffic images, test it by artificial images, quantify its dynamic errors, and visualize its qualitative performance. Simulation results show that 3TCNN-PP is comparable to related CNNs and better than a previous CNN-PP, respectively. The code, annotated data, and simulation videos of this work can be found on our website for further research on NN-PP algorithms of autonomous driving.

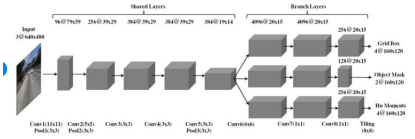

Figure 1.4: CNN Nueral network

5. **Digital Image Processing**; image processing using basic mathematical equation such as 3D layer conversion to Matrix method for further operation like Normalisation and weight sharing.

1.4 Problem statement

To design and implement an algorithm for detection and prediction of Curved lanes using Kalman Filter for ADS(Autonomous Driver Assistant System)

1.5 Application in Societal Context

Traffic accidents are one of the leading causes of death.Bad assistance to the driver is one of the reasons for severe accidents. We need to provide better lane assistance to the Driver .So to overcome with this problem lane detection and prediction algorithm should be implemented in every autonomous vehicle .The lane detection and prediction algorithm helps the autonomous vehicle to detect the lane and To stay within the boundaries of the lane which will help the driver to drive more accurately and efficiently.While prediction algorithm helps system to work on the possible position of the curve which will eventually reduce the risk of accident.

1.6 Organization of the report

CHAPTER 2:

In this chapter we are going to discuss about the function block diagram of the system, we have used functions like Gray scale conversion,canny edge detection, masking algorithm, hough transform and kalman filter.

CHAPTER 3 :

This chapter includes the how we are going to implement the system in order to get the required output .we use image processing for pre-processing, probablistic hough transform for lane detection and kalman filter for prediction .In image processing we have gray colour conversion,gaussian blur,canny edge detection,region of interest,masking.after performing image processing we apply hough transform for lane detection and then then we apply kalman filter for prediction of the lane position.

Chapter 2

System design

System designs consists of all subtopics with explanation about all techniques that were used in implementation.

2.1 Functional block diagram

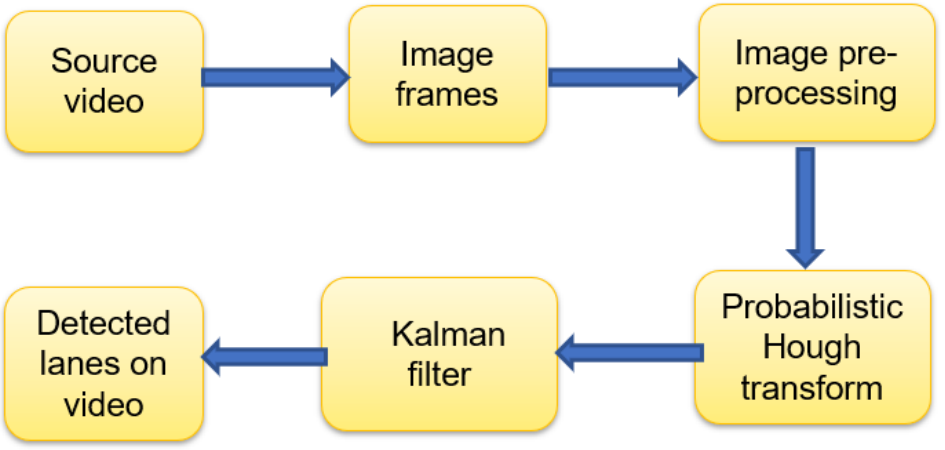

Figure 2.1: Block diagram

EXTRACTION OF FRAMES
The Frames are taken from the videos as input then it will be extract as image. Initially we are considering the video as our dataset as a source of processing , By this we are trying to extract every frame from the video to process them easily and this process will continues until all the frames are extracted from the video.

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.

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 .

CANNY EDGE DETECTION Canny edge detect the edges by fixing the MIN MAX threshold 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 .

REGION OF INTEREST(ROI) Region of interest is region where we are the extracting the desired part of the 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 .Fillpoly function 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.

PROBABILISTIC HOUGH TRANSFORMATION the transformation allow us to discriminate features byusing analytical equations.It has been generalised in order to detect arbitrarily 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 parametric space having radian and resultant distance of of the axes. The parametric space identifies uniquely a curve in the image space.

KALMAN FILTER The kalman filter is work on input data, for which it will take the left over data of Hough transform last coordiante points and inclusion in it's matrix equation for the selection of lane coordinates for the masking purpose and recursively work if the lane coordinate still lie on the curvature for further computaion. Again, it is just a filtering process used to filter out the best coordinates for the detection of lane coordinate cluster.As shown in the figure

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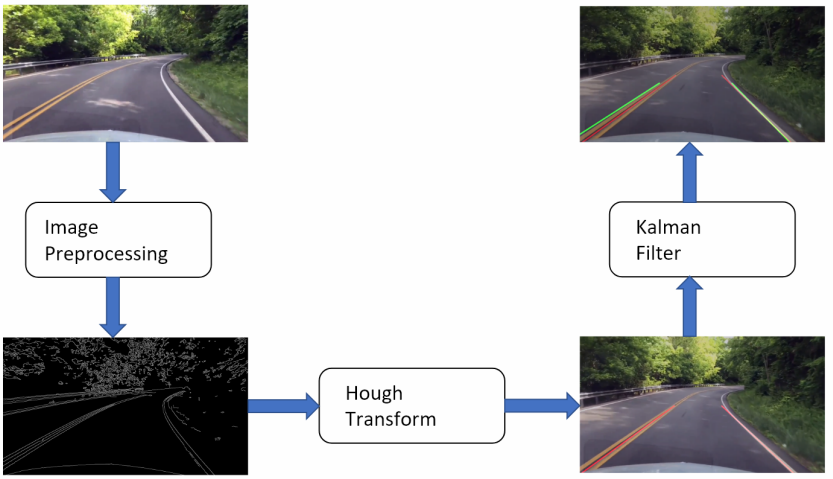
2.2 Final design

As our final phase of the project we are using the lance detection using OpenCV libraries for initial steps of identifying the Lane and for masking purpose as the output, for finding the coordinates of lane we merely depend on the curvature of the road, if it is straight lane than Hough transform is our priority and if we are getting the transformation out of the lane than Kalman filter will come under further operation for predicting the possible placement of curvature. The Video is processing in its fixed frame rate in order to make the algorithm work perfectly and doesn't slow the video next frame getting slowdown. We had tested our algorithm in different data sets of road for the sake of verification of our project and we can conclude that it work as expected.



Kalman Filter

Chapter 3

Implementation details

3.1 Algorithm

Step-1. The recording of road from any camera device act as our source, the video will be used to reduce the frame rate for our image preprocessing.

Step-2.The images will be generated with a fixed frame rate with proper aspect ratio of screen repectively.

Step-3.Different libraries will be used on images to generate the lane input for our detection process. 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.For the detection on curve lanes, we are using the kalman filter as our masking process from the last points of hough tansform, if the input data does not follow the stright lane.

Step-6.The images generated after masking will be folded into a video layer using frame rates, so that next image is passed instantly which will make it function as video while getting displayed on screen. The final lane detection will be sent back to the output display screen.

3.2 Flowchart

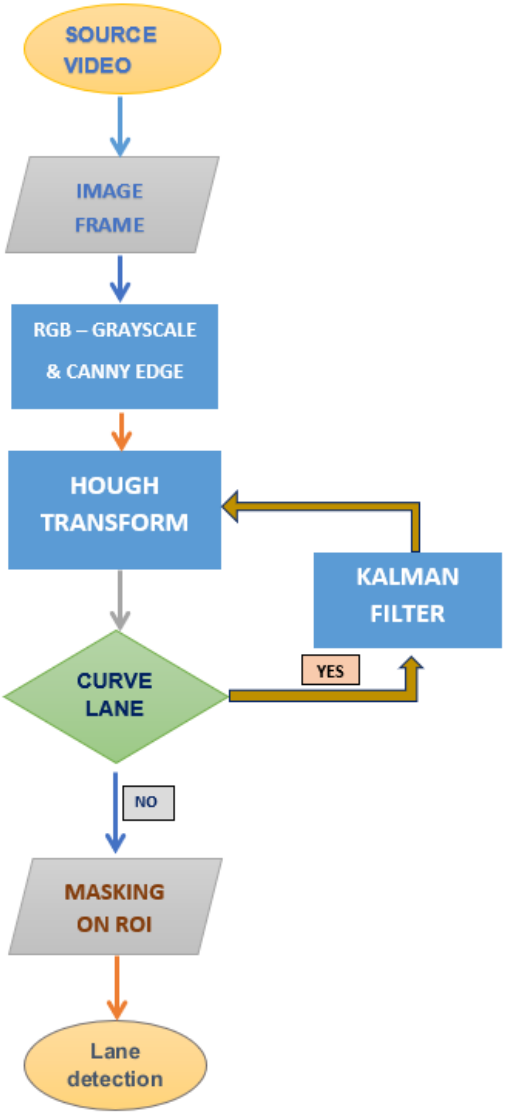


Figure 3.1: FLOW CHART

Chapter 4

Optimization

4.1 Introduction to optimization

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

4.2 Types of Optimization

(1) Canny edge detection for finding Region of Interest

(2) Conversion of RGB scale to gray scale for making the detection of road easy.

(3) Using Probabilistic Hough Transform for the detection of straight lane.

(4) Kalman filter for seeking the curved lane

4.3 Selection and justification of optimization method

for reducing noise and thickness of the edge is not uniform, some of the edges are thick while others are thin and also there are unwanted pixels that may not constitute images. those lies between the Max and Min threshold they are considered to be part of edges. So to overcome these we use canny edge detection.

The RGB carrys 255 x 255 x 3 matrix, which will take more time and space for algorithm to learn. Hance, slowing down the performance of our Kalman filter. But, the grayscale convert it into 255 x 255 x 1 matrix, which will work faster and efficient with the masking layer as there will only one scale to detect the edges.

for the purpose of feature isolation of particular shapes in images and videos and identify the specific shapes in images, in our cases it is the straight lane of the road which we will detect for the prediction purpose, so we used the hough transform. For further optimization we used the probabilistic hough transform.

The Curved lanes is detected using Kalman filter as it is fast and efficient in finding the expected future point for the curvature of the road, which are not aligned. The Curved lanes are then shown by using masking technique for the driver assistance.

Chapter 5

Results and discussions

5.1 Result Analysis

The road lane is very much capture by the machine and it is able to masking the future layer off any road. The speed of car is relatable with the formation of virtual lane in the screen. It is neither slow for driver to predict the lane of road neither very fast, in order to over predict the lane which may lead to wrong assumption of lane. The range of detection on road is till the vanishing point of road, which is suitable for Driver to predict the end of road on uncertain terrain of land. The algorithm is fundamental and chances of improvement is possible in order to make the autonomous safety system getting upgraded and overcoming problems mentioned in reports.

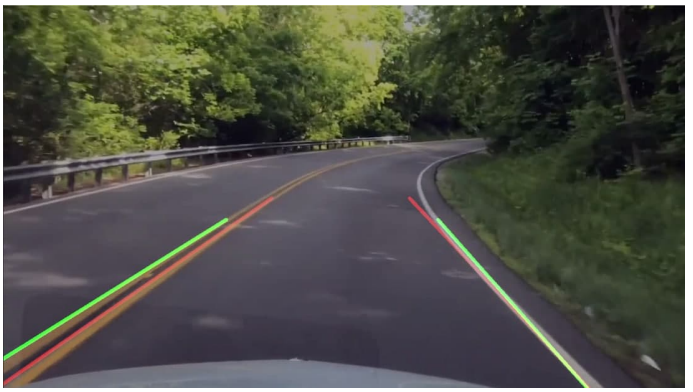


Figure 5.1: Final output Kalman Filter
The Kalman filter is predicting the future lane for ADS

With the analysis purpose, the performance of each frame is keep increasing with techniques used.For applying the filter The videos captured must be of same aspect ratio which need to be fixed. Another problem of square distance between predicted and actual lane was minimize as shown below. For countering that we uses image conversion for detection and prediction by sticking to the region of interest. In the end the Hough transform used to give overfitting, so we come up with Probabilistic hough tansform as our choice of detection of the lane

Figure 5.2: Gray scale Image
The RGB scale is convert to Gray scale which will ease the computation and implementation of Kalman filter.

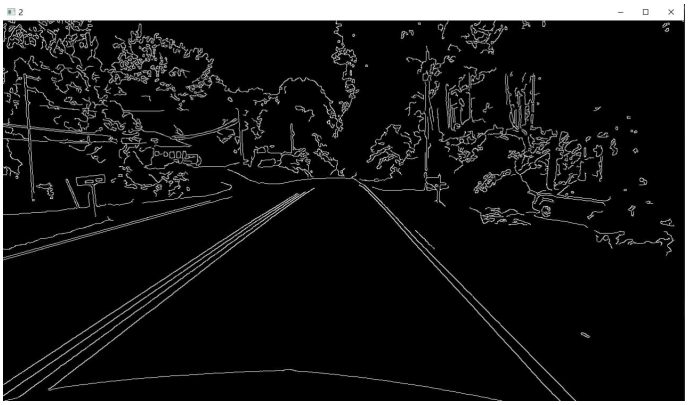


Figure 5.3: canny edge detection
The canny edge detection detect the fixed edges by giving the minimum and maximum value of threshold.

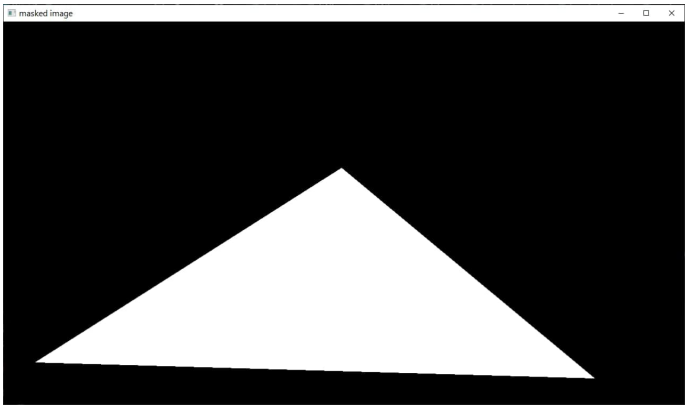


Figure 5.4: Masking Region
The Masking region is where the points of lane detection will be plottedd , this is done in order to avoid the overfitting of predicted lane

Figure 5.5: Probablistic Hough transform
The images shows that the straight lane is detected by using Msking color on the image frame.

5.2 Discussion on optimization

The Final output is catching the lane of the road with avoiding the unpleasant pixels which will contribute towards generating the images. The Grayscale overcome the limitation of RGB scale, then the canny edge detection is used for edge detection. Finally the hough transform is used to detect the straight lane and finally for the Curved lane detection, we are using kalman filter.

Chapter 6

Conclusions and future scope

The future of our project could be application on big scale which will work not only on individual car or its driver but based on each and every car and driver of this world with their experiences and mistake we can make the future of vehicle more safe and secure on Machines hand rather than human.

6.1 Conclusion

The model built is successfully detecting the lane and predicting the Future aspects of the road by using Hough transformation and Kalman filter for 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. The Vicinity of road are computing better and other malicious things, it is neglecting including holes, cracks on the road, fog, rain and reflection of light on the road.

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.