MINI PROJECT REPORT

TITLE: LANE DETECTION SYSTEM

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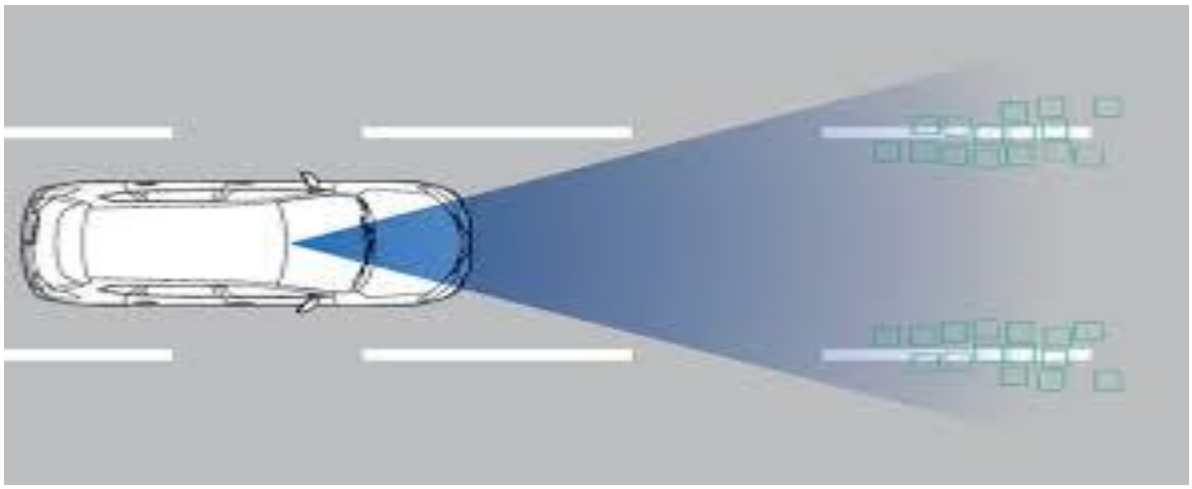


ABSTRACT:

Lane detection is a computer vision task that is used to identify the boundaries of driving lanes in a video or image of a road scene.

Lane detection is an important component of self-driving or autonomous vehicles, as it provides information about the road layout and the position of the vehicle within the lane, which is crucial for navigation and safety. The main technology used here is known as computer vision. Computer vision is a field of Artificial Intelligence that allows machines such as computers to be able to derive meaningful information from images videos and other visual inputs.

The two main technologies required for computer vision to work are.

(1) deep learning

(2) convolutional neural network (CNN)

Deep learning is a machine learning technique that allows computers to perform tasks that humans naturally do.

A CNN breaks down the input images or videos into small pixels and performs convolutions which is a mathematical operation on two functions to produce a third function. The pixels are given labels and predicts what it is seeing. Then it gives its outputs on the given images and videos.

The main goal and expected outcome of lane detection system is to accurately identify, track and locate the lane markings in real time as well and even in challenging conditions such as poor lighting, glare, or complex road layouts.

INTRODUCTION:

(1) Lane detection is an important problem in the field of artificial intelligence and computer vision. Lane detection algorithms typically use image processing techniques to analyse the video stream from a camera mounted on a vehicle. The output of the algorithm is typically a set of parameters that describe the position, orientation, and curvature of the detected lanes. The challenge in developing accurate and robust lane detection systems is that lane markings can vary in colour, shape, and size depending on the road conditions, lighting, and weather. Moreover, lane markings may be occluded by other vehicles or objects on the road, or they may be absent altogether in some areas.

(2) Some famous techniques that are used in lane detection system are:

- Hough Transform: This is a technique for detecting straight lines in an image. It converts an image into a binary form and identifies the lines that may represent lanes.
- Canny Edge Detection: this technique detects edges in an image and then Hough transform is used to identify the lanes.
- Deep learning and CNN: Deep learning models such as convolutional neural networks (CNN) can be used in which the images are broken into smaller pieces and then on further processing the lanes can be detected.

- Kalman Filtering: in this technique a mathematical model is used to estimate the location and the direction of the lanes . the model gets updated using sensor measurements and the estimates get better over time.
- Semantic segmentation: in this technique regions are divided into lane and non-lane regions and then on further processing the exact location of the lanes can be found.

The main technique that we are using in our project is an open cv (computer vision) technique. The language for the code will be python. The technologies involved are going to be Hough transform and canny edge detection. The final system shall detect the lanes on the road from an image or a video.

(3)

Some famous existing projects and their drawbacks are:

- LaneNet: LaneNet is a deep learning bases lane detection system that uses a u-net architecture (semantic segmentation) for lane detection. One main limitation of this system is it fails to detect lanes in robust weather conditions such as rain and snow.
- Lane detection using deep learning: This method uses a combination of semantic segmentation and deep learning for lane detection. The main limitation of this system is that a large amount of training data is needed, and it can be time consuming and expensive to collect.
- Lane Detection using OpenCV: This project uses traditional computer vision techniques such as Hough Transform and Canny Edge Detection to detect lanes. The main limitation of this system is that it doesn't detect curved lanes effectively and is sensitive to lighting conditions.
- Lane Detection using Kalman Filter: This project uses a Kalman filter-based approach to estimate the location and direction of the lanes. The main limitation of this system is that it requires accurate sensor measurements which are difficult to obtain in real life scenarios.

(4) some contributions to the lane detection system we can give to ensure better outcomes

- Developing more robust systems that can even work under challenging weather conditions such as rain and snow.
- Using multiple radars and sensors to ensure better detection of the lanes.
- New deep learning architectures can be designed that can give accurate outputs with less amount of data and are cost effective.
- Real time lane detection systems can be designed that can be used even during fast speeds and poor lighting conditions.

LITERATURE REVIEW:

Some of the famous research papers on lane detection and their drawbacks are:

- Real-time lane detection on highways, urban and rural roads- by A. Broggi:

This research paper proposes a real-time lane detection algorithm that can be applied to various types of roads such as highways, urban and rural roads. The algorithm is based on a combination of edge detection, colour segmentation, and Hough transform techniques. The system designed in this technique was able to detect lanes in real life with high accuracy and could also work under challenging weather conditions. The main drawbacks of this system were it could not predict the lanes properly when the markings were worn out or covered. And it couldn't predict the lanes when there were multiple markings or at road intersections.

- Robust lane detection and tracking in challenging scenarios- by M. Bertozzi:

A lane detection method is suggested in the paper that can work in difficult conditions including curvy roads, roads with low illumination, and roads with obstructions. The main techniques suggested here are edge detection, colour segmentation, and model fitting techniques.it also has a kalaman filter to estimate the state of the markings in the future. The proposed algorithm was able to deal with difficult situations like curvy roadways, inadequate lighting, obstructions and detect lanes with accuracy. The combination of edge detection, colour segmentation, and model fitting techniques require significant processing resources, mainly for real-time applications. This can make it harder for the technique to be used on devices with low processing power or speed.

- "End-to-end learning of driving models from visual perception" by M. Bojarski:

The paper proposes an end-to-end deep learning approach for self-driving, which learns driving behaviour directly from visual input such as camera images. The technique uses a convolutional neural network (CNN) to interpret raw camera pictures and produce steering angle commands that are used to control the vehicle. The results of testing this method showed that it could drive safely and effectively in a variety of situations, including urban and rural areas, as well as in various lighting and weather conditions. One main limitation of this model is that it was not easily interpretable and as a result it is more difficult to know how the model makes decisions and it becomes difficult to correct its errors.

- A novel lane detection algorithm based on deep learning and lane area detection - by J. Li:

This method first uses a lane area detection method to separate the input image into different regions, including the lane area, the road area, and the non-road area. the lane detection algorithm uses a deep convolutional neural network (CNN) to study features from the input image and then a processing step is used to identify the lane boundaries. The CNN is trained on a large dataset of images and can learn to detect lane markings in various lighting conditions and road scenarios. The main drawback of this model is that if the segmentation is not accurate, it could affect the accuracy and robustness of the lane detection algorithm.

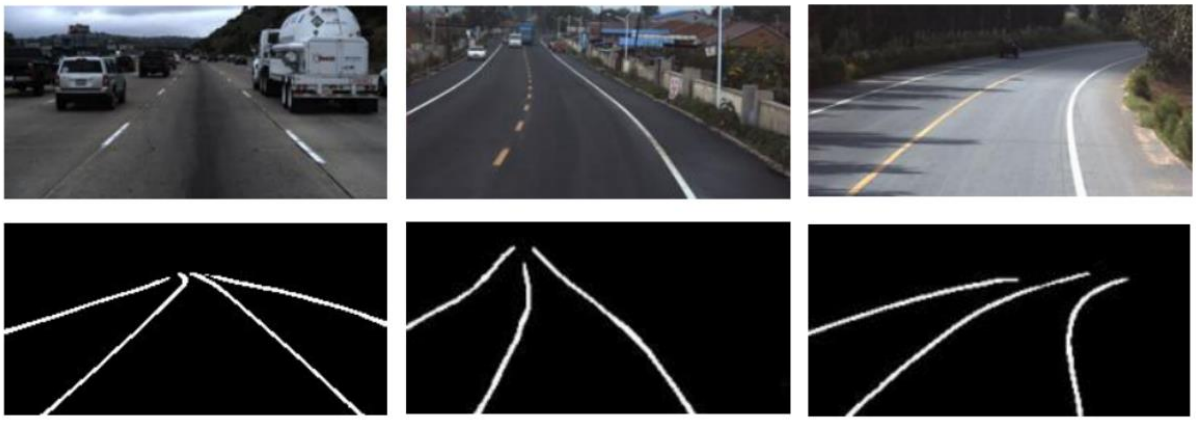
- Lane detection using deep learning: a survey - by S. Guo:

This is a survey paper that gives a thorough overview of current developments in deep learning-based lane detection. The paper discusses the various issues and challenges with lane detection, such as obstructions, lighting conditions, and uncertainty in lane markings, and how deep learning can address these challenges The authors discuss the various datasets used for training and designing deep learning-based lane detection algorithms, including TuSimple, CULane, and the KITTI dataset. The main drawback of the survey is that it may not cover all recent developments in lane detection using deep learning, as the field is rapidly evolving.

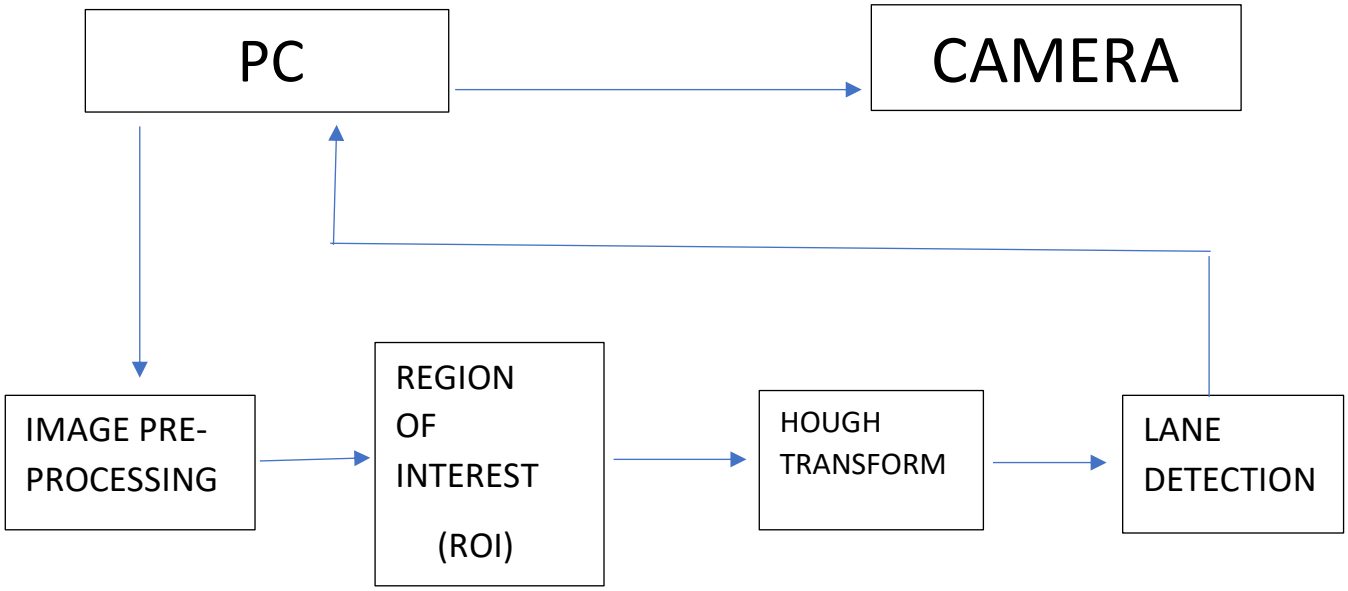
MODEL/TOOLS OF THE PROJECT:

As we know the main aim of a lane detection system is to detect lanes properly .

This is how the output should look before and after lane detection.



The block diagram of the project will be:



Significance of the terminology used in the blocks are:

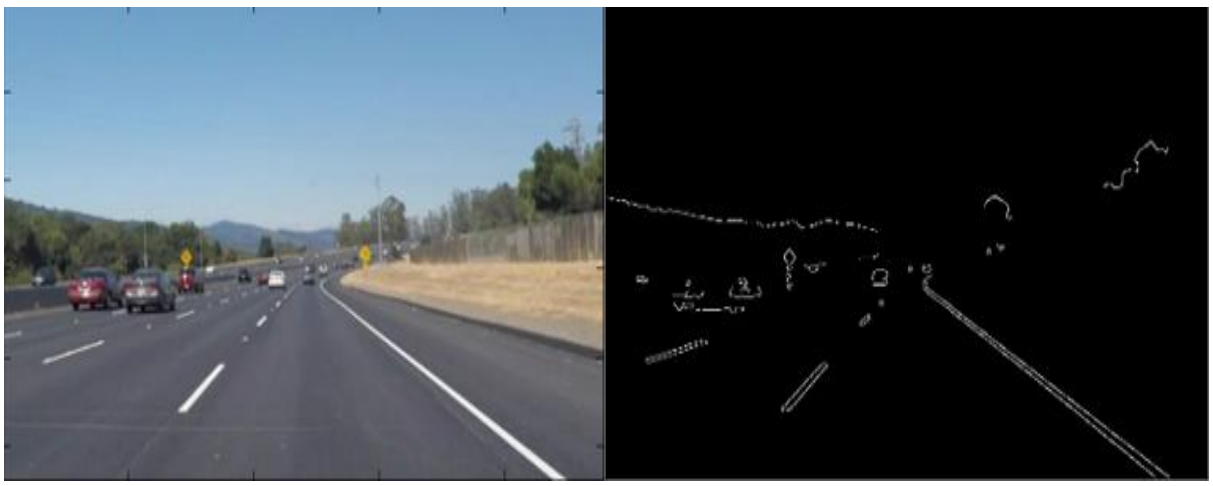
(1) Capturing the input image – a hardware like a camera is used to input an image
(2) Image Pre processing - an image is pre processed to enhance its quality. The processes like noise reduction, edge detection, contrast and colour management are applied.
(3) Region of interest - In determining the computational complexity (number of resources) of lane identification, ROI plays an important role for detection. Here only the selected areas are detected and taken for the next level of processing. These selected ROI images are then used for lane detection using the proposed algorithm. The selection of ROI reduces the processing time of the frames.
(4) Hough Transform - The Hough Transform is used on images after the canny edge detection has taken place to obtain the image pixels that are desired. So here in this system to detect the marking of the lanes from the image data, Hough Transform is used.
(5) Lane Detection – a separate colour is used to mark the lane.

Canny Edge Detection:

With the use of a technology called canny edge detection, the amount of data that needs to be processed can be greatly reduced while still extracting meaningful structural information from various vision objects. It has been extensively used in many different computer vision systems.

The basic standards for edge detection are as follows:

- the detection should accurately catch as many edges shown in the image as possible with minimal possible errors.
- The edge point detected from the operator should accurately localize on the centre of the edge.
- A given edge in the image should only be marked once (repetitive marking is not allowed).



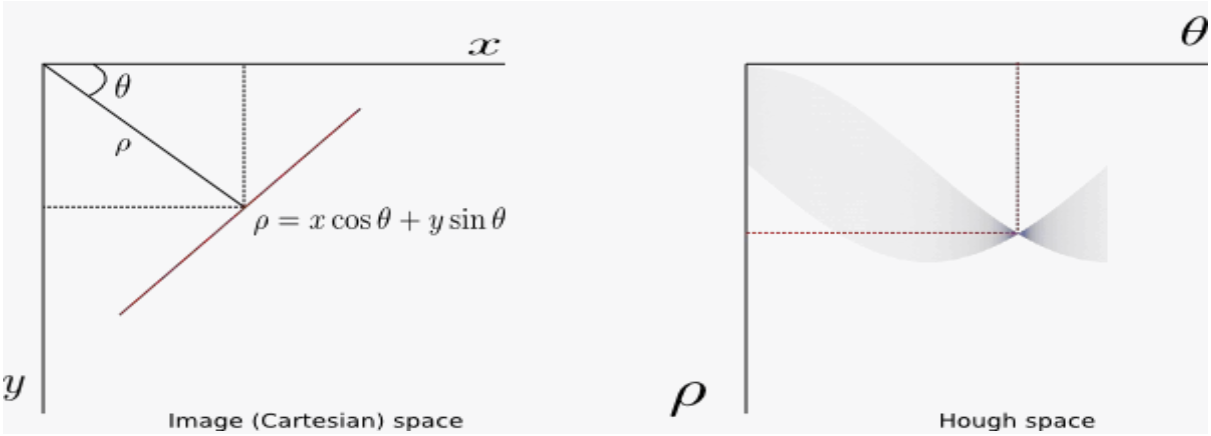
The image on the left is of a road and the image on the right is the picture of the same road after performing edge detection.

Hough Transform:

The features of various shapes inside an image can be separated using a technique called as Hough Transform. This technique is generally used for the identification of arbitrary shapes such as straight lines, circles, ellipses, etc. The Hough Transform is implemented on images after canny edge detection to obtain the image pixels that are desired. Here Hough transform is used to detect the marking of the lanes from the given image data.

Let us assume we have a straight line of the form y = mx + c where m is the slope and c is the intercept. It can also be written in the form $R = x\cos(\theta)+y\sin(\theta)$.

Here R is the distance from origin and θ is the angle formed by the perpendicular line and x axis in anti-clockwise direction. This straight line can be represented with just two values (R, θ) and can be plotted in a space known as Hough Space. The Hough Space is a 2D plane that has a horizontal axis representing the slope and the vertical axis representing the intercept of a line on the edge image.



The reason for Hough space is that while scanning the image, the same value of (R, θ) will occur many times for a straight line. The occurrences of (R, θ) can be accumulated as votes, and finally, when the scanning of the image is done, the (R, θ) value which got a high number of votes are identified as a line and can be reconstructed to its actual straight-line form to represent on the image.

This is the way Hough transform works and this is the method by which the straight lane lines are detected. After all the above processes a lane is detected and can be distinguished from the original input image or video.

CONCLUSION:

Lane detection is an important problem in the field of artificial intelligence and computer vision, which involves detecting the lanes on a road from an image or video stream captured by a camera mounted on a vehicle. Some of the techniques used in lane detection systems are Hough Transform, Canny Edge Detection, Deep Learning and CNN, Kalman Filtering, and Semantic Segmentation. Existing projects in this area include LaneNet, Lane Detection using Deep Learning, Lane Detection using OpenCV, and Lane Detection using Kalman Filter, each with its own limitations. An OpenCV technique was used here to make the lane detection system, we discussed about the main required technologies for the project which include capturing an image, pre-processing the image, region of interest, canny edge detection and Hough transform. As discussed The output of the algorithm is a set of parameters describing the position, orientation, and curvature of the detected lanes. Lane markings can vary in colour, shape, and size depending on road conditions, lighting, and weather, and may be

occluded by other vehicles or objects on the road, or they may be absent altogether in some areas. The field of lane detection is constantly evolving and some of the main areas with potential for future development are autonomous vehicles, detecting multiple objects at a single time, lane detection can also be used for security. The lane detection system can detect drivers who are not following the traffic rules and this information can be presented to the traffic government.

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