

# A Surey on a Classical Computer Vision Pipeline for Lane Detection and Turn prediction In Autonomous Driving

Katuru Vinod, Shankar Prakash Vallam, Pulla Ramji Ambedkar, Polamreddy Mounika, Thota Naveen, Patanam Hema

*Dept of CSE, 4<sup>TH</sup> Year Student Gokula Krishna College of Engineering Sullurpeta, AP. India*

*Abstract--Autonomous driving is a major advancement in AI, with Lane Detection Systems (LDS) playing a crucial early role. As urban traffic grows, road safety becomes essential, with many accidents caused by unintended lane departures. Advanced Driver Assistance Systems (ADAS) like Lane Departure Warning and Adaptive Cruise Control help vehicles assess their surroundings and react to potential dangers. However, complex road environments pose challenges in accurate lane prediction. Key visual cues include road boundaries, pavement texture, and lane markings. Machine learning has significantly improved lane detection through image processing and computer vision. In a typical LDS, frames from a real-time video feed are converted to grayscale, denoised using a Gaussian filter, and processed with a Canny Edge Detector to highlight lane edges. A region of interest is then isolated, and the Hough Line Transform (HLT) identifies lane lines, which are superimposed on the original image to estimate the vehicle's position within the lane.*

*Let me know if you'd like this shorter or even more technical. –*

**Keywords—** Lane Detection, Autonomous Driving Car, Computer Vision, Hough Transform, Canny Edge Detector , Trajectory Prediction

## INTRODUCTION

A major challenge for autonomous vehicles is predicting the motion behavior of other road users, such as pedestrians and other vehicles. This task, known as trajectory prediction, is essential for safe navigation. It enables the vehicle to anticipate future movements and plan accordingly. Many deep learning based trajectory prediction algorithms are developed today to increase the accuracy of predicting the future paths of vehicles, pedestrians, and other objects on the road [1]. Besides the achievements in machine learning and object recognition, AI-based perception has certain limitations re grading the reliability of the results. Uncertainties, such as sensory disturbances, insufficient training data, or a lack of dynamic context

assessment, lead to failures, which may have vast safety implications for the autonomous vehicle. Non transparent decision-making, plus the overall complexity, pre vents the safety of such models from being assured. Accord ingly, safety parameterization is usually restrictive and leads to the systematic underperformance of autonomous vehicles.. The majority of accidents on the roads are caused by drivers leaving the lane without obeying the correct laws. The use of lane detecting devices makes it easier to see the lane markings on the road and warns the user when he switches to the wrong side of the road. A crucial problem with advanced driver assistance systems is the accurate identification of lane roads. Vehicles equipped with systems for anticipating lane boundaries causes the cars to avoid crashes and produce an alarm if a vehicle crosses a lane restriction. With the aid of computer vision technology, automobiles may be able to comprehend their environment. Artificial intelligence has a subfield that makes it possible for software to perceive the information of images and videos. The development of deep learning has made it possible for modern computer vision to recognise various objects in photos by analysing and contrasting millions of examples and identifying the visual patterns that distinguish each object. While deep learning is very effective for classification tasks, it has many flaws and is prone to unanticipated failure. As a result, route acquisition is a prominent subject in ML and computer diagnostics, and is used in IDS. This system collects data through route markers in a busier area and uses it to accurately predict automobile location and trajectory in relation to the route.

## RELATED WORKS

LDS may be classified into projections based on roads and versions based on neural networks. Former models extract geometrical shapes from images and analyze

parameters based on 2D or 3D models. Neural network methods make use of deep learning algorithms to identify lane lines and achieve high accuracy. The transferability and authentic efficiency of one model are sometimes insufficient for handling a variety of road circumstances. In the screening test using the road characteristics, road boundary characteristics are extracted for segmentation and identification utilizing variations between the lane dividers and its surroundings. Lane line edges, color, and geometric elements are the key characteristics. A two-stage feature extraction lane detection approach to address the robustness issue brought on by inconsistent lighting and backdrop clutter, where each lane has two limits. The aforementioned detection techniques are simple to use, low in complexity, and capable of achieving excellent real-time performance, but they are quite sensitive to outside factors. Misjudging lane lines is more likely to happen on wet days or in low .

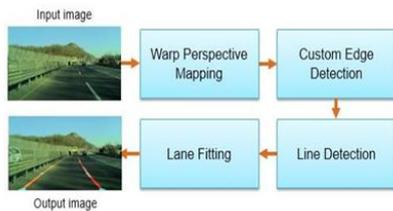


Fig. 1. Existing Methodology [3]

### PROPOSED SYSTEM

A real-time tracking algorithm has been proposed based on a series of images taken from a real-time input feed. After RGB image is converted to grayscale Gaussian filter is used to perform noise removal. The Canny Edge Detector detects the edges with significant variations in intensity. The canny image is masked except for region of interest and Hough Line Transform detects the extremes of the shades of the picture. The findings using HLT is a value of pixels that is superimposed into the original image, as detected lane lines. Route acquisition means the recognition or segregation of lines on the road in the field of self-driving and private vehicles, as the name implies. The real time feed is decoded or converting into a sequence of images and given to the pre-processing module. The term "feature detection" in computer vision refers to techniques that calculate abstractions of picture information and subsequently determine whether or not each image point has an image feature of a specific type. Video frames are converted to grayscale since it is easier to process a single channel image than a three-channel RGB image. As noise can lead to misleading edges, image

smoothness is required before proceeding. The Gaussian filter (GF), a type of low pass filter, is used in this operation. To minimise distortion and obscure specific portions of a photo, a GF is used. The filter is constructed as a peculiar homogeneous core and performed to every unit in the Region of Focus to produce the desired outcome. The goal of edge detection is to find object edges inside photographs. Edge detection methods are employed to attempt to find regions in a picture in which there is a sudden change in intensity. An image can be recognised as a matrix or a collection of pixels. The amount of light present at a particular spot in the image is stored in a pixel. An intensity value of zero signifies no intensity or completely black, while an intensity value of 255 symbolises maximum intensity or completely white. Each pixel's intensity is represented by a numeric number that ranges from 0 to 255. The brightness of a group of pixels varies over time in a gradient. A steep change is indicated by a strong gradient, whereas a shallow change is shown by a modest gradient. A Canny Edge Detector calculates the dimensions of the blurred image on all sides and tracks edges with major dynamic changes. Canny Edge Detector Reproductive Region is the location of the covered road. Here, a mask of the same size as of the street image is constructed. The image's dimensions are chosen to include the lanes on the roads and identify the polygonal as area of interest. The image's dimension, which would effectively be an array of all zeros, is then used to form a mask. Now the region of interest dimensions is white, the polygonal dimension is filled in this mask with an intensity of 255. With the image and the mask, a bitwise AND operation is performed to create the final region of interest. Finally, it hides the image and reveals the region followed by the mask's polygonal contour.

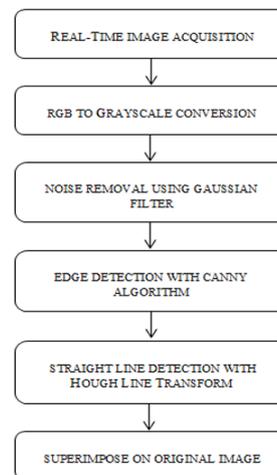


Fig. 2. Proposed system flowchart

Hough Line Transform can be used to find straight lines in region of interest. These straight lines represent lane lines and for line continuity Hough probabilistic algorithm and be applied.

### METHODOLOGY

Each picture goes through a sequence of visual cues to clear the background and capture only the white and yellow lines as shown from figure 4 to figure8. The original image is given in Figure 3.



Fig. 3. Original Images

#### A. Colour Masking

The process involves the acquisition of a specific colour (white / yellow lines) in the content of live streaming video. Since the video is made up of endless frames at different times the cooler is available individually. The mask highlights a particular region of interest from the image following the acquisition. This is done by specifying the range of colours that create the mask for those colours.

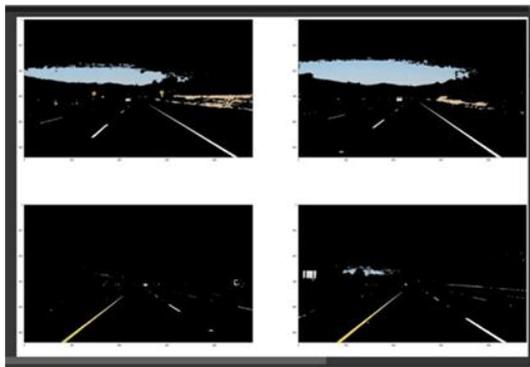


Fig. 4. Colour Masked Images

B. Noise Removal from The Masked Image And Identifying ROI Image noise is a random variation of brightness or undesirable colour information with the product of inconsistent or negative lighting conditions and hides the required information. Saving image details while deleting random noise in a photo as much as possible is doneto make the image smooth. Then the location of interest can be selected accurately and manually to do the

required work. That area will then be transferred as input to the next project to be performed.

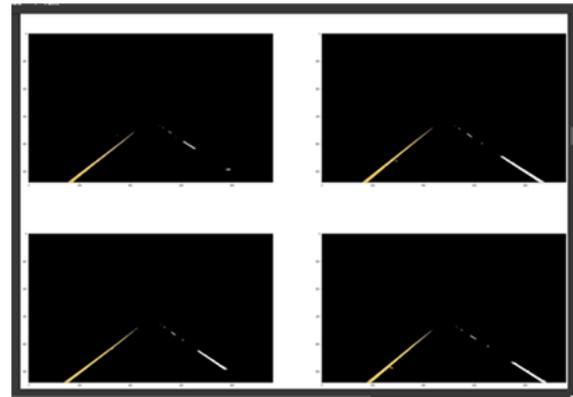


Fig. 5. Masked Images Showing ROI

#### C. Apply The Canny Algorithm to Find Edges of the Lane Lines

Canny method accepts a gray scale image as input and uses a multi-stage algorithm. The process of the Canny edge detection entails calculates the dimensions of the blurred image on all sides and tracks edges with major dynamic changes.

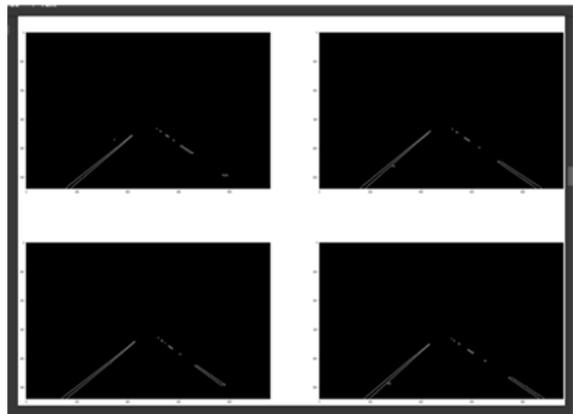


Fig. 6. Canny Edge Detector Output

#### D. Apply Hough Line Transform to Trace Lines Along The Image

Hough Transform in its simplest form is technique to detect any shape even if it is broken or distorted as long as it can be represented in mathematical form. A line is represented as:

$$y = mx + c \rho = x \cos \theta + y \sin \theta$$

Where,  $\rho$  is the perpendicular distance from origin to the line and  $\theta$  is the angle formed by the perpendicular line with the origin measured counter-clockwise. Any line can be represented as a function of  $(\rho, \theta)$ . The function creates a histogram array representing the parameter space. It intuitively detects lines by considering the intersection of multiple lines in an image space as multiple points in

the Hough space. If a line, which is an image detected as an edge has discontinuities, the discontinuous line in image space is transformed to look for intersection points in Hough space that represents the next point in the continuity of the line. Bright spots at some locations can be considered as possible lines in the image.

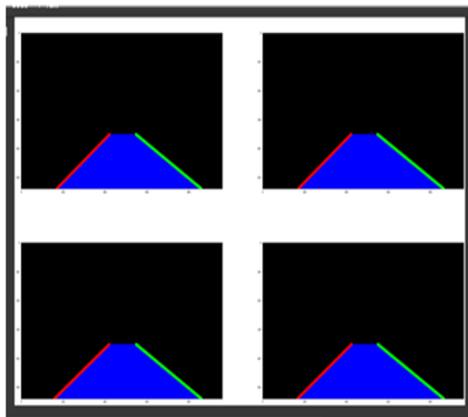


Fig. 7. After Applying Hough Transform

## CONCLUSION

In this paper, a real-time tracking algorithm has been proposed based on real time feed from a car driving on a highway. A lane departure warning system is a control system that assists a vehicle in maintaining a safe journey within a marked highway. As mentioned above the system uses a series of images taken from a real-time input feed. In this series some of the different frames used are displayed in the route finding algorithm. Since the lanes are usually long and smooth curves, they were considered straight lines within the appropriate range for vehicle safety. Routes were found using Hough conversions with a limited search area. This route identification model successfully demonstrates a robust approach to the development of Advanced Driver Assistance Systems (ADAS) and Driving Systems. At this point, the output from the pipe will be integrated into another speed and title control algorithm. To do this, the steering angle can be computerized from the received line and transferred to the controller to keep the car centred. The system detects when a vehicle deviates from the lane and automatically adjusts the steering wheel to restore proper movement within the lane without input from the driver.

## REFERENCES

[1]. Xingyu Zhou et al., "Driver-Centric Lane-Keeping Assistance System Design: A

Noncertainty-Equivalent Neuro-Adaptive Control

- [2]. Approach," IEEE/ASME Transactions on Mechatronics, vol. 28, no. 6, pp. 3017-3028, 2023. [CrossRef] [Google Scholar] [Publisher Link]
- [3]. Manav Garg, Apeksha Sehrawat, and P. Savaridassan, "Vehicle Lane Detection for Accident Prevention and Smart Autodrive Using OpenCV," 2023 International Conference on Computer Communication and Informatics (ICCCI), Coimbatore, India, pp. 1-5, 2023. [CrossRef] [Google Scholar] [Publisher Link]
- [4]. Steffen Maurer et al., "Designing A Guardian Angel: Giving an Automated Vehicle the Possibility to Override its Driver," Proceedings of the 10th International Conference on Automotive User Interfaces and Interactive Vehicular Applications, pp. 341-350, 2018. [CrossRef] [Google Scholar] [Publisher Link]
- [5]. Vijay Gaikwad, and Shashikant Lokhande, "Lane Departure Identification for Advanced Driver Assistance," IEEE Transactions on Intelligent Transportation Systems, vol. 16, no. 2, pp. 910-918, 2015. [CrossRef] [Google Scholar] [Publisher Link]
- [6]. Em Poh Ping et al., "Vision-based Lane Departure Warning Framework," Heliyon, vol. 5, no. 8, pp. 1-18, 2019. [CrossRef] [Google Scholar] [Publisher Link]
- [7]. Jongin Son et al., "Real-Time Illumination Invariant Lane Detection for Lane Departure Warning System," Expert Systems with Applications, vol. 42, no. 4, pp. 1816-1824, 2015. [CrossRef] [Google Scholar] [Publisher Link]
- [8]. Jinsheng Xiao et al., "Lane Detection Based on Road Module and Extended Kalman Filter," Image and Video Technology: 8th Pacific-Rim Symposium, PSIVT 2017, Wuhan, China, pp. 382-395, 2018. [CrossRef] [Google Scholar] [Publisher Link]
- [9]. A.V. Vinuchandran, and R. Shanmughasundaram, "A Real-Time Lane Departure Warning and Vehicle Detection System using Monoscopic Camera," 2017 International Conference on Intelligent Computing, Instrumentation and Control Technologies (ICICT), Kerala, India, pp. 1565-1569, 2017. [CrossRef] [Google Scholar] [Publisher Link]

- [10]. Wenshuo Wang et al., "A Learning-Based Approach for Lane Departure Warning Systems With a Personalized Driver Model," *IEEE Transactions on Vehicular Technology*, vol. 67, no. 10, pp. 9145-9157, 2018. [CrossRef] [Google Scholar] [Publisher Link]
- [11]. Yassin Kortli, Mehrez Marzougui, and Mohamed Atri, "Efficient Implementation of a Real-Time Lane Departure Warning System," *2016 International Image Processing, Applications and Systems (IPAS)*, Hammamet, Tunisia, pp. 1-6, 2016. [CrossRef] [Google Scholar] [Publisher Link]
- [12]. Kaiming He, Jian Sun, and Xiaoou Tang, "Single Image Haze Removal Using Dark Channel Prior," *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol. 33, n [12], pp. 2341-2353, 2011. [CrossRef] [Google Scholar] [Publisher Link]
- [13]. Abdelhamid Mammeri, Azzedine Boukerche, and Zongzhi Tang, "A Real-Time Lane Marking Localization, Tracking and Communication System," *Computer Communications*, vol. 73, pp. 132-143, 2016. [CrossRef] [Google Scholar] [Publisher Link]
- [14]. Marcos Nieto et al., "Real-Time Lane Tracking using Rao-Blackwellized Particle Filter," *Journal of Real-Time Image Processing*, vol. pp. 179-191, 2016. [CrossRef] [Google Scholar] [Publisher Link]
- [15]. Mohamed Aly, "Real Time Detection of Lane Markers in Urban Streets," *2008 IEEE Intelligent Vehicles Symposium*, Eindhoven, Netherlands, pp. 7-12, 2008. [CrossRef] [Google Scholar] [Publisher Link]
- [16]. Davy Neven et al., "Towards End-to-End Lane Detection: An Instance Segmentation Approach," *2018 IEEE Intelligent Vehicles Symposium (IV)*, Changshu, China, pp. 286-291, 2018. [CrossRef] [Google Scholar] [Publisher Link]
- [17]. Tobias Kühnl, Franz Kummert, and Jannik Fritsch, "Spatial Ray Features for Real-Time Ego-Lane Extraction," *2012 15th International IEEE Conference on Int*
- [18]. A. Sharma, M. Kumar and R. Kumar, "Lane Detection Using Python," *2021 3rd International Conference on Advances in Computing, Communication Control and Networking (ICAC3N)*, 2021, pp. 88-90, doi: 10.1109/ICAC3N53548.2021.9725626.
- [19]. M. V. G. Aziz, A. S. Prihatmanto and H. Hindersah, "Implementation of lane detection algorithm for self-driving car on toll road cipularang using Python language," *2017 4th International Conference on Electric Vehicular Technology (ICEVT)*, 2017, pp. 144-148, doi: 10.1109/ICEVT.2017.8323550.
- [20]. Lane Detection on Roads using Computer Vision Abhishek Goyal, Mridula Singh, Anand Srivastava, *International Journal of Engineering and Advanced Technology (IJEAT)* ISSN: 2249 – 8958, Volume-9 Issue-1, October 2019
- [21]. T. T. Duong, C. C. Pham, T. H. -P. Tran, T. P. Nguyen and J. W. Jeon, "Near real-time ego-lane detection in highway and urban streets," *2016 IEEE International Conference on Consumer Electronics-Asia (ICCE-Asia)*, 2016, pp. 1-4, doi: 10.1109/ICCE Asia.2016.7804748.
- [22]. Wang, W., Lin, H. & Wang, J. CNN based lane detection with instance segmentation in edge-cloud computing. *J Cloud Comp* 9, 27 (2020). <https://doi.org/10.1186/s13677-02000172z>
- [23]. A. S. . Bale, S. . Tiwari, A. . Khatokar, V. . N, and K. . Mohan M S, "Bio-Inspired Computing-A Dive into Critical Problems, Potential Architecture and Techniques", *Trends Sci*, vol. 18, no. 23, p. 703, Nov. 2021
- [24]. Bale, A.S., Kumar, S.S., Kiran Mohan, M.S., Vinay, N. (2022). A Study of Improved Methods on Image Inpainting. In: Johri, P., Diván, M.J., Khanam, R., Marciszack, M., Will, A. (eds) *Trends and Advancements of Image Processing and Its Applications*. EAI/Springer Innovations in Communication and Computing. Springer, Cham. [https://doi.org/10.1007/978-3-030-75945-2\\_15](https://doi.org/10.1007/978-3-030-75945-2_15)
- [25]. B. C. R, S. Joy, A. S. Bale, A. S. Naidu, V. N and V. S N, "Advanced Computing in IoT for Door Lock Automation," *2022 International Conference on Electronics and Renewable Systems (ICEARS)*, 2022, pp. 565-569, doi: 10.1109/ICEARS53579.2022.9752140.
- [26]. S. Joy, R. Baby Chithra, A. S. Bale, N. Ghorpade, S. N. Varsha and A. S. Naidu, "A Comparative Study on Recent Trends in Iris Recognition Techniques," *2022 International Conference on Electronics and Renewable Systems (ICEARS)*, 2022, pp. 1521-1525, doi: 10.1109/ICEARS53579.2022.9752355.
- [27]. Ajay Sudhir Bale, Naveen Ghorpade, Muhammed Furqaan Hashim, Jatin Vaishnav,

Zahra Almaspoor, "A Comprehensive Study on Metaverse and Its Impacts on Humans", *Advances in Human Computer Interaction*, vol. 2022, Article ID 3247060, 11 pages, 2022. <https://doi.org/10.1155/2022/3247060>

- [28]. A. S. Bale et al., "Recent advancement in emergency vehicle communication system using IoT," in *IoT and Big Data Analytics for Smart Cities*, 1st Edition., Boca Raton: Chapman and Hall/CRC, 2022, pp. 121–158. DOI: 10.1201/9781003217405-7
- [29]. Hemanth Kumar Bangalore Naveen, et al., *Internet of Things (IoT) – Powered Enhancements to Industrial Pollution Monitoring. Modeling and simulation of environmental systems: A computation approach* (Edited by: S. P. Maurya, A. K. Yadav, & R. Singh, Eds.; 1st ed.). Taylor & Francis.