Real time lane detection system using Python and OpenCV on Raspberry Pi

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ABSTRACT - Driver assistance system is a technology used to make motor vehicle travel safer by automating, improving or adapting some or all of the tasks involved in operating a vehicle. Driver assistance serves to make travel comfortable and easier, while also increasing car and road safety. While some systems help with the task of driving, others alert the driver to errors or hazards, such as lane departure detection and drowsiness detection. Aside from vehicle control, driver assistance can also refer to secondary driving tasks such as location finding, route planning and obstacle detection. Driver assistance is a developing field. This paper aims at detecting lanes using Python and OpenCV. In real time vehicular movements will be captured using a camera and the same will be processed to achieve the goal. The Hough Transform is used to detect lanes in an image or video.

Keywords: Lane detection, Hough Transform, Canny edge detection, Python OpenCV

I. INTRODUCTION

Driver Assistant System is designed to assist drivers in the perception of any dangerous situations before, to avoid accidents after sensing and understanding the environment around itself. To date there have been numerous studies into the recognition. Traffic accidents have become one of the most serious problems. The reason is that most accidents happen due to negligence of the driver. Rash and negligent driving could push other drivers and passengers in danger on the roads. More and more accidents can be avoided if such dangerous driving condition is detected early and warned to other drivers. Most of the roads, cameras and speed sensors are used for monitoring and identifying drivers who exceed the permissible speed limit on roads and motorways. This simplistic approach, and there are no restrictions.

II. BACKGROUND

Prof A. B. Deshmukh et al [2] in their paper that Lane detection is an essential component of Advance Driver Assistance system (ADAS). Many different approaches have been proposed till today by researchers but still it is a challenging task to correctly detect the road lanes in various environmental conditions. The main purpose of the system is to detect the lane departure to avoid road accidents and to provide safety for pedestrians. The proposed method detects the road edges using the canny edges detector whereas the feature extraction technique like Hough transform is used in image analysis and digital signal processing. The main input to the system is camera captured images in order to detect and track the road boundaries. This concept of image processing is implemented using OpenCV library function on raspberry-pi hardware. This method can correctly detect the roads in various challenging situations. Results shows that the proposed method can detect both the straight and curves lanes correctly. [2]

Over the last few years, there is rapid increase in the embedded electronic subsystems in vehicles; intelligent driver assistance system forms a significant component. The different electronic subsystems such as vision based advance driver assistance system form the significant contribution toward the intelligent driver's assistance system. The application of the intelligent driver assistance system works towards to form a driver less vehicle. These new up growing technologies are trying to create a driver assistance system that goes beyond the automatic control system. [3]

Recently, many studies are conducted based on advanced driver assistance system (ADAS) to avoid car accidents. Mostly, the lane departure warning system (LDWS), this system warns the driver when the vehicles tend to depart of its lane, which is the most basic and important part of the ADAS. [4]

The literature related to advance driver assistance is mostly in view of utilizing one or more rear camera to detect the lane stripes. There are various sensors like LIDAR, RADAR and so on are utilized for recognizing the things and 3D display of the roads. Likewise, here and there camera confronting the driver is utilized to detect the behavior (drowsiness, sleepiness etc.) of the driver while driving. [5]

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In lane departure warning system, the lane detection is the initial step to be taken. There are two types of methodologies used in lane identification: the elements-based methodology and the model-based methodology. The elements-based methodology detects the lane from the images of roads by detecting the low-level elements such as lane edges etc. This methodology requires all round painted lanes or solid lane edges, otherwise it cannot detect it. This methodology may experience the ill effects of impediment. [6]

The model-based methodology uses geometric parameters such as assuming the shape of lane can be presented by straight line or curve. [7]

Abhay Tewari et al proposed in their paper that Lane detection techniques play a significant role in intelligent transport system. Abhaya et al [2] proposed a smart driver assistance system that will help drivers to avoid accidents during lane departures by providing prompt and quick marking of lanes. Proposed novel system is providing automatic detection and recognition of traffic signs. Detection is providing good results under different lightning conditions. Recognition is based on cascade pattern of CNNs that are trained using Histogram of oriented gradient (HOG). The region where Traffic signs are located are identified as a candidate region and can be calculated through the process called MSERs. Synthetic dataset has been generated so as to increase the number of images in dataset to increase the performance in terms of accuracy and to train model better.

III. ALGORITHM

The block diagram of a proposed lane detection system on Raspberry Pi is shown in the figure below:

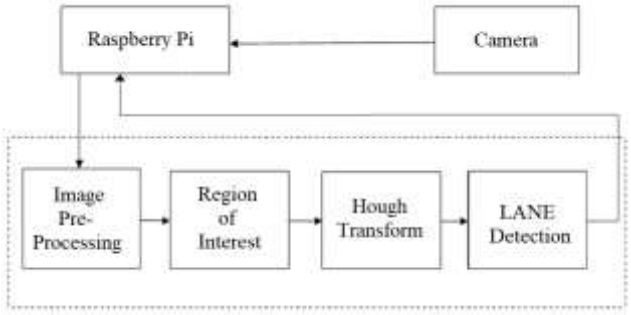

Figure 1: Block diagram of Lane Detection System

Each blocks of a block diagram are explained one by one below:

1. Capture input image: Hardware like Camera is used to take input image.

2. Image Preprocessing: To enhance the quality of image, we need to preprocess it. The processes like noise reduction, edge detection, contrast and color management are applied.

3. Region of interest: In determining the computational complexity of lane identification and LDI system, ROI plays an important role to detect it. Here only the selected are as is detected or taken for the next level of processing. These selected ROI images are then used for lane detection using a proposed algorithm. The selection of ROI reduces the processing time of the frames.

4. Hough Transform: The Hough Transform is implemented on images after the canny edges detection has taken place so as to obtain the image pixels that are desired ones. So here in this system to detect the lanes marking from the image data, Hough Transform is used.

5. Lane Detection: Here, the Lane will be marked with a separate color.

Two important algorithms Canny Edge Detection and Hough Transform are used to implement Lane Detection System which are explained below:

Canny edge detection:

Canny edge detection is a technique to extract useful structural information from different vision objects and dramatically reduce the amount of data to be processed. It has been widely applied in various computer vision systems. Canny has found that the requirements for the application of edge detection on diverse vision systems are relatively similar. Thus, an edge detection solution to address these requirements can be implemented in a wide range of situations. The general criteria for edge detection include: [1]

1. Detection of edge with low error rate, which means that the detection should accurately catch as many edges shown in the image as possible.

2. The edge point detected from the operator should accurately localize on the center of the edge.

3. A given edge in the image should only be marked once, and where possible, image noise should not create false edges.

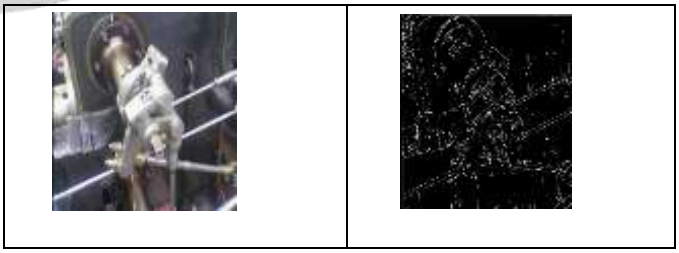

Figure2: Example for canny edge Detection [1]

Hough Transform:

The features of various shape 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 the canny edges detection has taken place so as to obtain the image pixels that are desired ones. So here in this system to detect the lanes marking from the image data, Hough Transform is used. The primary point of interest of the

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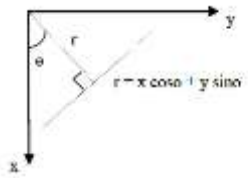
Hough Transform technique allows gaps in feature boundary descriptions and is not affected by noise. In general, the straight-line equation is given by y = mx + c can be represented as point (c, m) in the parameter space or Cartesian co-ordinate system. For the Hough transform we convert the equation to polar co- ordinates i.e. in terms of rho and theta. [3]



Where r is the distance from the initial position to closest point on straight line and theta (ɵ) is the angle between the line connecting the origin and the x axis. The (r, ɵ) plane is referred to as Hough space. The Hough transform detect the straight line in two dimensional arrays (matrix). Each element of the matrix has values equal to the sum of the pixels that are positioned on line. So, the elements with the highest values represent the straight lines.

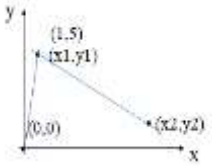
$$\frac{y - y1}{y1 - y2} = \frac{x - x1}{x1 - x2} \longrightarrow y = mx + c$$

y = mx + c, we can rearrange it as:

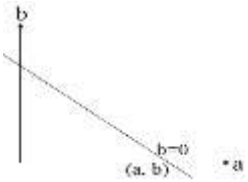
y = ax + b or b = -ax + y

We have converted xy plane into ab plane

b = -ax + y



b = -a (1) + 5



b = -a + 5

The variables are (a, b) the points became in the (a, b) plane

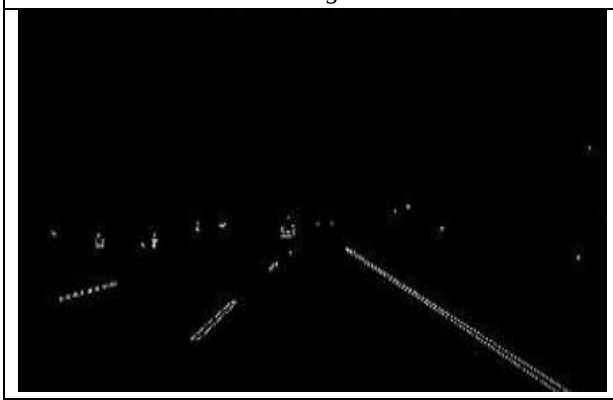
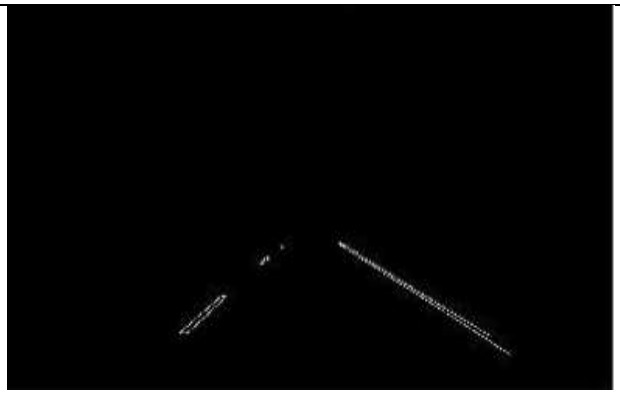
b = -a + 5

b = 0

IV. RESULTS

The System is implememted using Python and OpemCV on Raspberry Pi. The results of the system on Image as well as video are shown in the figure below:

RESULTS ON IMAGE

	
image read	*RGB to Gray image and blur filter*
	

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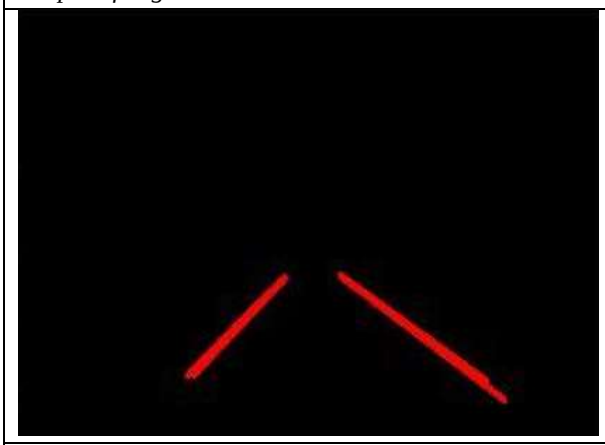
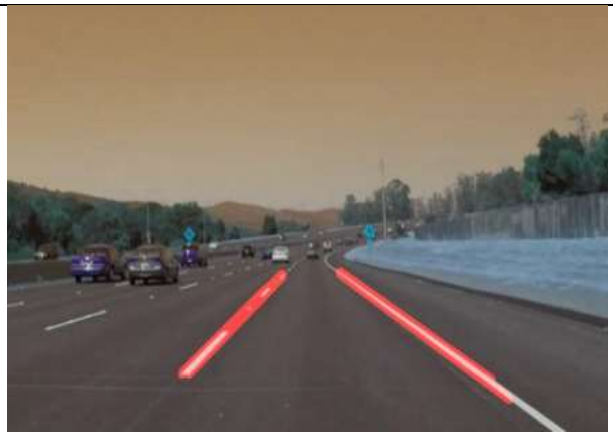
Output of edge detection	*Output of Region Of Interest*
	
Output of Hough Tranform	*Final Output of Lane detection*
	
Final Output on image 1	*Final Output on image 2*

RESULTS ON VIDEO

	
Output of Edge detection on video 1	*Output of Edge detection on video 2*
	
Output of Hough transform on video 1	*Output of Hough transform on video 2*

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CONCLUSION

This paper demonstrates the implementation of lane detection system on embedded development board like raspberry pi. Lane detection system has many difficulties. These difficulties arrive from shadows, occlusion by other vehicles, changes in the road surfaces itself, and differing types of lane markings. This paper implements a system for detecting lanes for warning drivers about lane departure. The Hough transform along with canny edge detection is used for detecting lanes from image and videos. The Hough transform is made more efficient by incorporating region of interest operation before application to make it more accurate. The algorithm is tested on Raspberry Pi for real time performance.

V. REFERENCES

[1] Digital Image Processing (Third Edition), Rafael C. Gonzales and Richard E. Woods, Published by PEARSON Education.

[2] Prof A. B. Deshmukh, Pravin T. Mandlik, "Raspberry-Pi Based Real Time Lane Departure Warning System using Image Processing", International Journal of Engineering Research and Technology (IJERT), volume 5, Issue 06, June 2016.

[3] Prof A. B. Deshmukh, Pravin T. Mandlik, "Image Processing based Lane Departure Warning System Using Hough Transform and Euclidean Distance", International Journal of Research and Scientific Innovation (IJRSI), Volume 3, Issue 10, October 2016, ISSN 2321–2705.

[4] B. Yu, A. Jain, "Lane boundary detection using a multiresolution hough transform", Proceedings of International Conference on Image Processing, pp. 748-751.

[5] Winserng Chee, Phooi Yee Lau and Sungkwon Park, "Real-time Lane Keeping Assistant System on Raspberry Pi", IEIE Transactions on Smart Processing and Computing, vol. 6, no. 6, December 2017

[6] Juan Pablo Gonzalez, Omit Ozguner, "Lane Detection Using Histogram-Based Segmentation and Decision Trees", IEEE Intelligent Transportation Systems Conference Proceedings, pp. 346-351.

[7] S. P. Narote, P. N. Bhujbal, A. S. Narote, D. M. Dhane, "A review of recent advances in lane detection and departure warning system", Pattern Recognition, vol. 73, pp. 216-234, 2018.

[8] J. Canny, "A Computational Approach to Edge Detection", IEEE Trans. Pattern Analysis and Machine Intelligence, vol. 8, no. 6, pp. 679-686, 1986.

[9] C. Bila, F. Sivrikaya, M. A. Khan, S. Albayrak, "Vehicles of the Future: A Survey of Research on Safety Issues", IEEE Transactios on Intelligent Transportation Systems, vol. 18, no. 5, pp. 1046-1065, 2017.

[10] Specifications of Raspberry Pi 3: https://www.raspberrypi.org/magpi/raspberry-pi-3-specs-benchmarks/

[11] Camera (Image and Specification) https://www.bhphotovideo.com/c/product/660392REG/Logitech_E3560_E3560_QuickCam.html

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