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A REVIEW ON LANE DETECTION ANDTRACKING TECHNIQUES

Pravin T. Mandlik
E&TC Dept.
Skncoe, Vadgoan
Pune, India.
Email: mandlik.pravin3030@gmail.com

Prof A.B.Deshmukh
Assistant Professor, E&TC Dept.
Skncoe, Vadgoan
Pune, India.
Email: amarbdeshmukh@gmail.com

***Abstract*- Most of the people die every year in road crashes due to drivers inattention and not following the traffic rules. The Lane detection systems are useful to avoid the accidents and safety is the main purpose of the system. The main goal of these systems is to detect the lane stripes and to warn the driver in case of the vehicle tend to depart from the lane. Many intelligent vehicles transport systems have the lane detection system as an important element while driving. Therefore, Lane detection and tracking is the challenging task in computer vision. In this paper, the various vision based lane detection techniques and algorithms are discussed. The performance of the different lane detection technique is also compared and studied.**

Keywords- Advance Driver Assistance System (ADAS), Hough Transform (HT), Lane detection, Lane Tracking, Lane departure warning.

I. INTRODUCTION

Now a days the road accidents has increased to a great extent. Most of the accidents occur due to drivers negligence and carelessness while driving. Advance driver assistance system (ADAS) plays an important role in providing safety to drivers. It helps to automate the car system and increases the driving experiences. The Advance driver assistance system (ADAS) provides a safe system to reduce the road accidents. The system takes an active step like warning the driver or takes a corrective action to avoid an accident during the dangerous situation. The Lane Departure Warning (LDW) is an important unit in Advance driver assistance system.

In vision based lane departure system, a camera is placed is placed behind the wind shield of the vehicles and images of the road is captured. The white stripes on the road are interpreted and lanes are identified. Whenever the vehicle goes out of the lane then the warning is given to the driver. In lane departure warning system, the lane detection is the initial step to be taken. There are two types of approaches used in lane detection: the feature based approach and the model based approach. The features based approach detects the lane in the road images by detecting the low level features such as lane edges or painted lanes etc. This approach requires well painted lines or strong lane edges, otherwise it will fail. This approach may suffer from occlusion or noise. The geometric parameters such as assuming the shape of lane can be presented by straight line or curve are used by the model based approached. This approach is robust against noise and missing data. [1][3]

II. LANE DETECTION AND TRACKING ALGORITHMS

In this section the various tracking algorithm for lane detection is discussed. The Table below summarizes and presents the various lane detection and tracking algorithms.

Y. Wang, E. K. Teoh and D. Shen [1] introduced "lane detection and tracking using b-snake". Here without using any cameras parameters, the lane detection and identification is proposed. The lane structures are described by the B-snake model. By using a set of control points B-spline can form any arbitrary shape. Then using the perspective parallel lines concept the problems of detecting both sides of lane stripes have been merged here as the problem of detecting the midline of the lane. A robust algorithm called CHEVP is proposed for providing a good initial position for the B-Snake. Also to determine the control points of the B-Snake model, Minimum Mean Square Error (MMSE) is proposed. This method is robust against noise, shadows, and illumination variations in the road images. This method is applicable to the dash and the solid paint line roads also to the marked and the unmarked roads.

M. Aly [2] introduced "A Real time detection of lane markers in urban streets". This algorithm is robust and real time efficient for detecting lanes in urban streets. The top view of the road images is generated using the inverse perspective mapping to reduce the perspective effect. Selective Gaussian kernel is used to filter the road image. Then RANSAC fitting technique is used to identify the lanes. This technique gives good result in all-weather condition but still there are some false positives. The drawback of these techniques is that it does not gives well accurate results for lane detection.

C. Mu and X. Ma [3] introduced "Lane detection based on object segmentation and piecewise fitting". The image captured by the camera is then converted to gray scale using piecewise linear transformation method. The region of interest (ROI) is obtained by the OTSU segmentation method. Then the sobel edges detection is used to identify the lane in the road images. This technique is robust in the presence of noise, shadow, lack of lane painting and changes of illumination conditions.

Parajuli, M. Celenk and H. Riley introduced "Robust lane detection in shadows and low illumination conditions using local gradient features"[4]. Here individual frame is extracted from the video and process each frame to detect and track road

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lane stripes. Then using vertical gradient of the image the shadow along the road is removed. This technique can locate precise lane marking points on each horizontal and curve stripes. The disadvantage of this technique is that it cannot detect the any high dynamic range portion of the image.

Y. Li et al. introduced "Multiple lane boundary detection using a combination of low-level image features"[5]. To detect the edges in ROI the Canny edge detector is used. The Hough transform is used to identify the straight lines from the binary output of Canny edge extractor. To remove the effect of noise, local maxima features are examined along the estimated lane edges. Then RANSAC algorithm is applied to exclude outliers. The final local maxima features are fit into a straight line. Next the lanes are tracked using the Kalman filter in the remaining frames.

J. Wang et al. introduced "An approach of lane detection based on Inverse Perspective Mapping"[6]. The input image is converted to binary image using the optimal threshold. Inverse perspective mapping is done to avoid the perspective effect. Then to partition n samples to k clusters, the K means clustering is performed. B-spline fitting is used to obtain lane markers by considering all the cluster points as control points.

S. Srivastava et al., "Improved lane detection using hybrid median filter and modified Hough transform"[7]. The main objective is to integrate lane detection algorithm with improved Hough transform and hybrid median filter (HMF) to improve the results when noise is present in the signal. Here first the images is converted to gray scale and passed to hybrid median filter. Then edges detection and Hough transform is used to identify the lane stripes from the road images. These method efficient and gives good results when noise is not present in the images.

Bing Yu, Weigong Zhang, and Yingfeng Cai introduced "A lane departure warning system based on machine vision"[8]. Firstly the Gaussian filter is used to remove the small noise in the road images. Then the dynamic threshold Value is judged by histogram statistics. And the linear parabolic model fitting is conducted to detect the lane from the road images. The lane departure decision is made on the basis of an angle between lanes and the horizontal axis. In this algorithm less parameters are needed to detect the lane departure compared to TLC or CCP.

Qing lin, Y. Han and H. Hahn introduced "Real time lane detection based on extended edge linking algorithm"[9]. This method is based on Region of interest (ROI) selection. First the region of interest is determined and then the edges pixels are found using the sobel operator. After detection of edges, the extended edges linking based on direction edges closing is done. The raster scan is performed to find out the starting point of edge. Then edges detection is carried out and adding the pixels along the oriented edges, to fill the gaps. The length of the edges having pixels less than 15 are removed out. Next step is to detect the color of the lane markers using lane hypothesis verification. After that Hough transform is applied to determine the values of θ and ρ.

V. Bottazzi et al. introduced "Adaptive region of interest based on HSV histogram for lane marks detection"[10]. The lane detection method is based on the histogram. Using earliers triangle model a dynamic region of interest is determined. First step is to calculate the histogram of the whole image and the road frame. The illumination changes are found out using the difference between the two images. The lane markers are segmented from the ROI. Lucas Kanade tracking is used to detect the lanes.

C. Guo introduced,"lane detection and tracking in challenging environments based on a weighted graph and integrated cues"[11]. First the input image is converted to inverse perspective image and then multiscale lane identification is done on images. Normalized cross correlation is used to find out the similarity of corresponding pixels. Learning algorithm is used to find out whether the lane marking is painted or not. Then weighted graph is constructed by integrating the intensity and the geometry cues. The weighted graph corresponds to pixels of a lane point. Using particle filter the lane boundary is determined. This algorithm is suitable for curve lanes, splitted and merged lanes.

Y. C. Leng and C. L. Chen introduced "vision base lane departure detection system in urban traffic scenes"[12]. The Sobel operator is used to identify the edges. Then Hough transform is used to detect he straight lanes. Lanes sometimes appear to intersect in road images. Then width of the lane differs at the different height of the images. The width lane is between the minimum and the maximum values. Then both (left and right) lane boundaries width is determined using the width of the lane. Then the lane departure can be identified by the position of the lane boundary.

H. Jung et al. introduced "An Efficient lane detection algorithm for lane departure detection" [13]. Here the image is partitioned into two rectangular regions. The lane markers appearing diagonal are detected using diagonally directional steerable filter. Then the left and right lanes are determined. The lane converges at the vanishing point as they in parallel. Then hypothesis is verified of the detected lanes. By determining the distance between the vanishing point and the horizontal line, the lane departure can be estimated.

S. Zhou et al [14] introduced "A novel lane detection based on geometrical model and Gabor filter". This algorithm contains three modules: lane model generation, parameter estimation and matching. Finally the lane model is obtained using the lane width. Vanishing point is detected using Gabor texture analysis, to estimate the lane parameters. Then Gaussian model is used to obtain the single vanishing point. The width and the orientation of the lane are estimated after vanishing point is detected. Then the canny edges detector and Hough transform algorithm is used to detect the lane boundaries. At last matching algorithm is used to identify the curvature of the road.

H. Tan et al. [15] introduced "A novel curve lane detection based on improved river flow and RANSAC". First, Inverse perspective mapping is done on the input image. Then the ROI

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is partiton into two regions: near and far vision field. Straight lines are detected using Hough transform from the near vision field. Then improved river flow is method is used in far vision field to extend the point detected in near vision field. The RANSAC algorithm is used to model the detected feature points in hyperbola pair model.

TABLE I. COMPARISON OF VARIOUS LANE DETECTION AND TRACKING ALGORITHMS

Methods	**Preprocessing**	**Detection**	**Tracking**	**Advantages**	**Drawbacks**
Y. Wang et al. [1]		Canny/Hough Estimation of vanishing points		This algorithm is proposed without using camera parameters	The problem of detecting the mid line of the lane
M. Aly [2]	Inverse perspective mapping, Selective oriented Gaussian filters	Hough transform and RANSAC spline fitting		Comparable results to algorithms using both detection and tracking	In presence of stop lines at cross walks, nearby vehicles detection not proper
C. Mu et al. [3]	Piecewise linear transformation	Segmentation by OTSU method and threshold selection	Sobel edge detection and lane markers detection by piecewise fitting	Good lane detection during the dim light environment	little false lane detection results because feature based method is usually affected by intensity of image
Parajuli et al. [4]	Local gradient features	Linear prediction model		This method is to track the road lane markers of various shapes (curved or straight) and locate precise lane marking points on each horizontal and other low illumination conditions.	It gives more false alarms.
Y.Li et al. [5]	Edges feature extraction and grouping	Kalman filter and Hough transform		Suitable for straight roads	Poor performance in heavy traffic and confusing road textures
J.Wang et al. [6]	Threshold method (OTSU method)	Inverse perspective mapping		Urban lane detection	Not susceptible to interference effect
S. Srivasta-va et al. [7]	Hybrid median filter	Edges detection algorithm	Hough transform	Computational complexity of Hough transform is optimum	This method fail to give efficient results when there is any kind of noise in road images.
Bing Yu et al. [8]	Gaussian filter	Linear parabolic model		Less parameters are used to detect lane departure than CCP or TLC	Complex roads cannot be detected
Qing lin et al. [9]	Sobel operator with non maximum suppression	Directional edges gap closing and Hough transform		Adaptive to various road conditions	False lane detection also occurs
V. Bottazzi et al. [10]	Histogram	Segmentation	Lucas Kanade tracking	Robust in illumination changes	High false positives rate
C. Guo [11]	Cascade lane feature detector	Catmull Rom splines	Particle filter based on weighted graph	Robust in various lightening and weather condition.	
Y.C. Leng and C. L. Chen [12]	Sobel operator	Hough transform		Suitable for urban roads	
H. Jung etal. [13]	Steerable filter	Haar like feature		Robust in illumination changes	
S. Zhou et al. [14]	Lane model is obtained using the camera parameters	Gabor filter based lane matching algorithm		Robust in noise and shadows	
H.Tan et al. [15]	Improved river flow	Hough transform		Suitable for straight and curve road	

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III. PROPOSED METHODOLOGY

By considering the problems such as improper detection of lane in shadows, during rain etc., lower lane detection rate for curved roads, improper indication of the lane departures, when lane departure occurs it cannot detect lane boundaries and bad images of roads. These are the some problems where we have focused mainly to detect proper lane departure on roads.

The image captured by the camera is first processed using piecewise linear stretching function (PLSF) and converted to gray scale images. It increases the contrast level of the lane image. These function shows good performance to different color lanes and hence increases the accuracy on lane detection under various environmental conditions. The normalized gray scale values are converted to a new gray values i.e. it is converted to binary images. The OTSU method is used to select the threshold values. Then 40% ROI is segmented for lane departure identification (LDI) and partition into two parts i.e. left and right lane marking. These partition is done to obtain the lane related parameters, the Hough origin. The lane identification and tracking is done using the Hough transform separately on the each sub-region of the segmented ROI. Then the lane departure is determined using the Euclidean distance. After estimating the euclidean distance of each of sub-region then the state of departure is detected. These algorithm is suitable for real time lane detection and tracking on roads.

IV. CONCLUSION

In this paper, literature review of various methods of lane detection and tracking is presented. Out of the presented techniques Hough transform is selected along with combination of other functions to make the algorithm accurate for lane detection. This method can detect the straight lanes properly as compared to curved lanes. Therefore the proper lane detection and tracking is done and it can also indicate the lane departure. Thus the future of the ADAS will lead to an autonomous driving concept.

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