A REVIEW ON LANE DETECTION AND TRACKING ALGORITHMS

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

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.

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.

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
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 detected the lane 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 $\theta$ and $\rho$.

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...
is partitioned 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>
<thead>
<tr>
<th>Methods</th>
<th>Preprocessing</th>
<th>Detection</th>
<th>Tracking</th>
<th>Advantages</th>
<th>Drawbacks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y. Wang et al. [1]</td>
<td>Canny/Hough Estimation of vanishing points</td>
<td>Hough transform and RANSAC spline fitting</td>
<td>Good lane detection during the dim light environment</td>
<td>Little false lane detection results because feature based method is usually affected by intensity of image</td>
<td></td>
</tr>
<tr>
<td>M. Aly [2]</td>
<td>Inverse perspective mapping, Selective oriented Gaussian filters</td>
<td>Hough transform</td>
<td>Comparable results to algorithms using both detection and tracking</td>
<td>In presence of stop lines at cross walks, nearby vehicles detection not proper</td>
<td></td>
</tr>
<tr>
<td>C. Mu et al. [3]</td>
<td>Piecewise linear transformation</td>
<td>Segmentation by OTSU method and threshold selection</td>
<td>Sobel edge detection and lane markers detection by piecewise fitting</td>
<td>Good lane detection during the dim light environment</td>
<td></td>
</tr>
<tr>
<td>Parajuli et al. [4]</td>
<td>Local gradient features</td>
<td>Linear prediction model</td>
<td>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.</td>
<td>It gives more false alarms.</td>
<td></td>
</tr>
<tr>
<td>Y. Li et al. [5]</td>
<td>Edges feature extraction and grouping</td>
<td>Kalman filter and Hough transform</td>
<td>Suitable for straight roads</td>
<td>Poor performance in heavy traffic and confusing road textures</td>
<td></td>
</tr>
<tr>
<td>J. Wang et al. [6]</td>
<td>Threshold method (OTSU method)</td>
<td>Inverse perspective mapping</td>
<td>Urban lane detection</td>
<td>Not susceptible to interference effect</td>
<td></td>
</tr>
<tr>
<td>S. Srivasta-v et al. [7]</td>
<td>Hybrid median filter</td>
<td>Edges detection algorithm</td>
<td>Computational complexity of Hough transform is optimum</td>
<td>This method fail to give efficient results when there is any kind of noise in road images.</td>
<td></td>
</tr>
<tr>
<td>Bing Yu et al. [8]</td>
<td>Gaussian filter</td>
<td>Linear parabolic model</td>
<td>Less parameters are used to detect lane departure than CCP or TLC</td>
<td>Complex roads cannot be detected</td>
<td></td>
</tr>
<tr>
<td>Qing lin et al. [9]</td>
<td>Sobel operator with non maximum suppression</td>
<td>Directional edges gap closing and Hough transform</td>
<td>Adaptive to various road conditions</td>
<td>False lane detection also occurs</td>
<td></td>
</tr>
<tr>
<td>V. Bottazzi et al. [10]</td>
<td>Histogram</td>
<td>Segmentation</td>
<td>Lucas Kanade tracking</td>
<td>Robust in illumination changes</td>
<td></td>
</tr>
<tr>
<td>Y.C. Leng and C.L. Chen [12]</td>
<td>Sobel operator</td>
<td>Hough transform</td>
<td>Suitable for urban roads</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H. Jung et al. [13]</td>
<td>Steerable filter</td>
<td>Haar like feature</td>
<td>Robust in illumination changes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. Zhou et al. [14]</td>
<td>Lane model is obtained using the camera parameters</td>
<td>Gabor filter based lane matching algorithm</td>
<td>Robust in noise and shadows</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H. Tan et al. [15]</td>
<td>Improved river flow</td>
<td>Hough transform</td>
<td>Suitable for straight and curve road</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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 accuracy level of the lane image. This 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. This 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.

ACKNOWLEDGMENT

The author would like to express his sincere thanks to Prof. A. B. Deshmukh for his support, co-operation and valuable suggestions.

REFERENCES