IMPLEMENTATION OF AUTONOMOUS VEHICLE LANE DETECTION, TRACKING AND DEPARTURE WARNING SYSTEMS USING DIGITAL IMAGE PROCESSING

[1]Pooja S. Kadu, [2]Anil V. Deorankar
[1]PG Scholar, [2]Assistant Professor
[1] Department of Computer Science and Engineering,
[1] Government College of Engineering, Amravati, India

Abstract: Autonomous Vehicles, as the basic and important part of an Intelligent Transportation Systems (ITS) are using an ADAS Advanced Driver-Assistance Systems algorithm for better safety in the busy, risky, and crowded transportation world through automated, adaptable and enhanced feature of it. Despite these parameters this system would show a better performance in real time. Thus its impact on transportation system in the near future would be grate and it could navigate route drive autonomously in urban highways as well as rural scenarios in a good way using maps, GPS, video sensors and so on. Although it provides applications like autonomous vehicle lane detection, tracking and departure warning system, adaptive cruise control, and backward collision interface etc. often. This applications could help in road lane detection, tracking, departure warning if wrong move occurred. Basically it would have surveillance over vehicle movement, its direction, performance in a different situations and so on. There are various methods would be proposed and proven by the various authors to be the best and efficient in practical coverage i. e. in real time.

Here we have developed an Autonomous vehicle lane detection, tracking and departure warning system which is mainly focusing on lane detection, tracking and departure warning sections and various parameters. Indeed here the first section could contains depiction of various previous proposed methods of lane detection and departure warning by different authors. Such as image processing, feature extraction, classification, pattern matching, thresholding, filtering etc. in brief. Second section could contains our proposed methods of frame extraction, frame enhancement, frame segmentation, frame classification, noise removal, lane detection and lane departure warning method and hereafter we would elaborate it one by one. Indeed these were proven to be one of the efficient method among the rest of methods under consideration of these parameters. So basically we are having the aim to present a detailed information of the proposed research efforts through comprehensive discussion.

Index Terms **- Lane Detection, lane departure, lane tracking, Digital Image Processing, region of interest as an (ROI), feature extraction, pattern matching, frame extraction, frame enhancement, frame segmentation, frame classification, noise removal, lane detection and lane departure warning method, ROI..**

I. INTRODUCTION

With the improvement in the mass of vehicles, the amount of car accident victims has risen yearly. .Many accidents are caused by an absence of knowledge of driving states due to driver carelessness, inattention or visual interference. An Advanced driver-assistance system an (ADAS) is regarded as an important technology to reduce such accidents. These are used to guide the driver in driving procedure and help in safety. Although it is providing an applications such as lane detection, tracking and departure warning system, ACC, BCI etc. Though it automate, develop, adapt and intensify vehicle systems for better driving safety. And this automated ADAS applications are used to reduce road destructiveness, by decreasing the human faults. Safety features are meant to avoid collisions, accidents, and crashes by extending technologies that warn the driver to possible obstacles or to avoid crashes and collisions by implementing Protection and taking over directional command of the vehicle. Adaptive features may automate illumination, present an adaptive cruise control application (ACC) and collision avoidance (CA), incorporate traffic warnings (ITW), connect to Smartphone, alert the driver of other vehicle or dangers, lane line departure warning application, automatic lane centering, automatic blind spots detection. Lane line detection and line tracking are considered as a basic module for ADAS. In addition, information about the lane detection used to detect nearing vehicles and obstacles.

Indeed in today's computer science arena, a digital image and signal processing (DIP and DSP) methods would be used in various computer algorithms to do processing on digital signals and images. As a range of the digital image and signal processing having lots of mileage over analog image and signal processing. It provides a significantly wider array of algorithms which can be implemented on the data and can reduce and eliminate difficulties such as the noise and signal malformation while processing. Since situational images are marked over two dimensions and multi-dimensions and this may be represented in the sort of multidimensional systems.

II. Type Style and Fonts Classification of Method of Lane Detection and Warning

Smart Vehicles have the potential to better road safety, minimize traffic jam and boost the efficiency of transportation by using these techniques. They would be able to recognize their next environment, interact with other traffic things, and could travel autonomously in highway and urban scenarios using video sensors, maps, GPS and so on.

Different image processing methods are given below:

a. Thresholding
b. Segmentation
c. Feature Extraction
d. Edge Detection
e. Noise Removal
f. Classification and Pattern Matching

Christopher Rasmussen et al. [1] in 2002, proposed a methodology of feature extraction using classification technique which dipicts a results on collective information from a color and texture image cues and laser range-finder are used to segment unstructured asphalt, gravel, and smut roads as input data to various autonomous vehicle system. Joel C. and Mohan M. Trivedi et al. [2] in 2006, proposed a methodology of feature extraction for various Driver-assistance systems objective leads to the progress of the novel approach "video-based tracking and lane estimation" (VioLET) systems was created using steerable filter which was provided an efficient method for detecting circular-reflector markings, solid-line markings, and segmented-line markings under varying lighting and road conditions. J. Wang, Y. Wu, Z Liang, and Y. Xi et al. [3] in 2010, proposed a methodology of thresholding and canny edge detection though its more focus on processing rate of a system. They proposed a new road edge algorithm as Random Hough Transform (RHT) which initially performed road edge detection and the follow-up tracking of road borders using Hough transform.

Amol Borkar, Monson Hayes, Mark T. Smith et al. [4] in 2011, proposed a methodology of which was pre-processing the camera images, lane markings appear as lines are most of the thin and covering horizontal space. The image is undergoing the IPM which is Inverse Perspective Mapping also known as geometric transformation to remove the consequences of perspective. The taken images are modified to appear as birds-eye view with lane marking now seems as almost parallel lines. In addition, the thickness of those lines remains constant in the different IPM image. Raghuraman Gopalan, Michael Shneier, Tsai Hong, Rama Chellappa et al. [5] in 2012, proposed a methodology which contains following steps, first is, choosing the features of pixel-hierarchy of the lane marking in the nearby area; second is, a sturdy boosting algorithm to extract the associated contextual features for recognizing lane markings and; filter the particle to track it. Yue Dong, Liangchao Li, Jintao Xiong, Jianyu Yang et al. [6] in 2012**,** proposed a methodology of which uses an effective algorithms to deal with the nearest two lanes as a left and right, in situation where in the typical road with a multiple lane lines on it which leads to difficulty in forming appropriate departure warning. Vijay Gaikwad and Shashikant Lokhande, et al. [7] in 2015, proposed a methodology of an image preprocessing technique of PLSF i. e. (Piecewise Linear Stretching Function) basically on ROI (Region of Interest) of color lane images which are approximately 40% of the images. Maurício Braga de Paula and Cláudio Rosito Jung et al. [8] in 2015, proposed a methodology in which lane edges are distinguished by implementing a linear–parabolic road lane picture, and planned on-the-fly camera calibration. Chung-Bin Wu, Li-Hung Wang, Kuan-Chen Wang et al**.** [9] in 2018, proposed a methodology of an efficient method of lane identification and departure warning system by using minimum complexity block-based method. Relied on the lane lines in the surrounding of the vehicle.

Peijiang Chen, Junhao Jiang et al. [10] in 2018, presented a method which is essentially based on machine vision theory and the algorithm design of lane lines departure warning system and it is depends on the angle of input image processing. The algorithm mainly uses the matrix properties of the digital image to reduce the speed of processing by using adaptive image cutting. Hough transform has used to calculate inclined lane lines.

III. SYSTEM IMPLEMANTATION WORK

We were develop a lane detection, tracking and departure system which will processing data in linear manner. It can use input as a video frame that was captured in real time through camera. In first step system can get video as an input which is real time. This videos are going under image extraction step, the video frames are extracted through this procedure. Although this frames are going under Frame enhancement to improve the luminance of the frame. Then this enhanced frame are processing through segmentation which is focusing on the dedicated part of a frame in indeed to reduce computation speed and time requirement. We have proposed a frame classification method differentiate between the lane pixels and non-lane pixels in efficient manner. The non-lane pixels detected despite the above step can go under the noise removal procedure. Henceforth the proposed lane detection method can use for lane detection and separate departure warning method will apply to detect departure of a vehicle from lane. This all can be shown in below architecture diagram,

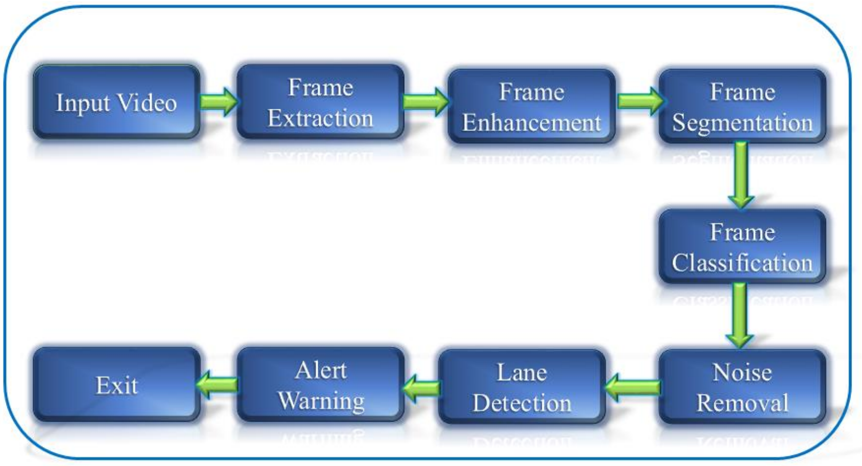

Fig. 1. System Architecture Diagram.

Steps included in lane detection procedure,

3.1 Input Video

The real time videos are taken as an input to the system and further procedure will be applying on frame extracted in below step. Although the input is captured in real time through camera.

3.2 Frame Extraction

The video is going under consideration in this step for extracting frame to further processing. The extracted frame can further go under the frame enhancement procedure.

$$f(x) = Extract\{object,\ filetype\} \quad (1)$$

3.3 Frame Enhancement

Indeed most of the time conditions of the roads are assumed to be covered with shadows of the building and trees and so on. Although the road conditions in morning, night and rainy season varying accordingly. Henceforth it could seems to be difficulty in lane detection procedure. So that this procedure will increase into the luminance of the frame.

$$M = \frac{\sum_{i=1}^{W}\sum_{j=1}^{H}(R_{i,j}, G_{i,j}, B_{i,j})}{W*H} \quad (2)$$

$$M = \begin{cases} 100 > M > 90 & W = 0.9 \\ 90 \geq M > 80 & W = 0.85 \\ 80 \geq M > 70 & W = 0.8 \\ 70 \geq M > 60 & W = 0.75 \\ M \geq 60 & W = 0.7 \end{cases} \quad (3)$$

$$PDF = Pix_o * \frac{F}{W} \quad (4)$$

$$f(E_n) = Pix_o + PDF \quad (5)$$

3.4 Frame Segmentation

Processing on an individual section of frame is easier, error free and efficient than processing of a whole frame as far as image processing is concerned. Therefore, this image is segmented into the ROI (Reason of Interest) as upper reason and lower reason. By using below formula the segmentation is performed,

$$ROI_{max}(H) = 0.3 * f(H) \quad (6)$$

$$ROI_{min}(H) = 0 \quad (7)$$

$$ROI,(W) = f(W) - [(f(W) * 0.3)_L + ((f(W) - f(W) * 0.7))_R] \quad (8)$$

3.5 Frame Classification

We have proposed method of an frame classification which proven as efficient as possible. The lane pixels and non-lane pixels are classified using frame classification procedure. The pixels are differentiate on the basis of its RGB contains. Often the pixels showing more frequency of white color can classified as a lane pixel only and rest section drafted as a non-lane part. Although the range intensity has been decided between 0 to 255 though the pixels having range above the 178 can be consider as lane pixels. And below it can be categories as non-lane pixels. The below formula has used for frame classification,

$$L_{Pix} = \begin{cases} R \geq 190 \\ G \geq 190 \\ B \geq 110 \end{cases} \text{ OR } L_{Pix} = \begin{cases} 120 > R \geq 160 \\ 210 > G \geq 140 \\ 120 \geq B \geq 15 \end{cases}$$

And (9)

$$L_{Pix} = \begin{cases} R \geq 190 \\ G \geq 190 \\ B \geq 190 \end{cases} \text{ OR } L_{Pix} = \begin{cases} 120 > R \geq 160 \\ 210 > G \geq 120 \\ 120 \geq B \geq 15 \end{cases} \quad (10)$$

$$\text{If True}, set = \begin{cases} R = 255 \\ G = 255 \\ B = 255 \end{cases} \quad \text{Else}, set = \begin{cases} R = 0 \\ G = 0 \\ B = 0 \end{cases} \quad (11)$$

Where, L_{Pix} lane pixel.

3.6 Noise Removal

This step can be used to remove the unwanted parts of the frames and therefore obtain the efficient results. To do this some parameters are considered here. Despite the above steps if some non-lane pixels are remained in the frame then that can be removed using noise removal procedure. The Histogram method is used for lane detection which is probing the lane pixels in two ways,

3.6.1 Horizontal Probing

The pixels are scrutinizing horizontally by considering pixel value in range given in an above classification procedure.

$$I_{pix\_H} = \begin{cases} 0 \; for \; 0 < W_c \leq 2 \\ or \\ 0 \; for \; W_c > 50 \end{cases} \quad (12)$$

3.6.1 Vertical Probing

The pixels are scrutinizing vertically by considering pixel value in range given in an above classification procedure. Following formula can be used for removing noise,

$$I_{pix\_V} = \begin{cases} 0 \; for \; 0 < W \leq 2 \\ or \\ 0 \; for \; W_c > 30 \end{cases} \quad (13)$$

3.7 Lane Detection and Departure Warning methods:

We have used a proposed method of lane detection that can be veracious and efficient in lane detection. The range of pixels derived on the basis of a particular frame has been used to detect lanes. The formula of lane detection is given below.

$$D_w = text\left\{I_{pix} \quad for \; round\left(\frac{3+r}{4}\right) and \; abs\left(j - round\left(\frac{c}{2} \leq 5\right)\right) and \; abs\left(j - round\left(\frac{c}{2} \geq 0\right)\right)\right\} \quad (11)$$

IV. RESULTS ANALYSIS

To objectively evaluate the performance of the proposed algorithm, the created dataset, has 1707 frames, is used. Table 1 presents the detailed performance for the straight roads obtained using the created one. Since this dataset includes data associated with clear lane markings and a uniform road surface, the detection rates for straight is 98.71% The proposed algorithm is executed on a computer with an Intel i3 core, 3.40 GHz CPU with 8 GB of RAM, 2GB of RADEON graphics. The test sequences are captured using a camera of mobile; at full HD, the camera had a resolution of 1920×1080, which is widely used in dashboard cameras. The speed of the vehicle was between 0 and 100 km/hr. To evaluate the robustness of the proposed algorithm, a dataset that corresponds to daytime, rainy weather, and cloudy weather, evening time and includes curved and straight lanes was obtained from YouTube. The test cases of cloudy weather was obtained from was created. Fig.1 displays the lane detection results obtained using the YouTube dataset for different lighting and weather conditions. This figure shows that both dotted and continuous lane markings, which are represented as red lines, are detected. Presents the departure warning results. The lane marking on the departure side is given in the form of loud alarm and message at the top of the frame is a warning.

Table 1: Descriptive Statics

Result Analysis No.	Condition	Road shape	Total frame	Detected frame	Detection Rate (%)	True Positive	True Negative	False Positive	False Negative
1	Cloudy	Straight	1707	1647	96.48	1511(88.51%)	66	70	0
2	Day time	Straight	351	350	99.99	316 (90%)	35	0	0
3	Afternoon	Curved	897	891	97.82	845 (94.20%)	12	132	1
4	Cloudy	Straight, curved	248	240	96.77	231 (93.14%)	17	0	0
5	Day time	Straight	705	613	87.97	613 (86.95%)	79	26	0
6	cloudy	curved	426	426	100	426 (93.42%)	12	16	0

(a)

(b)

(c)

(d)

(e)

(f)

(g)

(h)

(i)

(j)

Figure 1: Lane detection in day time and cloudy weather in (a) ,(b) ,(c), (d), (e), (f), (g), (h), (i), (j). These are Self-created and YouTube obtained dataset.

V. CONCLUSION

In our implementation paper, we have studied the previous different image processing methodology by different authors thoroughly and it is very much helpful for us to choose an appropriate method for lane detection and lane lines departure warning efficiently throughout the road. As well as it is efficient in changing weather conditions, shadows on the road, condition of a road and much more. In implementation section we have used different methods of image processing and obtained an efficient result as well. Although based on this detection a necessary warning will issue to help the driver while driving a vehicle.

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