Lane Departure Warning System

Rashmi N. Mahajan, Dr. A. M. Patil

***Abstract*— The most important considerations under limelight is safety in automotive. Lane departure warning (LDW) system monitors the position of the vehicle with respect to lane boundary. When the vehicle is in danger of leaving the lane unintentionally, the system delivers the warning to driver. Development of the techniques such as lane departure warning system that helps drivers to assist in driving can help reduce the number of accidents significantly. The concept in such techniques works toward development of the lane departure warning system based on image processing techniques. The system uses a high speed camera which scans the image of the road scene ahead at regular instants. The Edge Detection Technique such as Hough Transform detects the lanes on the road and compared with the current car position. In such a case, when lane is departed, the audio visual warning is issued to alert the driver.**

***Index Terms*— Lane detection, Hough Transform, CHEVP algorithm**

I. INTRODUCTION

Most traffic accidents were caused by the negligence of the drivers. In order to reduce the number of traffic accidents and to improve the safety and efficiency of the traffic, the researches and companies on Intelligent Transportation System (ITS) have been conducted worldwide for many years. Intelligent vehicle (IV) system is a component of the ITS system, which aims to assist drivers in perceiving any dangerous situations earlier to avoid the accidents through sensing and understanding of the environment around itself. The goal of the Intelligent Vehicle Systems is mainly that of improving driving safety and reducing the driver's capacity and capability.

Advance driver assistance system is used for increasing the safety of driving cars which construes traffic situations independently and support the driver. An important part of an advance driver assistance system is the evaluation of image sequences recorded with cameras mounted in a moving vehicle. Lane Departure warning System (LDW) uses a camera to monitor the distance between the vehicle and lane markings and, if the vehicle drifts towards the lane markers, the system first sounds an audible warning, followed by a selective application of the brakes to help move your vehicle back into its lane. The Hough Transform is a widely used method for finding global patterns such as lines, circles, and ellipses in an image by localizing them in a parameterized space. It is especially useful in lane detection because lines can be easily detected. In order to do any kind of lane-edge detection, filtration of the image to smooth out any noise picked up during image capture is the most important.

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II. LITERATURE SURVEY

Safe driving is the main motivation behind the driver assist systems. Bing-Fei Wu et al. explained that the DSP image processor on ALDWS works with operating frequency of 600MHz and the lane marking detection speed can be more than 35 frames per second with Quarter Video Graphics Array (QVGA) size [1]. O. Khalifa et al. described the algorithm which uses a combination of scan boundary lines and Hough transform to fit a hyperbola pair model [2]. Joshua M. Clanton et al. explain a method fusing GPS/inertial navigation sensor/vision and a high-accuracy map for highway lane tracking. This method provides a backup lateral offset measurement that can be used for LDW when the LDW vision system loses track of the lane markings [3]. In Yong Zhou et al. [4], it is proposed Virtual boundary based Lane departure Warning Method (VLWM) which allows the driver to drift beyond the physical lane boundary by adding a virtual lane boundary. Accounting for the driving habit of the driver, lane geometry, and the local driver behaviour changes, the virtual lane width is determined using a fuzzy-logic inference method.

Juan M. Collado has shown that a parabolic lane model is fitted to road markings and tracked through a particle filter. The right and left lane boundaries are classified in three types (solid, broken or merge lane boundaries), through a Fourier analysis, and adjacent lanes are searched when broken or merge lines are detected [5]. Pei-Yung Hsiao et al. in 2006 made a design of the embedded lane departure warning system on a custom board to gain enough capability to carry out the huge calculations for lane departure warning algorithms [6]. Joel C. McCall et al. performed a work on Video-Based Lane Estimation and Tracking (VioLET) system which is designed using steerable filters for robust and accurate lane-marking detection with the help of an up-to-date and comprehensive analysis of the current state of the art in lane-detection research [7]. Yue Wang et al. in 2003 described the B-Snake based lane model which is able to explain a wider range of lane structures since B-Spline can form any arbitrary shape by a set of control points which can be determined by a minimum error method called Minimum Mean Square Error (MMSE) and a robust algorithm, called CHEVP (Canny/Hough Estimation Of Vanishing Point) [8]. As in proposed in Yue Wang et al. in 1998, Catmull-Rom spline can form arbitrary shapes by control points as it can describe a wider range of lane structures than other lane models such as straight and parabolic model, and also, formulates the lane detection problem in the form of determining the set of lane model control points [9].

III. METHODOLOGY

Fig. 1.1 shows the basic block diagram of Lane Departure Warning System.

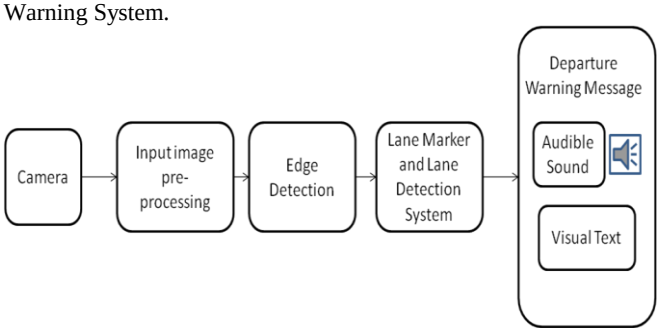

Fig. 3.1 Block diagram of LDW system

A. Input Video Selection

Input video from the Camera mounted on the rear view mirror of the car is taken with different road sections under different lighting conditions. Fig. 3.1 shows the flowchart of the proposed LDW system

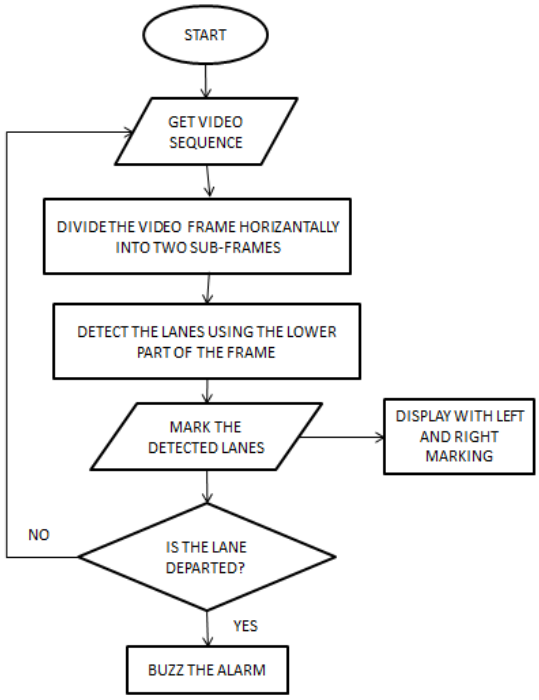

Fig. 3.2 Flowchart of the proposed LDW system

B. CHEVP Algorithm

(Canny/Hough Estimation of Vanishing Points)

This algorithm is used for the edge detection and the lane marking system. Automatic initialization technique, able to extract the location of any type of the lane shapes, is important and necessary. The CHEVP (Canny/Hough Estimation of Vanishing Points) algorithm has been developed to meet these requirements. The road is assumed to have two parallel boundaries on the ground, and in the short horizontal band of image, the road is approximately straight. As a result of the perspective projection, the road boundaries in the image plane should intersect at a shared vanishing point on the horizon. First of all, image is divided into two sub frames horizontally and selecting the lower part of the image frame which is then converted to intensity image in order to fulfil the system requirement [10].

C. Canny Edge Detection

Canny edge detectionis applied to selected image by using 2-D FIR filter and then applying the auto thresholding value. We get the edge detected image. The purpose of edge detection in general is to significantly reduce the amount of data in an image, while preserving the structural properties to be used for further image processing.

The algorithm runs in 5 separate steps:

1. Smoothing: Blurring of the image to remove noise.
2. Finding gradients: The edges should be marked where the gradients of the image has large magnitudes.
3. Non-maximum suppression: Only local maxima should be marked as edges.
4. Double thresholding: Potential edges are determined by thresholding.
5. Edge tracking by hysteresis: Final edges are determined by suppressing all edges that are not connected to a very certain (strong) edge.

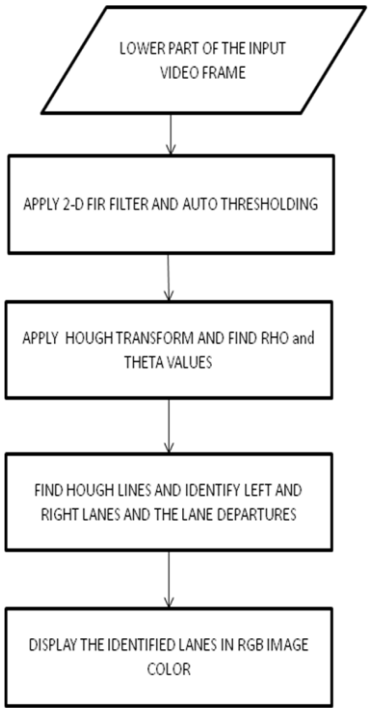

Fig. 3.3 Flowchart of the lane detection system

D. Hough Transform

The technique used to identify the vertical lines in the filtered image and keep hold of the most likely edge of the lane is the Hough transform.

Fig.3.3 shows the geometric diagram of Hough transform. An edge pixel can be represented as (x, y) coordinates in geometric space. The number of lines passing through this point is indefinite. Any straight line can be defined as equation (1) as below

$$y = mx + c \ldots\ldots (1)$$

where m is the slope of the line and c its y- intercepts. Fig. 3.3 shows the geometric diagram of Hough Transform.

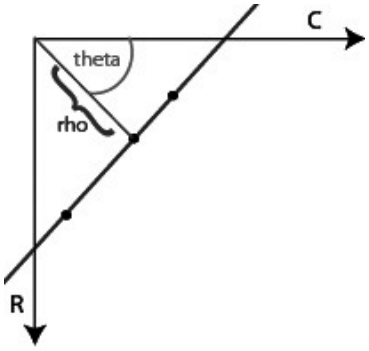

Fig. 3.4 Geometric Diagram of Hough Transform

However, for vertical lines the slope is undefined. Hence, they can be represented in the form of polar coordinates by following equation (2) as

$$r = x \cos\Theta + y \sin\Theta \quad \ldots\ldots\ldots (2)$$

where r is the perpendicular distance from the line to the origin and θ is the angle made by r with the x-axis. The range of Theta (θ) is $-90° \leq \theta < 90°$.

Each straight line can be represented as a unique point (r, Θ) in the Hough's parameter space. If (r, Θ) were to be plotted for different possible lines passing through (x, y) Cartesian points, it yields a curve in parameter space. Data points that are collinear in the Cartesian space can be easily depicted in the Hough parameter space because their curves intersect at a common (r, Θ). The Hough transform uses a voting scheme to detect the probable edge of the lane. A suitable threshold which in our case is 75 is applied to detect the extracted lane.

These steps are first performed on the left half of the image to find the left lane boundary and then on the right half to locate the right lane boundary.

E. Lane Detection and Departure Warning System

Lane detection system detects lane markers by matching the current lane markers with the markers from previous video frame. The departure warning displays of detected lane marks and produces a warning depending on the classified lane marks and the vehicle position. The system produces left departure warning message, the vehicle moves across left lane markers and right departure warning message the vehicle moves across right lane markers [11, 12].

F. MATLAB

MATLAB (Matrix Laboratory) is a multi-paradigm numerical computing environment and fourth-generation programming language. Developed by MathWorks, MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages, including C, C++, Java, and Fortran. MATLAB is widely used in academic and research institutions as well as industrial enterprises [13]. The subsystems for performing the pre-processing and processing operations for lane detection is designed individually and integrated. The system was developed using MATLAB/Simulink.

IV. RESULTS ANALYSIS

The system was tested on different drives varying from a high speed drive on a highway to a low speed drive on city roads. The input video is taken at Pimple Saudagar, Pune, Maharashtra.

According to the tested results, the system can detect any size of input video frame resolution but the ideal frame size resolution is 320x240 pixels per frame. As stated above, the system can process any type of input data format and the ideal data format is (.avi) format.

Video player on display shows the type and color of the lane markers. It also shows the left and right lane markers and warning messages. The driver is notified by the warning message that indicates when vehicle is moving across the lane marker. Yellow line is used to describe the left lane. Pink line is used to describe the right lane.

The text "Left Departure" uses to notify the driver on the lane departure warning system when car crosses the left lane road as same as the text "Right departure" that uses to notify the driver when the car crosses the right lane road.

Fig. 4.1 Original RGB Image

Fig. 4.2 Lower Portion of Input Video Frame

Fig. 4.3 Edge Detection

Fig. 4.4 Binary Image

Fig. 4.5 Lane Marking on The Lanes of Road

Fig 4.5 Departure Warning Message Dispayed (Left)

V. CONCLUSION

In this paper, it is shown that the lane detection warning system which is a mechanism designed to warn a driver when the vehicle begins to move out of its lane in that direction on freeways and arterial roads. The Hough Transform, CHEVP algorithm etc. are the techniques used for lane detection to warn the driver from lane departure. This work has also shown that lane detection using a single forward facing camera is also possible. This could prove valuable in safety application in vehicle where the driver is not paying attention to the road, falling asleep, etc. Experimental results expose the robustness and efficiency of the performance of the lane detection algorithm in various environments.

VI. FUTURE SCOPE

The lane departure module requires more testing and experiments that was performed on the work.

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