Detection of Lane and Vehicle in Lane Departure Warning System (LDWS)

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Abstract - Advanced driver-assistance systems (ADAS) are technologies accustomed build automobile travel safer by automating, rising or adapting some or all of the tasks concerned in operational a vehicle. Driver assistance serves to make travel comfortable and easier, while also increasing car and road safety. Lane departure warning (LDW) system is also one of the driver assistance. It is a mechanism designed to warn the motive force. It uses a camera to monitor lane markings and detect when a vehicle is drifting out of its lane of traffic. When the vehicle begins to move out of its lane, audio warnings, visual feedback warning, or minimum speed to engage or other alert warns the driver of the unintentional lane shifts that the driver will steer the vehicle back to its lane. Lane detection is one vital method within the vision-based vehicle assist system. The results of lane edge detection play a very important role in feature-based lane detection. The sophisticated conditions of road build the proper edge detection of lane markings become terribly difficult. In order to get an ideal edge of lane markings in road image, a method of lane edge detection based on Canny algorithm and lanes are detected on shadow roads based on F.H.D (Finlayson-Hordely-Drew) algorithm.

Keywords: **ADAS, Driver-assistance, lane detection, LDW, F.H.D, Canny etc*;***

1.INTRODUCTION

This chapter gives an overview of Lane Departure warning system (LDWS). In road-transport language, a lane departure warning system could be a mechanism designed to warn the driving force once the vehicle begins to maneuver out of its lane. These systems are designed to reduce accidents by addressing the most causes of collisions: driver error, distractions and drowsiness. In 2009 the U.S. National road Traffic Safety Administration (NHTSA) began finding out whether or not to mandate lanedeparture warning systems and frontal collision warning systems on vehicles.

The video camera based driver assistance function Lane Departure Warning (LDW) warns the driver in case of unintentionally leaving the ego lane. LDW warns the driver in case of an unintentional lane departure of ego vehicle. An unintentional lane departure may refer either to an actual lane departure or to an imminent lane departure. The warning to the driver can help to reduce lateral collisions and lane departure accidents. LDW uses video camera based lane marking detection to measure the distance and orientation of ego vehicle with respect to the left and/or the right lane marking if available. In the vehicle system, the warning to the driver can be visual, audible or haptic. Lane detection is an important prerequisite for the vision based vehicle assist system. It can be used for intelligent autonomous and smart vehicle applications, such as the lane departure warning system, vehicle navigation, and forward collision avoidance. Here, lane detection is considered for LDWS. Lanes are detected using some algorithms and functions are used for lane departure warning system. Lane departure warning is a warning only. When you let the automobile drift close to, onto, or over the lane marking, the car alerts you. As the driver, you have got to require corrective action by steering the automobile back to the center of the lane. LDW is available on roads with different lane marking types (solid, dashed and Bott's Dots) and lane marking colors (white, yellow/orange and blue). Addition to that, it also detects the vehicle detection.

2. LITERTATURE SURVEY

Xuqin Yan and Yanqiang Li proposed a method of lane edge detection based on canny algorithm. Lane detection is one vital method within the vision-based vehicle assist system. The sophisticated conditions of road create the right edge detection of lane markings become terribly difficult. In order to induce a perfect fringe of lane markings in road image, a method of lane edge detection based on canny algorithm is proposed. Firstly in line with the importance in lane markings recognition, the road image is divided into three regions. Only the regions with useful information are processed. Then by the features of gray distribution and lane markings width, some noises are removed from the image. Using the form options of lane markings, the lane edges are detected based on canny algorithm. Finally by use of the Hough rework theory, lane detection is achieved.

Jiannan Wang, Hongbin Ma, Xinghong Zhang and Xiaomeng Liu proposed Detection of Lane Lines on Both Sides of Road Based on Monocular Camera. There are plenty of systems that are able to warn drivers about different types of dangers: lane departure, collision possibility and various traffic signs. However, there is still room for development, because modern technologies, like the rising vision about the internet ofthings, allow us to create much more efficient systems. Also, the detections can be improved to perform better in various situations, such as different light conditions, road quality, etc. The current version is capable of lane and painted traffic sign detection and is able to warn the driver about a possible lane departure on videos captured in daylight, with medium quality road markings. Our system uses a lane detection method that is based on the Hough transformation and contour detection for the painted traffic sign detection.

3. PROPOSED SYSTEM

- Lane detection is one necessary method within the vision-based vehicle assist system.
- The results of lane edge detection play a very important role in feature-based lane detection.
- The difficult conditions of road build the right edge detection of lane markings become terribly difficult.
- In order to urge a perfect fringe of lane markings in road image, a way of lane edge detection supported cagy ruleis projected.
- Lane Departure Warning uses a camera to sight the gap of paved surface markings so analyzes that data to see if the vehicle is near to drift across road markings.
- MPC2.5 Video Camera is used and it is a multi-purpose camera that was developed especially with the requirements of heavy commercial vehicles in mind.
- In the vehicle system, the warning to the driver can be visual, audible or haptic.
- LDW uses video camera placed in middle of dashboard to measure the distance and orientation of ego vehicle with respect to the left and/or the right lane marking if available.
- LDW is available on roads with different lane marking types (solid, dashed and Bott's Dots) and lane marking colors (white, yellow/orange and blue).
- Addition to that, it also detect the vehicle detection using haar cascade.
- Accidents can also be avoided by detection of vehicles.
- And also lanes are detected on shadows of trees.

4. METHODOLOGY

- **Lane Detection**

Sample Videos are taken as input. Videos are then converted into frames. Pre-processing of images are done to remove noise and edges are detected which helps to detect lanes on road. Driver will be warned if vehicle moves out of its lane.

Figure (1) Lane Detection Flow Chart

a) Pre-processing

Videos are given as input and Videos are converted into frames. Images which are extracted from the video contain noise and other unwanted factors such as variation in lightning, shadow from nearby objects etc. The RGB image is converted to the grayscale image. It will treat yellow or white lane lines the same. The grayscale image is normally overridden by the noise and need to be removed to avoid false alarms.

$$\omega_0(t) = \sum_{i=0}^{t-1} p(i)$$

$$\omega_1(t) = \sum_{i=t}^{L-1} p(i)$$

We have used Gaussian blur to smoothen the image and remove the noise. Smooth out the image before applying canny edge detection so we do not detect faint edges. Kernel size is given where larger kernel size implies averaging/smoothing over a larger area. Additionally, FHD (Finlayson-Hordely-Drew) algorithm is applied to remove strong shadow component from the ROI. The Noise suppressed grayscale image is further binarized for edge detection using Otsu's Threshold Method. In image analysis, we often need an automatic, data- driven way to distinguish two types of relatively homogenous things, like land vs. water, forest vs. grass or foreground vs. background. For single-

$$\mu_0(t) = \frac{\sum_{i=0}^{t-1} i p(i)}{\omega_0(t)}$$

$$\mu_1(t) = \frac{\sum_{i=t}^{L-1} i p(i)}{\omega_1(t)}$$

$$\mu_T = \sum_{i=0}^{L-1} i p(i)$$

band images that have a bimodal pixel distribution, a two-class segmentation can be performed by finding a single threshold that separates the two classes. The binary image free from noise and shadows. The ROI contains the information about lanes and markers and the disregarded part of the image is done black.

In computer vision and image processing, Otsu method is the simplest and powerful method of image segmentation. It is useful in discriminating foreground from the background. Thresholding operation is used to convert a gray scale image into binary image. The advantage of obtaining first a binary image is that it reduces the complexity of the data and simplifies the process of recognition and classification. The most common way to convert gray-level image into a binary image is to select a single threshold value (T). Then all the gray level values below T will be classified as black (0) i.e. background and those above T will be white (1) i.e. lanes

$$g(x,y)=\begin{cases}0 & \text{if } f(x,y) < T\\ 1 & \text{if } f(x,y) \geq T,\end{cases}$$

Where (x, y) represents a gray value/are the coordinates of the threshold value p, T represent threshold value, g(x, y) represents threshold image, f(x, y) represent gray level image pixels/input image. Otsu method is a popular thresholding method and that it works on the histogram of the image. It assumes the image contains two classes of pixels – foreground and background. It also assumes the image has a bimodal histogram displaying 2 peaks and then sets a threshold on the image such that the intra class variance is minimized. In Otsu's method we exhaustively search for the threshold that minimizes the intra-class variance (the variance within the class), defined as a weighted sum of variances of the

$$\sigma_w^2(t) = \omega_0(t)\sigma_0^2(t) + \omega_1(t)\sigma_1^2(t)$$

two classes:

Weights ω_0 and ω_1 are the probabilities of the two classes separated by a threshold t, σ_0^2 and σ_1^2 are variances of these two classes.

Otsu shows that minimizing the intra-class variance is the same as maximizing inter-class variance.

Which is expressed in terms of class probabilities μ- and class means ω

While the class mean $\mu_{0,1,T}(t)$ is:

The following relations can be easily verified:

The class probabilities and class means can be computed iteratively. This idea yields an effective algorithm.

Algorithm:

1. Compute histogram and probabilities of each intensity level

2. Set up initial $\omega_i(0)$ and $\mu_i(0)$

3. Step through all possible thresholds t = 1, . . . maximum intensity

ω_i $$\omega_0\mu_0 + \omega_1\mu_1 = \mu_T$$
$$\omega_0 + \omega_1 = 1$$

1. Update and μ_i
2. Compute $\sigma_b^2(t)$

4. Desired threshold corresponds to the maximum $\sigma_b^2(t)$

b) Edge Detection

Edge Detection is done by Canny Edge Detection.

Steps for Canny Edge Detector Algorithm.

Noise reduction. finding Intensity Gradient of the Image. non-maximum Suppression and Hysteresis thresholding.

Noise reduction: noise can be reduced by applying Gaussian filter where it uses Gaussian smoothing operator to smooth it. Kernel size is 5x5 and the degree of smoothing is determined by the standard deviation of the Gaussian that is σ = 1.

$$G(x,y) = \frac{1}{2\pi\sigma^2}e^{-\frac{x^2+y^2}{2\sigma^2}}$$

Finding Intensity Gradient of the Image: smoothened image is then filtered with a Sobel kernel in both horizontal and vertical direction to get first derivative in horizontal direction and vertical direction.

$$Edge\_Gradient(G) = \sqrt{G_x^2 + G_y^2}$$
$$Angle(\theta) = \tan^{-1}\left(\frac{G_y}{G_x}\right)$$

Non-maximum Suppression: After getting gradient magnitude and direction, a full scan of image is done to remove any unwanted pixels which may not constitute the edge. For this, at every pixel, pixel is checked if it is a local maximum in its neighborhood in the direction of gradient.

Hysteresis Thresholding: The Algorithm is implemented in 3 regions:

- A: Pixel higher than upper threshold = edge (kept)
- B: Pixel below Low rejected
- C: Pixel between High and Low is accepted if connected to edge

c) Region of Interest

Create mask called region of interest (ROI). Everything outside of the ROI will be set to black/zero and working with the relevant edges. Set the value of height and width in x and y co-coordinates. Polygonal region of interest is considered. The region of interest (ROI) is taken in the image. Apply trapezoidal mask over edges. Use bitwise AND operation to return image only where mask pixels are non-zero.

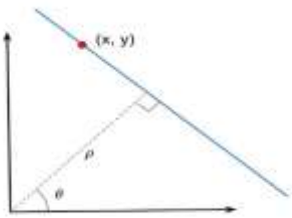
d) Lane Detection

The operator used to detect the lines and determine the lane is Hough Transform. Hough Transform was initially developed to detect only Straight Lines and to recognize arbitrary shapes such as circles or ellipses.

The operator used to detect the lines and determine the lane is Hough Transform. In order to map the lines parallel to y axis, we use the polar form of the above equation, which is expressed as:

$$\rho = x\cos(\theta) + y\sin(\theta)$$

Here ρ represents the perpendicular distance of the line from the origin in pixels, and θ is the angle measured in radians, which the line makes with the origin as shown in the figure. The following steps are performed to detect lines in an image.



Step 1: Initialize Accumulator

When we say that a line in 2D space is parameterized by ρ and θ , it means that if we any pick a , it corresponds to a line. Imagine a 2D array where the x-axis has all possible values and the y-axis has all possible values.

Step 2: Detect Edges

Collect evidence for every cell of the accumulator because every cell of the accumulator corresponds to one line. If there is a visible line in the image, an edge detector should fire at the boundaries of the line. These edge pixels provide evidence for the presence of a line. The output of edge detection is an array of edge pixels $[(x_1, y_1), (x_2, y_2)...(x_n, y_n)]$

Step 3: Voting by Edge Pixels

For every edge pixel (x, y) in the above array, we vary the values of from 0 to and plug it in equation 1 to obtain a value for ρ. These curves intersect at a point indicating that a line with parameters $\theta = 1$ and $\rho = 9.5$ is passing through them.Select the bins in the accumulator above a certain threshold to find the lines in the image.

If the threshold is higher, you will find fewer strong lines, and if it is lower, you will find a large number of lines including some weak ones.

e) Lane Departure Warning System

Once lanes are detected, next task is to determine the departure from lane and generate a warning alarm. To determine the departure we set origin point at the center of bottom edge of ROI image and calculate the transverse position of lanes from the origin using a simplified algorithm.

As the camera is placed at the center of dashboard, the origin virtually coincides with the location of camera. We consider a horizontal line AB parallel to bottom edge of image and dividing the ROI in two equal parts. Let the intersection points of the line AB with the two detected lanes be P(x1, y1) and Q (x2, y2). Departure distance calculation Distance of these two points from the origin is calculated which gives information about vehicle position with respect to the two lanes.

$$d_1 = \sqrt{(x_o - x_1)^2 + (y_o - y_1)^2}$$

$$d_2 = \sqrt{(x_o - x_2)^2 + (y_o - y_2)^2}$$

Now suppose we find that vehicle is closer to left lane we still don't know that vehicle is moving towards the left lane or away from the left lane marker. If vehicle is moving towards the left lane marker then it is possible to go outside the lane marker and in that case warning signal has to be triggered but if vehicle is moving away from left lane marker, it is very likely to stay in the present lane.

- **Vehicle Detection**

Vehicle Detection is done by using car data sets and while using detect multi-scale method. Video is converted into frames. Each frame is converted into black and white. Apply Histogram equalization on the image. Detection of cars **is** detected by drawing rectangle on object.

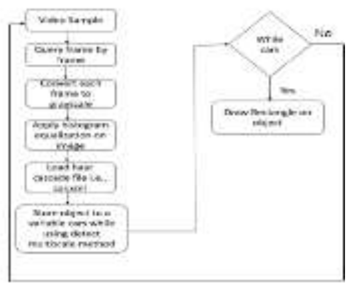


Figure (2) Vehicle Detection Flow Chart

5. Experimental Results

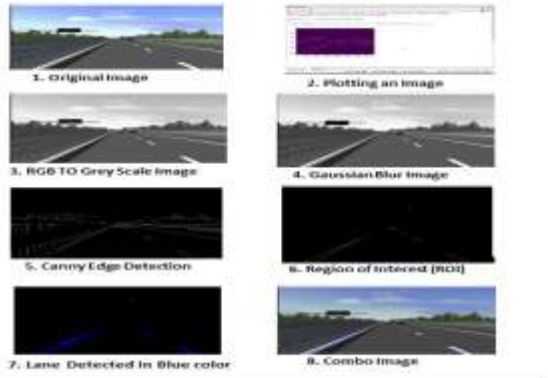


Figure (3) Left Lane Detection in one frame

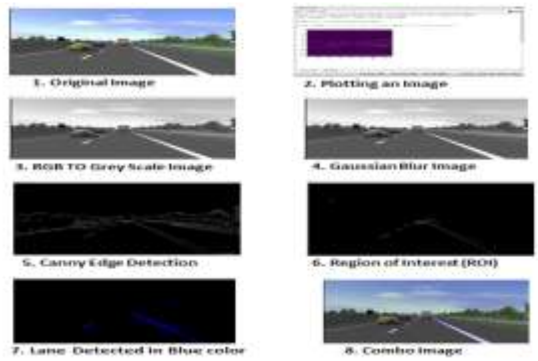


Figure (4) Right Lane Detection in one frame

Figure (5) vehicle Detection

Lane and Vehicle Detected in video

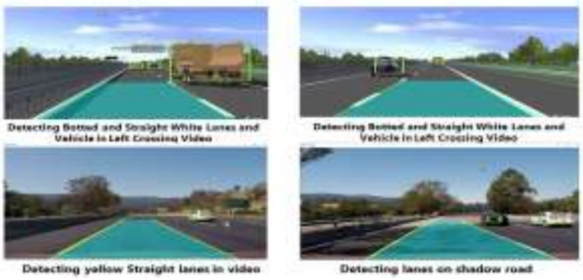


Figure (6) Lane and Vehicle Detected in video

6. CONCLUSION

Developed and implemented an algorithm for real time lane detection and departure warning system using vision based system. The challenges of a vision based detection systems such as presence of shadows, variation in illumination of roads; segmented lane marker etc has been addressed by implementing suitable filtering and computational algorithms. The improved Hough transform has been implemented to minimize the computation time and make the system effective and accurate for real time application. The algorithm developed in openCV software was tested for different sets of images under lightning condition and in the presence and absence of shadows. The accuracy of lane detection is found to be 97 % which is quite satisfactory. Frame by frame analysis of the captured video was performed to simulate the real time system. Time taken to analyze 1250 frames was 110 s.

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