A REVIEW OF LANE DETECTION TECHNIQUES

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Abstract:*With increase in the number of road accidents, it haslead to concern over the nature of accidents. Most of the time, it is due to human error. So LDWS are being developed for assisting the driver. The main purpose of it is to detect the lanes and warn the driver of lane departure. There exist various techniques for the detection of lanes. Most of these techniques have focused on straight lane. The main purpose of this paper is to analyze various lane detection techniques and explore their shortcomings.*

Key Words:*Image processing, Lane Detection, LDWS, Hough Transform*

1. INTRODUCTION

Digital Image Processing [11] is a component of digital signal processing. The area of digital image processing involves the manipulation and analysis of images using digital computers. For the improvement of image, it involves modifying the digital data.It helps in maximization of the clarity, image sharpness and detailing of features of interest towards information extraction and further analysis.

The field of image processing can be further divided into three main areas: image coding, pattern recognition and image restoration.

- The first area, *image coding* deals with digitization and compression of image data so as to make efficient use of memory space during storage and channel capacity during transmission.
- The second area is commonly referred to as *pattern recognition* or *computer vision* and is concerned with the processing of images to be used for machine analysis. The goal of this area is to allow the machine to analyze a picture, extract the desired image information, and make decisions based on that information.
- The third area is concerned with the processing of pictures where the resulting image is to be used by humans or machines. Processes of enhancement and restoration are both concerned with the improvement of image quality and appearance to make them better suited for human viewing or machine analysis.

1.1 Lane

A lane is a part of a roadway that is reserved to be used by a single line of vehicles. It is used for controlling and guiding drivers and reducing traffic conflicts. For traffic in each direction, there are at least two lanes on most of the roads and separated using lane markings. Lanes are specified by road surface markings on multilane roadways and busier two lane roads.

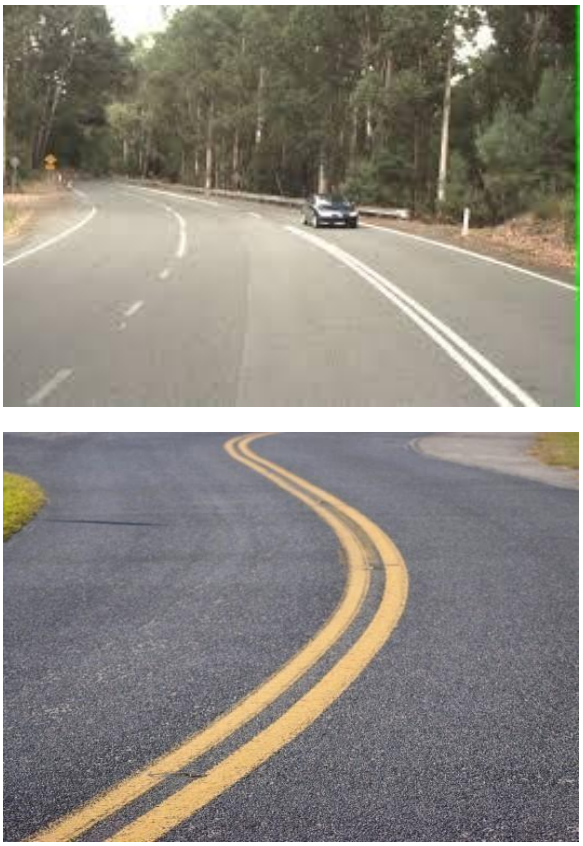

Figure 1: Lanes

1.2 Types of Lanes

- Traffic Lane : Lane for the vehicles moving from one destination to another
- Express Lane : Used by faster moving traffic and has less access to exits/off ramps
- Reversible Lane: To match the peak flow direction of vehicles is changed. Periods of high traffic flow are accommodated by this lane.
- Auxiliary lane : Used for separating entering, exiting or turning traffic from the through traffic
- In some areas, for non-moving vehicles lane adjacent to curb is reserved

1.3 Lane Detection

Lane detection is one significant method in the visualization based driver support structure and capable to be used for vehicle routing, cross power,crash avoidance, or lane departure warning system [12]. Different road condition that create this difficulty more complex include dissimilar variety of lanes (straight or rounded), occlusions cause by obstacle, fog, darkness, illumination change (like nighttime), and so on. Therefore it is the method to locate lane in the picture and is a significant enable or attractive skill in different automobile application, include lane departure recognition and warning, travel control, crosscontrol, and self-directed driving.

A lane departure warning system(LDWS) is a technology designed for warning a driver when the vehicle begins to depart from its lane. An effective lane detection [13]system will navigate autonomously or assist driver in all types of lanes likstraight and curved, white and yellow, single and double, solid and broken and pavement or highway lane boundaries. The system should be able to detect lane even under noisy conditions such as fog, shadow, and stain.

1.4 Benefits of Lane Detection:

- Gives assistanceand details to pedestrians and drivers
- Uniformity of the markings is an important factor in minimizing confusion and uncertainty about their meaning
- Allows vehicular drivers to drive safely

2. RELATED WORK

Jae-Hyun Cho et al. (2014)[1] applied the Hough transform with optimized the accumulator cells in the four ROI in parallel and detects lanes with high efficiency. Although Hough Transform can detect only straight lines, the poor lane recognition rate on the curve road has been resolved fairly.

Chan Yee Low et al. (2014) [2] presented a robust road lane marker detection algorithm to detect the left and right lane markers. The algorithm consists of optimization of Canny edge detection and Hough Transform. Canny edge detection performs features recognition then followed by Hough Transform lane generation. Hough Transform is applied to find relevant lines that can be used as the left and right lane boundaries. Reducing the image to smaller region of interest can reduce high computational cost.

Dajun Ding et al. (2013) [3] proposed an algorithm based on road ROI determination for detecting road region using information of vanishing points and line segments. Unnecessary information included in input images was analyzed in a region of interest (ROI) for reducing amount of computation. Hough Transform is used for detecting line segments. Road ROI is determined automatically in every frame. This method works effectively in various road conditions.

HongliFani and Weihua Wang (2013) [4] proposed a new algorithm for color road image edge detection. The original color data in RGB color model were converted to Lab color model and the difference information between the gray image from L channel and the red-green image was obtained with different image method, and the threshold was obtained using optimal threshold value algorithm, then edge detection was carried out. The results show that algorithm has high resistance to noise and retain better edges for color road image edge detection than the traditional algorithms.

N. Phaneendra et al. (2013) [5] adopted lane detection method which consisted of image preprocessing, binary processing and dynamical threshold choosing, and Hough transform model fitting. Instead of Hough transform, Kalman filter was used for improving lane detection performance.
Based on distance between lane and center of bottom in captured image coordinate, decision making of lane departure was proposed. Efficiency and feasibility of the solution was indicated by the experimental results.

Wang Jian et al. (2013) [6] found that when selected seed points are correct, the accuracy of the method of road region extraction based on regional growth is high. This method can identify lane region exactly. But when selected seed points are wrong, lane identification will fail, and lead into some interference information. In this paper, the deficiency of this method is improved. It uses this method to identify lane feature region, and introduces the area threshold value to filter scanned region growing area. This can reduce the interference of useless information on lane identification. Lane identification algorithm and lane departure warning algorithm achieve good experimental results from speed and recognition rate.

F. Mariut (2012) [7] proposed a simple algorithm that detects the lane marks and its characteristics and is able to determine the travelling direction. The Hough Transform was used to detect the lines in images. A technique was developed for extracting inner margin of lane to ensure right detection of lane mark.

KamarulGhazali et al. (2012) [8]proposed an algorithm for detecting unexpected lane changes. An algorithm based on H-maxima and improved Hough Tranform was proposed which defines region of interest from input image and then divides the image into near and far field of view. Hough Transform was applied on near field of view to detect lane marks after noise filtering. The results showed that this algorithm is effective for straight roads.

Yong Chen and Mingyi He (2012) [9] proposed an algorithm called lane boundaries projective model (LBPM) for sharp curved lanes. Using lane model lane posterior probability is derived and then using particle swarm optimization lane maximum posteriori probability is found. Through lane model, lane boundaries are positioned and lane geometric structure is calculated. The results show that this method is effective for sharp curved lanes. But it detects only host lane.

ZhiyuanXu et al. (2009) [10] presented a method based on CLAHE for removing the effect of fog. A maximum value is established to clip the histogram and distribute the pixels clipped to each gray level. This method can limit the noise in an image while enhancing image contrast.

3. LANE DETECTION TECHNIQUES

A. Hough Transform:

Hough Transform [7] is a technique used for extracting features that can be used in image anlaysis and digital image processing.Traditional Hough Transform is basically used for identifying lines in the images. There was a difficulty in detecting straight lines, circles etc. in automated analysis of digital images. The edge detector has been used in pre-processing stage for obtaining points on image that lie on desired curve but due to some problem in image, some of the pixels were missing on desired curve. So for solving this problem Hough Transform is used.

Hough Transform is an efficient [8] tool for the detection of straight lines in images, even in the presence of noise and occlusion. By counting unique equation for every possible line through point of image, it is able to find dominant lines in an image. By selecting pixels form image object set, the edge pixels can be grouped into an object class.

For the detection of lines in an image, it is first converted into a binary image using some threshold. Then the dataset is added with suitable instances. Hough space is the main part of Hough Transform. In a Hough Space each point (d, T) is matched to a line at angle T and distance d from origin. The point along a line is given by the value of a function in Hough space. For each point, consider all line which goes through that point at discrete set of angles based on priority basis.

An array called accumulator is used to detect lines in Hough transform. The dimension of the accumulator is equal to number of unknown Hough transform parameters. Initially, lines are generated that can pass through each point. In case of an intersection of a line with other lines of other points, the vote for those (d,T) parameters is incremented. Finally the pair of (d,T) parameters with the highest vote is selected as predominant line present on the image plane based on the points that compose this line

The Hough Transform is basically used for the detection of straight lanes. But it can be improved to detect the curved lanes effectively and efficiently. This improvement is not given much focus till now.

Figure 2: Original image, Process image and Hough Transform image in daytime.

B. Edge Detection

This method [4] is based on the idea of identifying points in an image at which image brightness changes sharply. Edge is defined as organized set of curved line segments. This set consists of points at which brightness of image changes sharply. Edge Detection is a tool used in image processing for feature detection and extraction. This algorithm significantly reduces data to be processed and may therefore remove less relevant information while preserving important properties of an image. If this algorithm is successful, the task of interpreting the information in original image may be simplified. However it is not always possible that ideal edges can be obtained from real life images of modern complexity.

An edge detection algorithm called canny edge detector is used to detect edges in an image. This method uses multiple stage algorithm and aims in discovering the optimal edge detection.

Canny edge detector is an edge detection algorithm that uses multiple stage algorithm so as to detect edges in images. Its aim is to discover the optimal edge detection.

C. Bilateral Filter

It is a simple and non-iterative scheme [14] which smoothen the image while preserving edges. The basic idea behind the working of bilateral filter is that the two pixels should be close to one another. This filter split an image into large-scale features i.e. structure and small scale features i.e. texture.

In this filter, each sample is replaced by a weighted average of its neighbors. Two forces are reflected by these weights: similarity between neighbor and centre sample such that similar samples are assigned large weight and closeness of neighbor with centre sample such that closer samples are assigned larger weights

D. Lane Boundaries Projective Model

This model [9] expresses straight line and sharp circular curve lane boundaries very well. Using lane model, gradient direction feature, lane likelihood function and lane prior information, the lane posterior probability can be found. Then by using particle swarm optimization algorithm, the lane maximum posterior probability can be found. After that the lane boundary is positioned and lane geometric structure can be accurately calculated using lane model

4.GAPS IN EXISTING WORK

Nowadays various lane detection algorithms have been used for assisting the driver in Advanced Driver Assistance System(ADAS). Majority of these techniques have focused on the detection of straight lanes and curved lanes have been ignored.Thus the gaps which exist in the literature are:

- Majority of work is based on straight lane images i.e. curved lane images have been ignored
- The improvement in Hough Transform has been ignored for better Lane Detection
- The effect of fog in Lane Detection has also been ignored

5. CONCLUSIONS

In this paper different lane detection techniques are reviewed and studied. All the reviewed methods identify the straight lanes in a very effective manner. But all these methods have ignored the detection of curved lanes. The present methods have ignored the concept of CLAHE for

efficient image contrast and using Improved Hough Transform for better curved lane detection.

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