Fast Lane Detection using improved Hough Transform

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***Abstract* – Lane detection is a major component of intelligent transport system. Lane detection helps to estimate the road geometry ahead as well as lateral position of vehicle. A fast lane detection algorithm is proposed by integrating compression and improved Hough transform. JPEG compression is a lossy compression for digital images. Hough transform helps in detecting lane markings. The main objective is to use Hough Transform along with JPEG compression to speed up the algorithm. Finally, various experiments will be conducted to test the efficiency of algorithm**.

***Keywords* - Hough Transform, Statistical Hough transform, Particle Filter, Joint Photographic Experts Group, Ant colony optimization, Intelligent Transportation systems, Discrete cosine Transform, Run length encoding**

I. INTRODUCTION

Research of road detection techniques is mainly focusing on detecting lane markings. Traffic safety is becoming more and more popular these days due to increase in urban traffic. Lane detection is crucial to lateral vehicle guidance and lane departure warning which can eliminate many avoidable accidents. Lane detection system is useful in intelligent cruise control systems, lane departure warning and road modelling. Color information[1] has been used to detect the road area and lane markings using the fact that the color of the pavement is black while the colors of the lane markings are white, yellow or red.

Hough transform[2] (HT) is a common techniques used for the detection of lines and circles in the field of image processing. The Hough transform was firstly introduced by Duda and Hart in 1972 to detect lines in images. It is robust and cost efficient method in term of computing time in detecting occluded objects in various types of data and could be modified to detect other shapes such as circles and ellipses.

In contrast to the central line, it is harder to detect adjacent lines because 1) they are not as distinguishable as compared to the central line, 2) they might be partially blocked by other vehicles, 3) detection might be hindered due to shadow or some noise.

In this paper we will propose a new improved lane detection algorithm. First of all the given image is compressed using JPEG compression in order to reduce its size afterward it is divided into two parts i.e. road part and non road part. Then, the road image is converted into binary image by using the histogram of intensity. Finally, improved Hough transform is used to detect lane markings in road image by using road geometry information. Eventually, various experiments would be conducted to determine the effectiveness of proposed algorithm.

II. OBJECTIVE

Main objectives of this research work are:-

1. To speed up the operation using efficient techniques.

2. Improve the hit ratio by increasing the actual number of hits. Hit ratio is calculated as:
   Hit ratio = Accurate hits / Total number of hits

3. Error rate will be reduced as the number of hits increases.
   Error Rate = 1- Hit ratio

4. Accuracy will automatically increase due to improved hit ratio and reduced error rate. As accuracy is calculated as the ratio of hits and error.

III. RELATED WORK

Ghazali et al. (2012) [3] proposed a lane detection method based on H-MAXIMA transformation and improved Hough Transform algorithm .The image is divided into near field of view and far field of view. In near field of view, Hough transform has been applied to detect lane markers after image noise filtering. This method has been developed using image processing programming language platform and was tested on collected video data.

Song et al. (2012) [4], proposed Canny edge and Hough transformation method of structured road lane detection for blind travel aid. Median Filter is used to develop image firstly, then mark off the region of interest in the initial image. Canny edge enhancement, threshold is function to segment the image and road lane is fitted by

modified Hough Transformation. The experimental results prove this algorithm is very robust and real-time.

Kim et al. (2012) [5], proposed intelligent technique for lane marking. First divided the image into halves and use the lower division in detection and binarize them by analyzing RGB way. Then the boundary lines are extracted by applying 4-directional contour tracking algorithm and vectors with distance and angle values are extracted from boundary lines to use as input for fuzzy C-means clustering algorithm. The experimental results of the proposed method is slightly slower than Hough transform.

Jiang et al. (2010) [6], designed a vision system to detect multiple lanes on structured highway using an "estimate and detect" scheme. Possible position of two adjacent lanes is estimated. In case of straight road, the central lane was detected using Hough transformation and simplified perspective transformation. For curved path, complete perspective transformation was performed and the central lane was detected.

Liu et.al. [2010] [7] proposed Statistical Hough transform (SHT) with a Particle Filter (PF) and show its application for robust lane tracking. SHT improves the standard Hough transform (HT) which was shown to work well for lane detection. The local descriptors are used as measurement for the PF, and had shown working of a new three kernel density based observation model.

Kang et al. (2010) [8] proposed a real-time lane detection algorithm. The algorithm integrates multiple cues, including bar filter which is efficient to detect bar-shape objects like road lane, color cue, and Hough Transform (HT). After obtaining integrated multiple cues they utilized particle filtering technique to realize lane tracking, which guarantees the robust and real-time lane detection. Experimental results verified that the algorithm gives a precise and robust detection of lane in various situations.

Daigavane et al. (2010) [9] described an approach on captured images using ant colony optimization (ACO) on Canny for edge detection. Lanes were extracted using Hough transform. The proposed lane detection system can be applied on painted roads and straight roads. The approach was experienced and the experimental results demonstrated that proposed scheme was robust.

Hota et.al.(2009) [10] developed a vision based system to detect line or curve like segments from a video image and merge them to detect road lane marks. The proposed vision based solution was easy but computationally efficient and hence worked in real time on the image sequence captured by camera mounted in the vehicle.

Faizal et al. (2009) [11] described a mid-line detection system on curve road as for drivers using simulation model. The system has recognized the curve road and detecting the tangent for each segmented curve. The purpose to find a point that is normal to tangent of the curve. Then, using pixel distance calculation, midpoint for the curve road is calculated in order to detect and draw a virtual mid-line. This mid-line would help for the drivers to stay center when driving on the curve road.

For safety measure, the system notifies the driver with a warning message if the vehicle goes off the lane. B-spline together with Generalised Hough Transform is used to find out the transformation parameter and the position of the model in the image. Experimental results on real road scene were presented.

IV. PROBLEM STATEMENT

Intelligent Transportation Systems (ITS) are developing to increase transportation efficiency and mitigate its negative impacts on society. Traffic floe monitoring, traffic guidance and traffic signal control are some of ITS applications relying on vehicle passage rate in the streets. There are already some conventional techniques for vehicle counting. In this work a novel method is proposed for lane marking based on compression and Hough transformation. Main objective is to combine feature of classical lane detection techniques, Hough transformation to detect the lane efficiently and JPEG compression for reducing the size of the image and to speed up road lane detection.

In order to visualize the result, the proposed methods will be implemented in Matlab. Suitable performance analysis will be drawn based upon the experimental result of proposed method over existing techniques.

V. RESEARCH METHODOLOGY

To attain the objective, step-by-step methodology is used in this paper. Lane detection algorithms have different phases which are used to accomplish this work. The algorithm is composed of following steps:

First, the captured image is compressed using JPEG compression in order to reduce its size. Secondly the image is divided into road part and non-road part by using camera geometry information. Thirdly, the color road image is quantized into a binary image. Fourthly, the improved Hough transform is used to detect the lane markings.

A. JPEG Compression

The name "JPEG" stands for Joint Photographic Experts Group. It is a common method of lossy compression for digital images. JPEG compression works best on photographs and paintings of realistic scenes with smooth variations of color and tone. . The purpose is to compress images by maintaining acceptable image quality. This can be achieved by dividing the image in blocks of 8×8 pixels and then applying a discrete cosine transform (DCT) on the partitioned image.

The resultant coefficients are quantised and the less significant coefficients are put to zero. After quantisation two programming steps are prepared, zero run length encoding (RLE) followed by an entropy coding. Some part of JPEG encoding is lossy information may get lost. Hence, the reconstruction may not be exact, another part is lossless that is no loss of information.

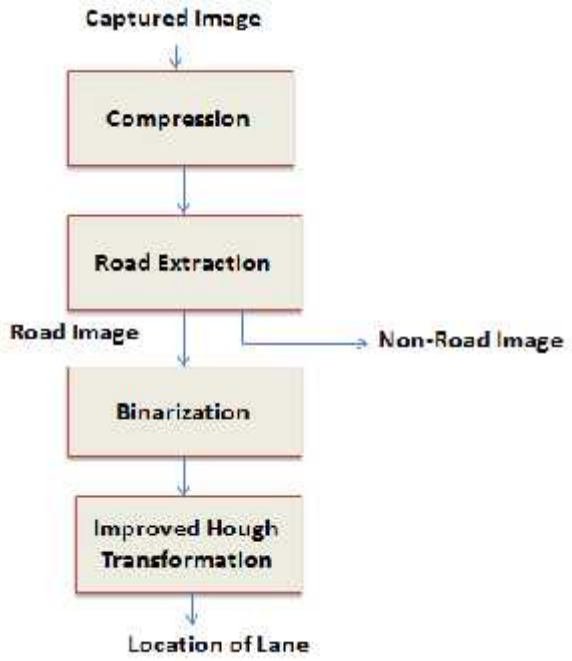

Figure 1: Lane Detection algorithm

B. Road Extraction

The captured image is extracted into parts that the road part and non road part. The road part consists of the lower image which includes the lanes that are to be detected. Whereas, the non part consists of the upper image excluding the lanes.

C. Binarization

Binarization is a method of converting an image of up to 256 gray levels to a black and white image. The simplest way to do image binarization is to select a threshold value, and classify all pixels with values above this threshold as white, and all the other pixels as black.

D. Hough Transform

The most popular method used to detect the straight line in digital images is the Hough transform method[1]. The line equation in Hough transform is given by

$\rho = x \cos\varphi + y \sin\varphi$

where parameters ρ and φ are shown in Fig.2.

The spaceof (ρ,φ) is usually called parameter space in which theline detection is performed. Given a binary image $I(x,y)$ with ρ ranging from min ρ to max ρ and φ ranging from min φ to max φ.

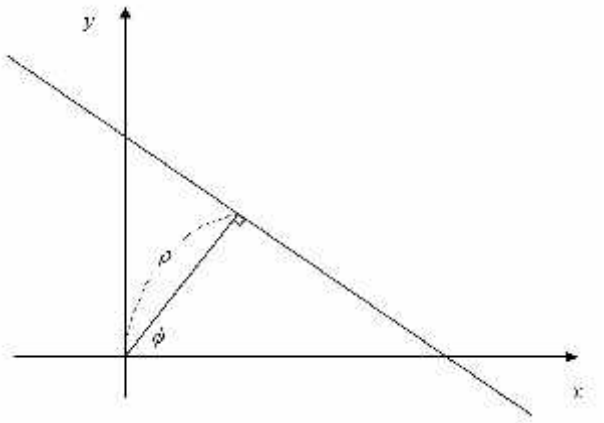

Figure 2: The straight line in Hough transform (adapted from [1])

The procedure of using Hough transform to detect a straight line is described below:

Step 1: Compute the Hough transform by
For min ρ = ρ to max ρ do
For min φ = φ to max φ do
S(ρ,φ) = 0;
For all (x,y) in $\rho = x\cos\varphi + y\sin\varphi$ do
If $I(x,y) = 1$ then $S(\rho,\varphi) = S(\rho,\varphi) + 1$;
end;
end;
end;

Step 2: Detect straight lines by finding strong peaks in the transform S(ρ,φ) . If there exists a strong peak at(m , m) ρ φ for S(ρ,φ), then there is a straight line$m$ m m $\rho = x\cos\varphi + y\sin\varphi$ in the $I(x,y)$.

VI. CONCLUSION AND FUTURE DIRECTIONS

Lane detection is a method of detecting the lanes of the road. So far, several methods have been proposed to detect lane markings painted on the road surface. Lane detection algorithm using Hough transformation and compression will be integrated for better results. Techniques will be implemented in MATLAB. Suitable performance analysis will be drawn based upon the experimental result of proposed method over existing techniques.

The algorithm proposed in this paper is simulation based, in future real time algorithm can be proposed.

VII. REFERENCES

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