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Road Lane Line Detection

Vaishnavi Ghodake , Jasiya Tamboli, Supriya Mali, Priti Gapat, Pratape P.P

Department Of Computer Science & Engineering, JSPM's Bhagwant Institute of Technology, Barshi, Maharashtra, India

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ABSTRACT

Driver support system is one of the most important feature of the modern vehicles to ensure driver safety and decrease vehicle accident on roads. Apparently, the road lane detection or road boundaries detection is the complex and most challenging tasks. It is includes the localization of the road and the determination of the relative position between vehicle and road. A vision system using on-board camera looking outwards from the windshield is presented in this paper. The system acquires the front view using a camera mounted on the vehicle and detects the lanes by applying few processes. The lanes are extracted using Hough transform through a pair of hyperbolas which are fitted to the edges of the lanes. The proposed lane detection system can be applied on both painted and unpainted roads as well as curved and straight road in different weather conditions. The proposed system does not require any extra information such as lane width, time to lane crossing and offset between the center of the lanes. In addition, camera calibration and coordinate transformation are also not required. The system was investigated under various situations of changing illumination, and shadows effects in various road types without speed limits. The system has demonstrated a robust performance for detecting the road lanes under different conditions

I. INTRODUCTION

Advanced Driving Assistance Systems (ADAS) require the ability to model the shape ofroad lanes and localize the vehicle with respect to the road. Although, the main reason to build intelligent vehicles is to improve the safety conditions by the entire or partial automation of driving tasks. Among these tasks, the road detection took an important role in driving assistance systems that provides information such as lane structure and vehicle position relative to the lane. However, vehicle crashes remains the leading cause of accident death and injuries in Malaysia and Asian countries which claiming tens of thousands of lives and injuring millions of people each year. Most of these transportation deaths and injuries occur on the nation's highways. TheUnited Nations has ranked Malaysia as 30th among countries with the highest number of fatal road accidents, registering an average of 4.5 deaths per 10,000 registered vehicles. Therefore, a system that provides a means of warning to a driver for a danger has been considered as a potential way to save a considerable number of lives.

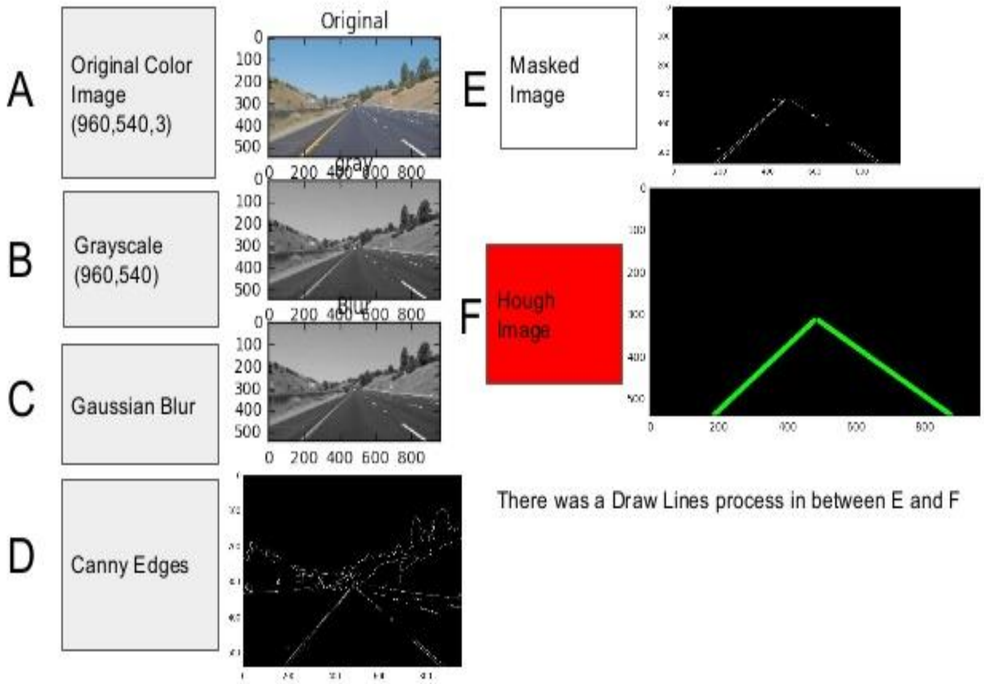
II. RELATED WORK

A large number of researchers are working cooperatively with a goal to build autonomous vehicles and many government institutions have also lunched various projects worldwide. These efforts have produced several prototypes and solutions, based on slightly different approaches Richard, (1997). In Europe the PROMETHEUSprogram (Program for European Traffic with Highest Efficiency and Unprecedented Safety) pioneered this exploration. More than 13 vehicle manufactures and several research institutes from 19 European countries were involved. Several prototype vehicles and systems such as (VaMoRs, VITA, VaMP, MOB-LAB, and GOLD) were designed as a result of these projects. Although the first research efforts on developing intelligent vehicles were seen in Japan on the 1970's, significant research activities were triggered in Europe in the late 1980's and early 1990's. MITI, Nissan and Fujitsu pioneered the research in this area by joining forces in the project "Personal Vehicle System" Broggi, (1998). In US, a great deal of initiatives has been launched to address this problem. The National Automated Highway System Consortium (NAHSC) was established in 1995 and the Intelligent Vehicle Initiative (IVI) in 1997 Kreuche, et al., (1998). At present many different vision-based road detection algorithms have been developed and deployed in these autonomous vehicles. Among these algorithms, the GOLD system developed by Broggi uses an edge-based lane boundary detection algorithm Chen et al., (2004). The acquired image is remapped in a new image by representing a bird's eye view of the road where the lane markings are nearly vertical bright lines on a darker background

III. ENVIRONMENTAL VARIABILITY

In addition to the intended application of the vision lane detection system, it is important to evaluate the type of conditions that are expected to be encountered. Road markings can vary greatly between regions and over nearby stretches of road. Roads can be marked by well-defined solid lines, segmented lines, circular reflectors, physical barriers, or even nothing at all. The road surface can be comprised of light or dark pavements or combinations. An example of the variety of road conditions is presented in some roads are relatively simple scene with both solid lines and dashed lines lane markings. Lane position in this scene can be considered relatively easy because of the clearly defined markings and uniform road texture. But in other complex scene in which the road surface varies and markings consist of circular reflectors as well as solid lines, the lane detection would not be an easy task. Furthermore, shadowing obscuring road markings makes the edge detection phase more complex. Along with the various types of markings and shadowing.

IV. THE PROPOSED ALGORITHM



A. Image Capturing:

The input data was a color image sequences taken from a moving vehicle. A color camera was mounted inside the vehicle at the front-view mirror along the central line. It took the images of the environment in front of the vehicle, including the road, vehicles on the road, roadside, and sometimes incident objects on the road.

The on-board computer with image capturing card captured the images in real time (up to 30 frames/second), and saved them in the computer memory. The lane detection system read the image sequences from the memory and started processing.

B. Conversion to Gray Scale:

To retain the color information as well as to segment the road from the lane boundaries using the color information, edge detection becomes difficult and consequently effects the processing time. In practice the road surface can be made up of many different colors due to shadows, pavement style or age, which causes the color of the road surface and lane markings to change from one image region to another. Therefore, color image were converted into grayscale. However, the processing of grayscale images became minimal as compared to a color image. This function transformed a 24-bit, three-channel, color image to an 8-bit, single channel grayscale image. The function formed a weighted sum of the Red

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component of the pixel value * 0.3 +Green component of the pixel value * 0.59 + Blue component for the pixel value *0.11 and the output is the gray scale value for the corresponding pixel.

C. Noise Reduction:

Noise is a real world problem for all systems including computer vision processing. The developed algorithms must either be noise tolerant or the noise must be eliminated. As presence of noise in proposedsystem will hinder the correct edge detection. Hence noise removal is a pre requisite for efficient edge detection with the help of (F.H.D.) algorithm Mohamed Roushdy, (2007) that removed strong shadows from a single image. The basic idea was that a shadow has a distinguished boundary. Hence removing the shadow boundary from the image derivatives and reconstructing the image was applied. A shadow edge image has been created by applying edge-detection on the invariant image and the original image. By selecting the edges that exist in the original image but not in the invariant image and to reconstruct the shadow free image by removing the edges from the original image by using a pseudo-inverse filter has been implemented.

D. Edge Detection:

Lane boundaries are defined by sharp contrast between the road surface and painted lines or some types of non-pavement surfaces. These sharp contrasts are edges in the images. Therefore edge detectors are very important in determining the location of lane boundaries. It also reduces the amount of learning data required by simplifying the image considerably, if the outline of a road can be extracted from the image. The edge detector was implemented for this algorithm. The one that produced the best edge images from all the evaluated edge detectors was the ‘canny’ edge detector.

It was important to have the edge detection algorithm that could be able to select thresholds automatically

However, the automatic threshold used in the default Canny Algorithm produced edge information that is far from actual threshold. A slight modification to the edge detection in canny has produced more desirable results.

The only changes necessary were to set the amount of non-edge pixels of the highest and lower thresholding to the best value that has provided more accurate edges in different conditions of image capturing environment

E. Line Detection:

The line detector used is a standard Hough transform Chen and Wang, (2006) with a restricted search space. For example a horizontal line is probably not the lane boundary and can be rejected. The restricted Hough transform was modified to limit the search space to 45° for each side. Also the input image is splitted in half yielding a right and left side of the image. Each the right and left sides are searched separately returning the most dominant line in the half image that falls within the 45° window.

F. Lane Boundary Scan:

The lane boundary scan phase uses the edge images, the Hough lines and the horizon line as input. The edge image is what is scanned and the edges are the data points it collects. The scan begins where the projected Hough lines intersect the image border at the bottom of the image. Once that intersection is found, it is considered the starting point for the left or right search, depending upon which intersection is at hand.

G. Hyperbola Fitting:

The hyperbola pair fitting phase uses the two vectors of data points from the lane scan as input. A least squares technique is used to fit a hyperbola to the data. One hyperbola is fit to each of the vectors of data points; however, they are solved in simultaneously due to the fact that they are a pair model. The parameters of the two hyperbolas are related because they must converge to the same point, due to the geometry of the roadway as shown in Figure 7. The formula for expressing the lane boundary as a hyperbola.

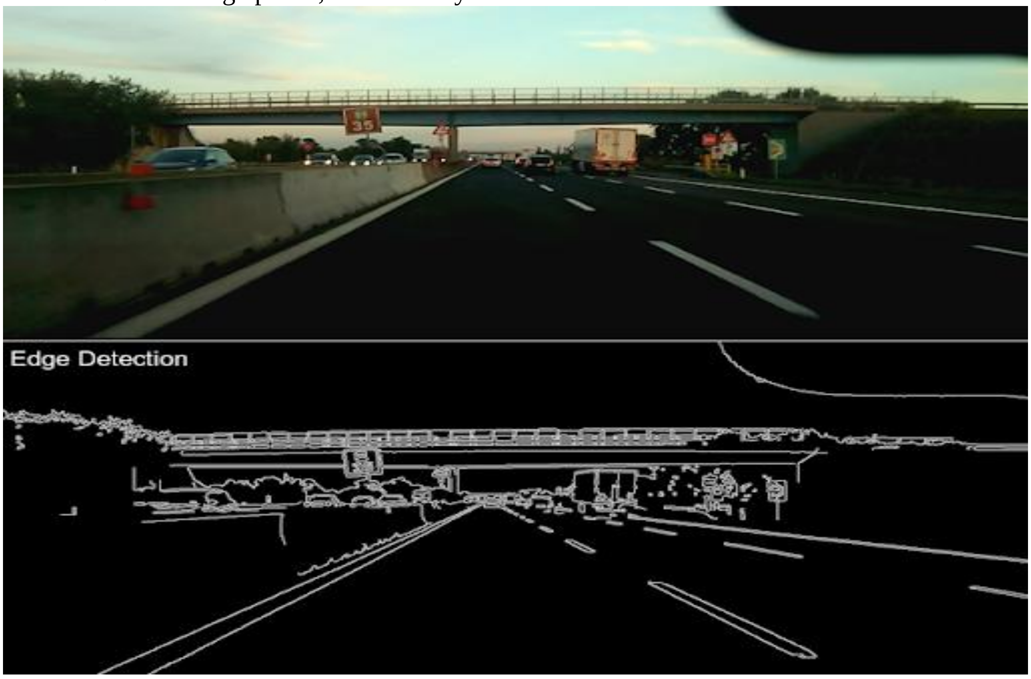
5. Experimental Setup

A CCD camera is mounted behind the driving mirror on the experimental passenger vehicle and it is used to monitor continuously the traffic scenes at the driving speed between 30km/hr. and 120km/hr. The vibration problem has been ignored in experiment since the stability of the vehicle and the camera can be achieved by some mechanisms now a days. The captured frame (620X480) were broken up into 30 frames per second (30fps) then delivered to the mobile computer which is equipped with Intel ® Core TM (2) 2.0 GHz processorand 2GB. The system has been experimentally evaluated under different weather and lighting conditions as described below

Experiment 1: Edges and Boundaries Detection:

To improve the performance of the algorithm different values of the non-edge image pixels were tested by assuming different intensities values as used to set the automatic thresholding for each frame is shown in

Set A describes the accuracy rate of the edge detection using different levels of non-edge pixels during day time in different locations. This Figure shows that at 80% of non-edge pixels, the accuracy of the detection rate approaches the highest level indicating that this value is the best to help us to prevent excessively noise edge detection.



Experiment 2: Hough Transform Processing:

In order to increase robustness of the estimated lane position, the image has been divided into halves and then limiting the range of the search angle to 45º to the left side and 135º to the right side. Each of these sides was searched separately returning the most accurate line that falls within the particular angle shows the detection accuracy rate of lines using restricted Hough transform during day time. However, this approach has great impact on the line detection results compared to the preliminary results. it can be noticed that the detecting of lines using this approach under different road structure such as clear and straight line marking segment or dashed lane markings were good. For clear road marking during day time, it can be seen the best accuracy obtained is 97% in straight single road and 95% in straight highway. Fordashed road markings, it can be seen that the best accuracy obtained is 89% in straight single road and 90% in straight highway.

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V. FUTURE SCOPE:-

Future work includes larger dataset so as to train our system to recognize lesser - known traffic signs that are used in other parts of the world. Another aspect that could be improved is the ability of the system to Recognize road signs at high speeds (>100 km/hr.). This would mean to substantially decrease the prediction time. We would also like to increase the maximum distance of recognition, so as to give the car sufficient time to take a real-time decision.

Compared with the side looking system, the forward looking system has a lot of road information to use. It can be used normally even on roads without clear lane markings. Of course, it also has its defects, that is, the forward looking system is easy to be disturbed by other information in the front road image, such as pedestrians, other vehicles, road pollutants, etc., when determining the transverse coordinate position of the current driving vehicle.

VI. CONCLUSION

In this paper, A real time vision-based lane detection method was proposed. Image segmentation and remove the shadow of the road were processed. Canny operator was used to detect edges that represent road lanes or road boundaries. A hyperbola-pair road model used to deal with the occlusion and imperfect road condition. A series of experiment showed that the lanes were detected using Hough transformation with restricted search area and the projection of their intersection will form the last scan point called the horizon.

Furthermore, In order to search out for the left and right vector points that represent the road lanes, the lanes can boundary phase uses the edge image and the left and right Hough lines and the horizon line as inputs, to effectively allocate the lane points. That was demonstrated by two hyperbola lines. The experimental results showed that the system is able to achieve a standard requirement to provide valuable information to the driver to ensure safety.

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