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Computer Vision based Road Lane Detection

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Abstract

Driver Assistance System is one of the most important features in smart vehicles to ensure the safety of the driver. It helps to decrease the number of accidents on road. The road lane detection is one of the important features in such systems. This paper focuses on a fast and reliable Road Lane Detection system. It can be paired with smart vehicles and Advanced Driving Assistance Systems (ADAS). This model includes the localization of the road and the determination of the relative position between vehicle and road. The model uses various computer vision algorithms which take in RGB images to give out lane-lines that represent the boundary of the road. Each of the algorithms used is emphasized in detail in this paper. The detection system was tested in videos captured with the camera of the vehicle. From the results, the system is said to be very reliable in detection of the lanes. The usefulness and shortcomings of the system are described in detail.

Keywords: Lane Detection, Hough Transform, Computer Vision, Canny Algorithm, Artificial Intelligence.

1. Introduction

Road safety has become more convincing with a huge increase in the urban traffic. One of the major reasons for accidents today is exiting the lanes without adhering to the rules [1]. These are often the result of sluggish attitude of the drivers. The most important thing to follow during driving in Lane Discipline. It is crucial for safety of both the drivers and the pedestrians. The main objective of this Lane Detection System is to identify the Lanes for the driver to follow the Lane Discipline in a better way. Lane Detection is one of the prime requirements of a Self-driving vehicle. The functions of this system can range from detecting the position of road lanes on a display, to assist the driver while switching lanes in the near future. Lane detection plays a vital role in the Advanced Driving Assistance Systems (ADAS). It can help compute the form of the road ahead and the position of the vehicle with respect to the lanes.

Computer Vision algorithms are the best tools that has the capabilities of analyzing the surroundings for detection and identification of objects. Road lanes generally have a pattern such as colored segments on the road surfaces. Computer Vision can be used to detect such road lanes. Computer Vision has progressed in a significant way over time that it can perceive various objects in an image or a video by inspecting models. The algorithms used in this paper is to detect lanes on the road by giving the video of the road as an input to the system by using computer vision technology and primarily designed with the objective of reducing the frequency of accidents. System can be installed in cars and taxis to prevent the occurrence of accidents due to reckless driving on the roads. Moreover, performance of the driver can also be monitored, Road Transportation Offices can use the setup to check and report the negligence of drivers and lack of attention on the roads

2. Literature Review

This Lane Detection System is proposed keeping in mind about the implementation in smart-vehicles. This system is easy to implement and does not require high-end specifications to work [3]. Lane detection is an important process in self-driving vehicles. There have been approaches to this model in literature. Work [2] designed a model which can detect lanes using color-based vision system. This model can detect lanes in the urban traffic scenes with the help of distinguishing colors of the lanes.

This model [3] combined three features namely starting position, intensity, and direction for the lane making it a complex model and unsuitable for real-time detection. The model by Cheng [4] had an approach to detect the lanes based on an automatic extraction without manual initialization or priority information under different environments and real-time processing.

Kang [5] developed a framework which searches for edges and groups them with similar direction as the lanes. This method was not able to handle complicated roads, leading for false detection. A deformable template model of lane structure [6] is used to locate lane boundaries by using intensity gradient information. This approach [7] combines edge distribution function with the Hough transformation algorithm with the linear parabolic model for detection of the lanes. The Hough transformation is a very good algorithm as it can detect the road lanes in any kind of environment [8]. The parameters of this model [9] are the same if the lanes are parallel on the same road. This feature can be used in other algorithms to improve the efficiency. Hough Transformation, Fast radial transform and corner detection algorithms were used to determine the lanes in this model [10-11].

3. Methodology

The structure of the algorithm is shown in Figure 1. A camera is fixed on the vehicle to capture the road. The baseline in the problem is set up as horizontal, which aligns the horizon of the scene in the image to be parallel to the x-axis. The image can be calibrated with standard data.

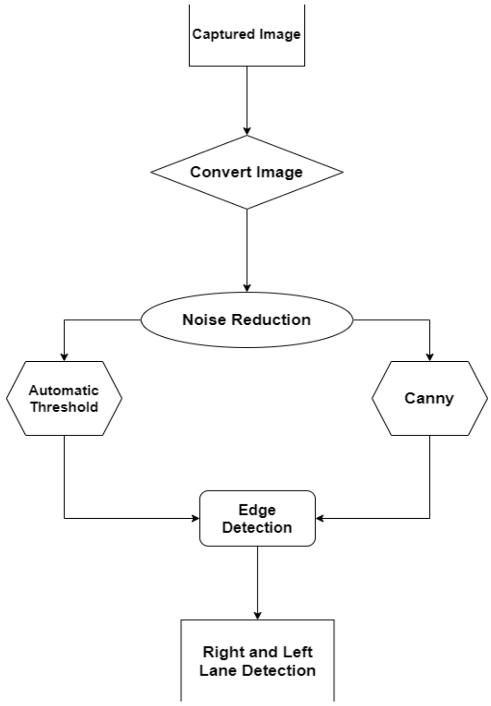

Figure 1 shows the Overview of the Proposed Algorithm

The algorithm converts the image to grayscale to reduce the processing time to give efficient results. Noise present in the image can be hindrance in determining the edge detection, So, [12] F.H.D Algorithm is used to make the edge detection better.

3.1 *Capturing Image*

A camera has been fixed inside a moving vehicle which record the road. The input data is a sequence of images taken from the camera. The camera takes images of the road, vehicles on the road and the objects present in the frame of the camera. A processor is used which captures images in real-time on up to 30 fps and saves them in the memory.

3.2 Converting Image to Gray Scale

Edge detection gets difficult when retaining the color information along with the segmentation of the road from the lane boundaries using the color information, this also increases the processing time. The road is made up of various colors and textures such due to the shadows, vehicles, pavements. These make the color of the lanes from one image region to another. To avoid these kinds of problems, the color image is converted into a grayscale 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 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.

3.3 Reduction of Noise from Image

Every Computer vision processing faces the problem of Noise. The algorithms developed should be tolerant to noise or they must eliminate the noise present in the image. Noise in images will affect the edge detection. Noise can be removed using the F.H.D Algorithm which removes shadows from the image. The image is reconstructed by removing the shadow. Pseudo-reverse filter filter has been used to select the edges that are present in the original image but not in the invariant image to reconstruct the shadow free image.

3.4 Edge Detection

An edge relates to a locale in a picture where there is a sharp change in the force/shading between nearby pixels in the picture. These sharp changes are the edges in the image. Edge detection is very important to detect the lane boundaries. It simplifies the image to a considerable amount that it reduces the amount of learning data required. The canny edge detector algorithm is considered as the best algorithm for edge detection.

The edge detection algorithm which can select thresholds automatically is the one most preferred. The canny algorithm selects threshold automatically, but it is noted that the threshold selected by this is far from the actual threshold. The threshold selected by the canny can be modified to get desired results. Setting the amount of non-edge pixels and lower thresholding are the only modifications needed for better results.

$$T_1=\min_{\substack{x=0.1\ldots,m \\ y=0.1\ldots,n}}\{f(x,y)\} \text{ and, } T_2=\max_{\substack{x=0.1\ldots,m \\ y=0.1\ldots,n}}\{f(x,y)\}$$

3.5 Line Detection using Hough Transform

Hough transformation is a technique used to detect shapes that can be represented mathematically. One advantage of the Hough transform is that it can detect shapes even if its broken or distorted. The purpose of this is to find imperfect instances to objects within a certain class of shapes. Here, Hough transform is used as a Line detector.

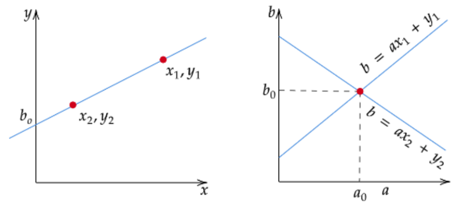

Figure 2 shows the Hough Transform Line Detection.

Any line which falls outside a certain region can be neglected. The horizon is calculated using the left and right Hough lines and projecting them to their intersection. The horizontal line at the intersection is referred to as the Horizon.

3.6 Lane Boundary Scan

This step uses the edge detected image, Hough lines and horizon as its inputs. The edge image is scanned, and the edges are its data points. When the hough lines intersect the image border at the bottom of the image, the scan begins. The starting point is the intersection for the left or right search. The search begins from the starting point towards the center of the lane and looks for the edge pixel.

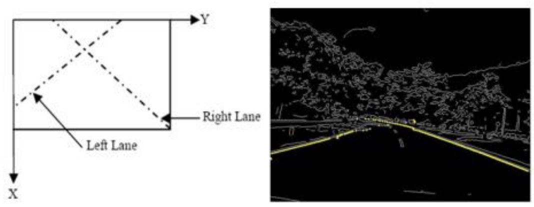

Figure 3 shows the Lane Boundary Scan

For the initial condition, the search will be at either of the borders, i.e., left, or right. The lane points are organized into two lists given as L(l) and L(r)

$$L(l) = \{(u_1, v_1), (u_2, v_2), \ldots, (u_m, v_m)\}$$

$$L(r) = \{(u_1, v_1), (u_2, v_2), \ldots, (u_m, v_m)\}$$

4. Result and Conclusion

The algorithm is evaluated qualitatively in terms of accuracy. The result screenshots of the system are included in this section. The algorithm seems to be fairly accurate in detecting the lanes in the road in daylight, night and rainy conditions.

Figure 4 shows the Lane Detection in Daylight

This frame (Figure 4) shows the lane detection in day light, the system was tested with 50 images of day light, and it was 96% accurate in detecting the lanes in the road.

Figure 5 shows Lane Detection in Night

This frame (Figure 5.) shows the lane detection in nighttime. The model was tested with 50 images of night. The model was 88% accurate in finding the lanes during night time,

Figure 6 shows Lane Detection in rainy, foggy road

This frame (Figure 6.) shows the model detecting the lane in rainy and foggy road. The model was tested with around 50 similar images and result was found to be 94% accurate.

Table 1 shows the Results of Lane Detection

Type of road	Images tested	Images with accurate result	Accuracy
Daylight	50	48	96%
Night	50	44	88%
Rainy	50	47	94%

5. Conclusion

A real time computer vision based Road Lane Detection method was proposed in this paper. The image was first converted into grayscale to reduce processing time. The shadows were removed from the image using image segmentation. Canny operator and hough transform were used to detect the lane boundary in the model. Overall, the model seems to be 92.6% accurate on average. The model can be implemented with better processing devices to improve the accuracy, a storage device can also be added to the model to store the data generated. The experimented results showed that the model is able to achieve a standard information for the driver to drive safely.

References

[1] Unsafe Lane Changes are a Top Cause of Auto Accidents (seriousaccidents.com)

[2] Y. He, H. Wang, and B. Zhang, "Color-Based Road Detection in Urban Traffic Scenes". IEEE Transactions on ITS, vol. 5, pp. 309-318, 2004. Author, F., Author, S., Author, T.: Book title. 2nd edn. Publisher, Location (1999).

[3] Y. U. Yim and S.-Y. Oh, "Three-Feature Base Automatic Lane Detection Algorithm (TFALDA) for Autonomous Driving". IEEE Transaction on ITS, vol. pp. 219-225, 2003.

[4] H.-Y. Cheng, et al., "Lane detection with moving vehicle in the traffic scenes". IEEE Transactions on ITS, Vol. 7, pp. 571-582, 2006.

[5] D.-J. Kang, M.-H. Jung "Road Lane segmentation using dynamic programming for active safety vehicles". Pattern Recognition Letters, Vol. 24, Issue 16, pp. 3177-3185, 2003.

[6] K. Kluge, "Extracting Road curvature and orientation from image edge points without perceptual grouping into features". IEEE Intelligent Vehicle Symposium, pp.109-114, Oct. 1994.

[7] C.R. Jung and C.R. Kelber, "A robust linear-parabolic model for lane following". The XVII Brazilian Symposium on Computer Graphics and Image Processing, 2004.

[8] Ahmed Hechri, FayçalHamdaoui, Anis Ladgham and Mtibaaabdellatif, "Using fuzzy logic path tracking for an

autonomous robot". In International Review of Automatic Control -Theory and Applications (IREACO), Praise Worthy Prize Publishers (Italy), (ISSN: 1974 – 6059) Volume 4 (Issue 1)

[9] Zu Kim. Realtime lane tracking of curved local road. In Intelligent Transportation Systems Conference, 2006. ITSC'06. IEEE, pages 1149-- 1155. IEEE, 2006

[10] Mohamed Aly. Real time detection of lane markers in urban streets. In Intelligent Vehicles Symposium, 2008 IEEE, pages 7--12. IEEE, 2008.

[11] S. Sivaraman and M.M. Trivedi. Integrated lane and vehicle detection, and trackingIEEE Transactions on Intelligent Transportation Systems, 14(2):906--917, June 2013

[12] Mohamed Roushdy, 2007. Detecting Coins with Different Radii based on Hough Transform in Noisy and Deformed Image, GVIP Journal, Cairo, pp: 1-5.