LANE DETECTION AND TRACKING SYSTEM FOR AUTONOMOUS VEHICLES USING HOUGH TRANSFORM

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Abstract: This paper puts forward a method to detect the lanes from a video in MATLAB platform using Hough Transform. This method is composed of three parts: video processing, individual frame processing and lane detection. The first part, video processing, includes reading the video and converting it into frames. The output of this part is a huge number of color images which will be processed individually in the following steps. The second part, individual frame processing, includes the processes of cropping the individual frames, converting them into gray scale images and binary images in successive steps and finally detecting the edges in the image using Canny filter. The third part, lane detection, also works on the individual frames which includes the process of applying Hough Transform to the edge detected image and getting the line parameters based on it.The output is displayed in the user interface using the line parameters obtained by applying Hough Transform.

Index Terms **- lane detection, Hough Transform, MATLAB, autonomous vehicle.**

I. INTRODUCTION

Due to heavy increase in city traffic, the road safety turns out to be critical. Considering the path to be the cause of about one third of all mishaps on the road, and the vast majority of these have come about because of the diversion and weariness of the driving person. Thus, a framework can alert person in-charge of a risk has an great ability to spare a substantial quantity of social property and human lives. Frameworks which are intended to help the driving person in driving are known as Advanced Driver Assistance Systems (ADAS). ADAS constitutes of numerous frameworks like collision avoidance system, blind spot detection, night vision, cruise control, and sign board detection [1]. Lane departure system is additionally a piece of this class. Objective of this framework is identifying the path markings and exhorting the driving person in the event that the vehicle tends to go out of the path.

Lane Change Assistance (LCA) that is based on camera is a vital zone of car innovative work. A fundamental component of LCA is the path location module. By ceaselessly checking the situation of a vehicle inside a path, crashes because of inadvertent path flight caused by driver diversions, weakness, or driving affected by other means could be stayed away from. An issue of finding path markings or limits out and about the surface with information of the street structure is known as lane detection [2] – [4]. Vision-based path identification frameworks include the utilization of at least one adjusted cameras watching out of the front windshield. Data as video or a picture grouping are obtained, after which they are examined to remove includes that intently compare to the ideal path markings. Lane detection has applications like blind spot detection, LDW (Lane Departure Warning), and lane bobbing detection. Because they firmly depend on path indicator as a basic structure for their evaluation of the circumstance. Also, it is a principle requirement of crucial modules for self-guided vehicle which empowers it to autonomously move on streets in heavy traffic situations [5] – [8].

The lane detection comprises of the confinement of explicit natives, in numerous frameworks, for example, street marks of the marked streets [9]. Different difficulties such as stationary and dynamic vehicles, poor line quality, tree shadows, structures and different autonomous vehicles, more honed bends, sporadic path shapes, combining paths, compositions and different markings on the street, surprising asphalt materials and divergent slants cause issues while detecting the lanes. It has been a dynamic explore on lane detection and huge assortment of calculations of different portrayals, recognition and following strategies, also, models are put forward [10].

Numerous methodologies are connected to detect the lanes that could be either based on feature or based on modal [11-12]. The techniques that are based on distinguish paths by features that are of lower level such as lane markings [13-15]. The techniques based on components are profoundly reliant on fully visible path checks, and experience the ill effects of feeble lane marks, commotion and impediments. The display built for a scenario may not suit in another. This makes the technique less versatile. Also, for better calculation of model parameters, an iterative error correction calculation ought to be connected and that is similarly tedious [16]. Not only the camera but also the processor that calculates and determines the lane plays an important role. However the load on the processor can be minimized by using methods such as Probabilistic Hough Transform [18].

In this paper, MATLAB is used. The paper starts with the assumption that the distance between adjacent vehicles is 2 meters so that the input images are cropped accordingly to focus on the region of interest. The input video is read in the first step. It is then divided into individual frames. As a result a huge number of individual images are obtained. This ends the video processing part. Next follows the image processing part wherein the individual frames are cropped, processed to binary image and Canny filter is applied. The final part is the lane detection which has the process of applying Hough Transform to obtain the line parameters. The whole process of lane detection algorithm follows the procedure as shown in figure 1.

II. VIDEO PROCESSING

The input, in this method, is given in the form of video. A video file in turn consists of several individual frames. So the first part of this paper deals with the technique of reading video file and then dividing it into individual frames resulting in thousands of image files. Both these steps are accomplished using a single function that is *VideoReader* function.

All the frames within the video file are extracted by the function *VideoReader* using Frame Extraction algorithm. Using read method individual frames from the buffer memory are read one by one and are saved to the directory. The outcome of all the images will be saved to the secondary memory. Consider 'n' is the number of frames, independent of the video length, then it results in 'n' number of individual images which are saved in memory. Sometimes this may lag the performance because many a time all the frames are not necessary. This is due to the fact that differential coefficient of adjacent frames is negligible. The adjacent frames are almost insignificant. This is because there is no much difference to be pointed out. As a result the information extracted from adjacent frames will be a replica of the previous one. The broad Input /Output (I/O) activities that are subsequently performed before the significant frames so obtained seem to destroy the frames of the system. Figure. 2 shows the single frame of the input video file.

III. IMAGE SEGMENTATION

The previous part results in numerous individual frames of images. These images consists of all the objects captured using the camera during the motion. All the information provided by the image is not necessary for the purpose of lane detection. So the individual images or frames has to be segmented. Segmentation includes cropping the image to obtain the region of interest, grayscale conversion and finally image binarization.

3.1 Cropping

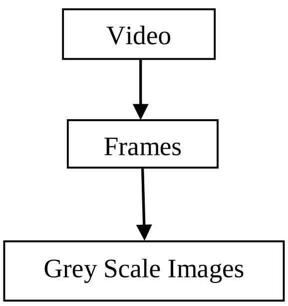
Cropping is the process of removal of unwanted regions from a complex image for the purpose of easy analysis. Before processing the image with color conversion techniques such as grayscale conversion and binarization it is important to focus the region of interest. The input image is of high resolution with large length and breadth including not only lanes but also other cars, trees, signboards, etc. The necessity of cropping is to remove these unwanted portion in image. A manual cropping is done in this method. In MATLAB, a function 'imcrop' is used for cropping out the unwanted regions. Figure 3 shows the cropped image.

3.2 Grayscale Conversion

Grayscale conversion is the process of conversion of color images into grayscale images. The RGB image has to be converted to grayscale before binarising. Color images are combination of three colors red, green and blue. In general, each and every pixel of the image is coded with a specific number representing the intensities of those three colors. When this color image is converted into grayscale image, it gets converted into an matrix of values ranging from 0 to 255. Typically '0' is taken as black and '255' is taken as white. Thus these values represent the brightness in corresponding pixels. In MATLAB, a function 'rgb2gray' is used for the conversion of color images to grayscale images. This function generates grayscale values using the weighted sum of the R, G and B components. Luminance algorithm [17] is used in grayscale conversion which is based on the equation (1).

$$Y = 0.2989 * R + 0.5870 * G + 0.1140 * B \qquad (1)$$

Where R, G, B represents the value of red, green and blue components respectively. Figure 4 shows the grayscale image of the cropped image.



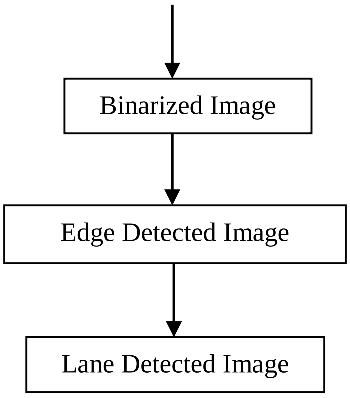


Figure 1: Lane detection Block diagram

3.3 Image Binarization

Binarization is the process of conversion of grayscale image into black and white image. Black and white image is called as binary image because each pixel of the image is represented either by '0' or by '1'. Generally '0' represents black and '1' represents white. In MATLAB, a function 'im2bw' is used to convert the grayscale images into binary images. This function utilizes thresholding technique wherein the values above the threshold value are converted to '1' and those below the threshold value to '0'. This process removes most of the objects present in the grayscale image and enhances the lane markings. Figure 5 shows the binarized image.

3.4 Edge Detection

Edge detection is the process of detecting the edges in a given image. Therefore this process is added to detect the edges in the binary image obtained. Since the binary image is devoid of many edges, edges can be easily determined in this process. In MATLAB, a function 'edge' is used for detecting edges from the images. Though there are many algorithms available for edge detection, like Sobel, Prewitt and Robert methods, this paper makes use of the Canny method. Figure 6 shows the Canny filter applied image.

IV. LANE DETECTION

The previous part results in a image with thin lines that represent the detected edges. This edge detected image is processed in this part to get the line parameters for lane detection. There is a decent quantity of algorithms available for line detection. Some of them are determination of line parameters from points using least square method, detecting the line parameters using the Harr-like characteristics, using Hough Transform to obtain the line characteristics, etc. Due to its robustness and tolerance in the scenario of false line detection the method of Hough Transform stands unique. Moreover this method can also detect lines with breaks [18]. These points make the reason so strong to use Hough Transform in this paper.

In MATLAB, a function 'Hough' is used to apply Standard Hough Transform to the images. Hough Transform works on the following principle: the image space and parameter space possess a point-line duality. This can be harnessed to transform the line in image space to Hough Transform parameter (ρ, θ), in the parameter space. Thus maximum value points can be identified in the Hough Transform parameter space. These are then used as line parameters to detect the lanes.

Equation (2) represents a line in polar form.

$$\rho = x \cos \theta + y \sin \theta \qquad (2)$$

Where 'ρ' represents the perpendicular distance of a line from the origin, 'θ' represents the angle, measured clockwise from positive abscissa, of the projection of 'ρ'. A pair of ρ and θ is sufficient to determine a line. By using Standard Hough Transform ρ and θ values for each and every point in the image are determined. The output of this Standard Hough Transform will be a matrix with values, in their rows and columns that correspond to ρ and θ respectively. Figure 7 shows the image with detected lanes. Figure 8 shows a result of Hough Transform.

Figure 2: Single frame of the input video file

Figure 3: Cropped Image

Figure 4: Greyscale Image

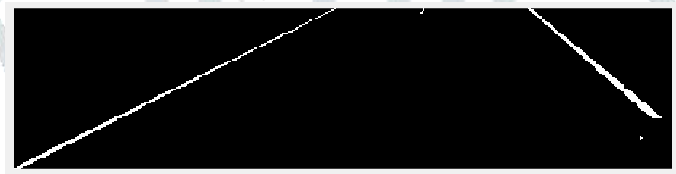


Figure 5: Binarized Image

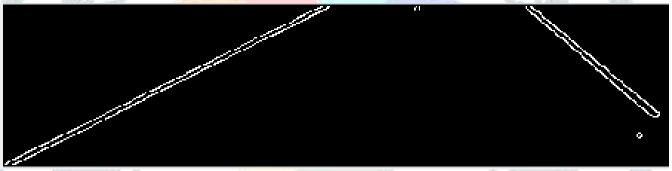


Figure 6: Canny filter Image

Figure 7: Lane Detected Image

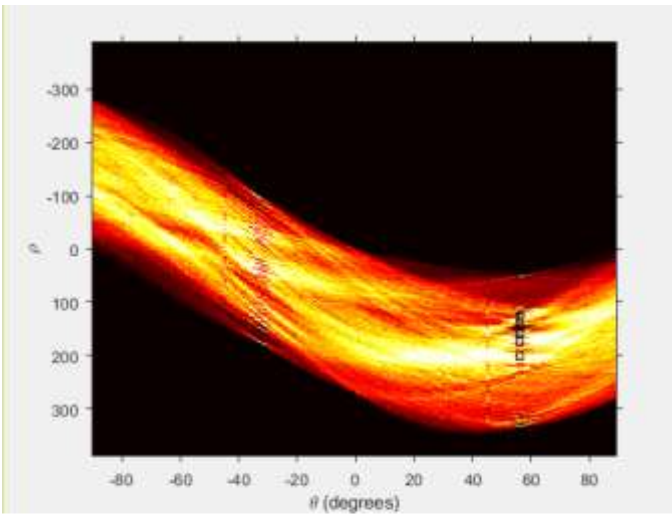


Figure 8: Result of Hough Transform

V. CONCLUSION

When a computer with Intel i7-5500U processor working at 2.40 GHz, 8 GB RAM and operating on 64-bit windows OS is used for a video of length 330 seconds containing 8173 frames, it took about 4480.64 seconds to complete the lane detection process. The advantage of this method is the usage of Hough Transform which is one of the best methods for lane detection. It is also robust to false lane detection.

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