Algorithm for Lane Detection Using Python

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Abstract. Images of the lane given as an input to the algorithm, which will provide information about the lane and the Environmental condition which will be analysed by algorithm inorder to support the driver. The type of lane or the structure of the lane can be a type of information provided by algorithm. While Lane analysis the algorithm will completely ignore the useless information (such as surrounding area of lane or background) and will completely focus on the Lane. Only the lane lines will be the region of Interest in the LDS. The developed system can surely reduce the complexity of vision data and will meet the real time requirements. Based on the problems encountered in detecting objects by autonomous vehicles an effort has been made to demonstrate lane detection using Open CV library.

1 Introduction

As vehicles are increasing day by day, the density of the traffic is also increasing. And as traffic is increasing the road accidents tend to increase. You cannot prevent the accidents completely or all of a sudden bring the accidents to zero, but the upcoming technologies have the potential to bring the accidents level somewhat close to zero (not exactly zero). The safety Advanced driver assistance systems which include lane departure warning (LDW) along with Lane Detection System can help will definitely help the driver or more technically warn the driver if any obstacle comes in the middle of the road or even when the vehicle is diverting from the following path. Exiting the lane without following proper rules is the root cause of most of the accidents on the avenues. Inadequate quantity of paint used for marking the lane boundaries makes it hard for system to detect the lanes with accuracy and other reasons can include environmental effects like shadows from things like trees or other automobiles, or street lights, day and night time conditions, or fog occurs because of invariant lightening conditions. These factors causes problem to distinguish a road lane in the backdrop of a captured image for a person.

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After the investigation, in the complex traffic environment where vehicles are numerous and the speed is too fast, the probability of accidents is much higher than usual. As the computational power is increasing various sophisticated Algorithms can be developed in-order to prevent such mishap. The future algorithm can be developed to keep a constant eye on the lanes while driving. Further an Algorithm can be developed to successfully track the lanes even in the most challenging environmental conditions such as (foggy, night-time, extreme sunny etc.) There should be feature in the system which automatically joins the crooked lanes (within the system) so that the vehicle won't get confused and shall pass the crooked lane lines. This can be done using the Hough Transform method.

Lane detection is a hot topic in the field of machine learning and computer vision and has been applied in intelligent vehicle system. The lane detection system comes from lane markers in a complex environment and it is used to estimate the vehicle's position and trajectory relative to the lane reliably. The lane detection task is mainly divided into two steps: edge detection and line detection.

2 Literature Review

M. Dhana Lakshmi et al. [2012] [1] in this paper an algorithm is used to detect white and yellow colored lane stripes which are present on the road. This algorithm was executed real time. The lane detection method was robust and effective in finding the exact lanes by using both color and edge orientations. The color segmentation procedure identified the yellow and white colored lanes followed by edge orientation in which the boundaries was eliminated, regions was labeled and finally the lanes was detected. The height of the cameras was positioned in such a way that the image captured by the camera can be cropped as per the required (x,y) co-ordinates, due to which the lane marking becomes more and more accurate and efficient.

Dan Levi [2011][2] Road Segmentation is suitably more easier and efficient than LIDAR. Global positioning like GPS and IMU certainly benefits on-board lane sensing. Google, the data available on google is certainly very large which can be used to detect the traffic prone areas nearby or globally.

Ma.B.Lakshmanan [3]: Detection of lane as well as pavement at the same time using various sensors (IEEE).Machine Learning techniques can be adapted to obtain more accurate results. AS a large 'TRAINING SETS' can be gathered for free of cost via from open source internet which can be further used to train the computer. Road Segmentation is showcased as a parameter in Bayesian Network.

Shen et al. [2012] [4] discussed about how to locate the positions of the road lane in real time. During or throughout this algorithm only 1 camera has been used. The algorithm worked in five steps. Initially edge detection was done to find all present edges from road image as road line required was included in it. Canny edge detection technique has been used in order to detect the edges of the lane lines on the road. A priority and orientation based searching method has been used for enhance and label potential lane segments from edge map, degrading unwanted edge features. Based on results from search, a linking condition was used to assemble matched segment that further strengthen the confidence of the potential lane line. Finally a cluster algorithm was used to localize the road-lane lines.

Cuong Le et al. [2012] [5] discussed the task of finding the pedestrian lanes that are indicated by painted markers for the vision impaired people. Left right lane

boundaries have been defined in the algorithm so as to track whether the vehicle is running on the right track. By combining color and local intensity information, this method detected correctly pedestrian marked lanes in different illumination and weather conditions (sunny, cloudy, strong shadows, times of day). This method has also been evaluated and compared with existing approaches. It has been found that the potential of the method in challenging environmental conditions.

Yassin Kortli [2016] [6] discussed lane detection results under various lane conditions. Experimental result shows satisfactory performance with an average detection rate of 97.84% under various illumination condition for straight lanes and 93.6% for curved lanes, which is better than the lane detection rate achieved by gradient distribution feature method. The successful detection rate is 94%. The algorithm focuses on the real time driving challenges i.e. traffic illuminations and external climatic conditions. Various images had been tested and the accuracy comes out to be as 94%. MATLAB programming has been used in-order to reach out to detect lane lines perfectly in this algorithm.

Abdulhakam.AM.Assidiq [2008] discussed [7] In this paper a real time based lane detection algorithm based on video sequence taken from a vehicle driving on highway was proposed This system's algorithm performs image segmentation and remove the shadow on the road. This Algorithm works perfectly fine for straight lanes. But fails to give the desired output for curve lanes. Hough transform is used for Lane lines detection.

Chang Yuan [2016] [8] In this paper a road segmentation and lane detection algorithm based on normal map has been described. Unlike the deep learning methods need to be trained on large data sets. This algorithm specially focuses on dealing with the complex illumination and dense traffic. This method can successfully remove the interference of buildings and vehicles on the basis of a higher precision depth map, and it also can be used to avoid collision on unstructured rural roads. Hough transform and vanishing point are combined to jointly identify lane boundaries. Experiments results shows that the Algorithm Works perfectly fine under various challenging conditions.

Stephen Schestedt [2007] 9] In this paper robust particle filter based algorithm for the lane marking detection. The algorithm runs in real time and is able to pick up any number of lanes. Paper addressed the most difficult lane marking detection problem . The algorithm was tested with several gigabytes of data sets captured by testable vehicle CRUISE. The data are logged in three different computers synchronized via Ethernet.

Wu et al [10] Proposed an algorithm in which the Lane warning system operates @600MHz processor which detects the lane marking line. The main benefit of this algorithm is that it uses 600MHz processor which gives beyond satisfactory result and the efficiency of the Lane warning System is quite good. As the vehicle switches on to the another Lane the Driver is warned and the vehicle speeds slows down

Dajun Ding et al. (2013) [11] proposed an algorithm based on road ROI determination for detecting road region using information of vanishing points and line segments. The Useless info which was present in the image was analyzed in a region of interest (ROI) in-order to reduce the computational work for the computer. Hough Transform is used for detecting line segments. Road ROI is determined automatically in every frame. This method works effectively in various road conditions. The foggy and advanced climatic conditions changes had been taken care of, which is of extreme

importance. Failure of Lane detection system in such a advanced climatic conditions may lead to accidents or even death of an individual.
N. Phaneendra et al. (2013) [12] 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.
ZhiyuanXu et al. (2009) [13] This algorithm discussed about CLAHE which is usually adopted to totally remove the FOG effect. This method firstly converts the image pixels into gray. By making use of such method can result in reducing the noise in image up to a certain level which simultaneously result in increasing the efficiency.
Wang Jian et al. (2013) [14] Confirmed that when a particular seed point is selected and is correct, both the efficiency and the accuracy of this particular method of road region extraction boosts up and is very high. This method can identify lane region exactly. But if the selected seed points are completely wrong the efficiency of this method gets affected and the accuracy decreases steadily as compared to when the selected seed points are correct. In this paper, the deficiency of this method is improved. This method can result in to decrease the useless information up to some extent while identifying process. The Lane identification algorithm and lane departure warning algorithm achieved a good experimental results from speed and recognition rate.
Jeng et al [15] Came up with a real time Lane detection using mobile phone, which is quite handy in use. This Lane detection Algorithm used 2-D Gaussian smoothing filter and Edge detection.
Crao.T Aghajan [2009][16]: Discussed about the Turn Assist with the help of GPS and using training Sets , Deep Learning , Multiple Lane Detection.
Wu.S Chiang H. Pemg [2008] [17]: Discussed about Lane Centering keeping the car in the middle of lane and warning the driver if the car leaves the lane. Warning can be a vibrating Sound. Rasmussen. C . Korah [18]: Discussed Full Autonomous driving for cross country driving. Autonomous driving in the non-paved area. Path detection in case of off-road driving.

3 Methodology

x

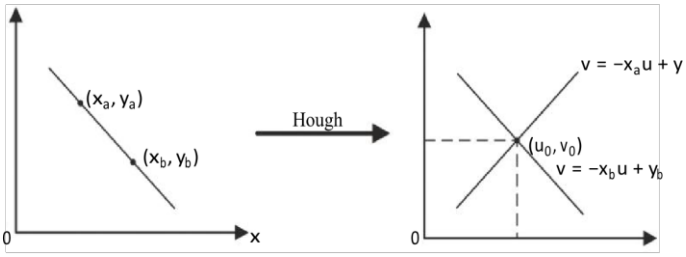

Figure1:(a) Figure1:(b)

Fig. 1. Hough transform. (a) A line in a Cartesian coordinate system and (b) spatial parameters after Hough transformation.

3.1 Hough Transform

The Hough Transform is a extraction technique used in computer vision and Image analysis. The purpose of this technique is to find imperfect instances of objects by voting procedure. Hough transform is mainly used in Image processing to detect the edges (i.e. Edge Detection) of a particular Image. Hough Transform is used for edge linking.

Classical Hough Transform was concerned with the identification of Lines in images , but later The Hough Transform was extended to finding positions of arbitrary shapes , most commonly circles or ovals. even elliptical.

Simplest case of Hough transform is detecting straight lines, Generally straight lines are represented as $y = mx + c$, but for the computational purpose Normal form of Lines is used $r = x \cos(\theta) + y \sin(\theta)$, where r is the distance of the line from origin , and the line connecting the origin with the closest point.

Given a set of two points a line can be drawn and we can calculate r and θ for that line. All the collinear points will give the
same (r θ) value as calculated in the first line. All the points on the same line will intersect each other at same (r, θ) in (r θ) plane.

So the problem of finding collinear points is converted into concurrent sinusoidal curves. The final result obtained from the Hough transform is that we will get a 2d array with matrix with one dimension is r and the other one is representing θ.

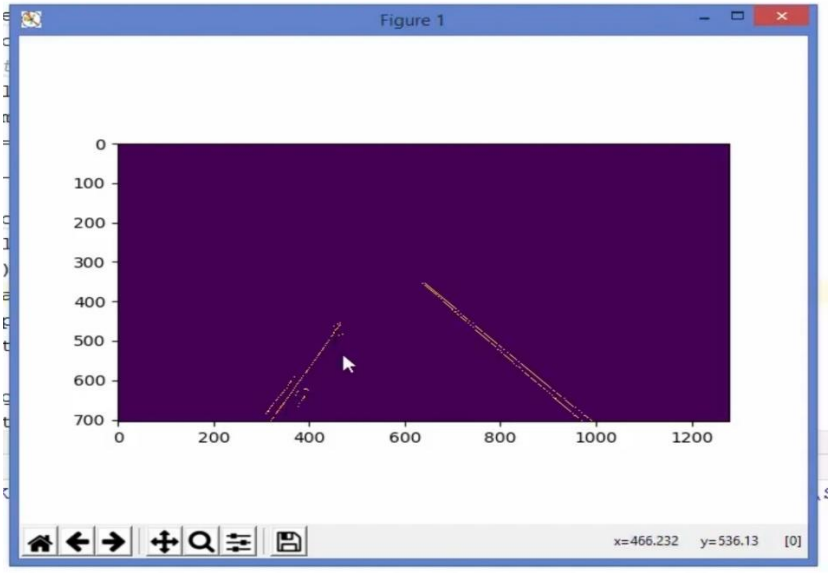

Fig. 2(a). The Hough Line Transform applied to Lanes.

Fig. 2(b). The Final Output.

3.2 Canny Edge Detection Technique

The canny edge detection is an edge detection technique that uses many algorithms to detect the varieties of range of edges in images. Canny is one of the most popular edge detection technique. It was developed by John F Canny in 1986. The main aim of the canny Edge Detection is to detect or identify the boundaries of any object inside the image. A detection is used to try and find regions in an image where there is a sharp change in intensity.

Canny edge Detection algorithm is composed of 5 steps:

1. Noise reduction
2. Gradient Calculation
3. Non-maximum suppression
4. Double threshold
5. Edge Tracking by hysteresis

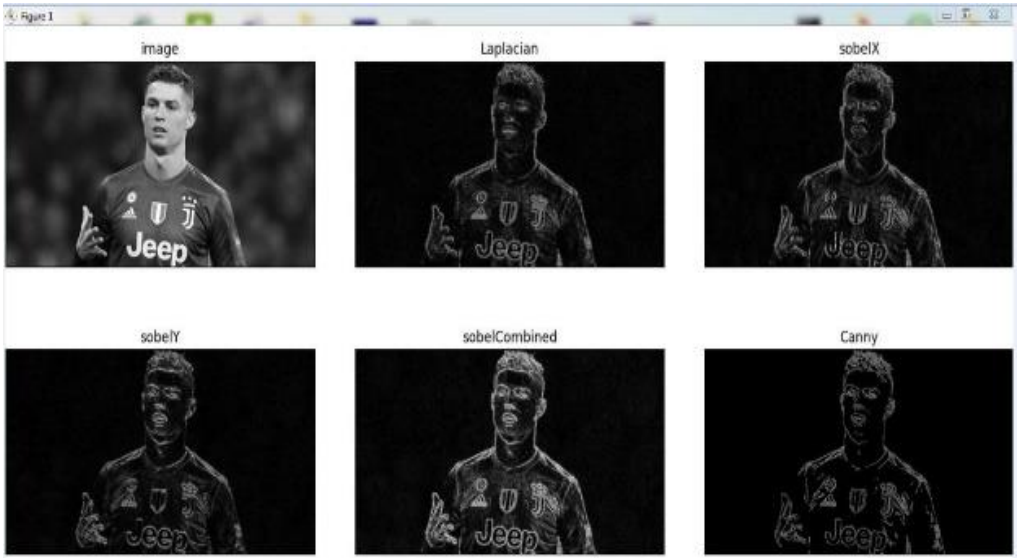

Fig. 3(a). Canny Edge Detection of Sample Image

(We used Canny Edge Detection concept to detect the edges in out road image.)

Fig. 3(b). Actual Image

Fig. 3(c). Copy of Original image converted to Grayscale.

3.3 Region of Interest

The dimensions of the image is so chosen that the road lanes points are covered and which is our region of interest. A mask of an image is created which is of same dimensions that of a chosen image whose lane are needed to be detected. The masked image would be an array of all zeros. Filling the triangular area in the mask with intensity of 255 due to which the region of interest dimensions are white. By using a Bitwise AND operation with canny edge detected image which will result in final region of interest.

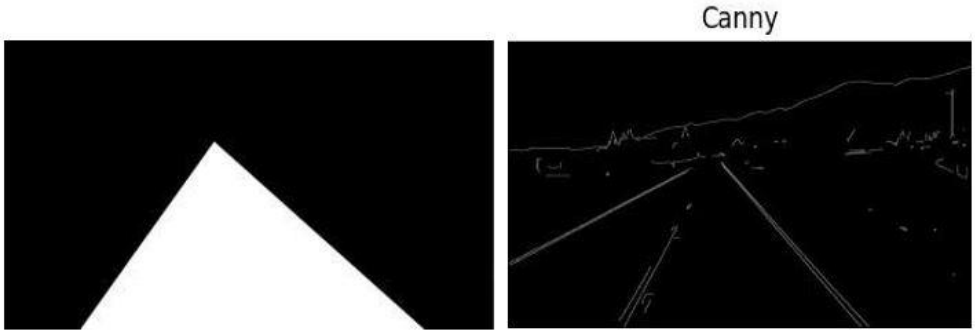

Fig.4(a) Masked Image

Fig.4(b). After canny Edge Detection

3.4 Equations and mathematics

Following are the equations that were used in order to plot the Straight line for the computation of lanes on the road.

$$y = mx + c \quad (1)$$

$$r = x\cos(\theta) + y\sin(\theta) \quad (2)$$

x

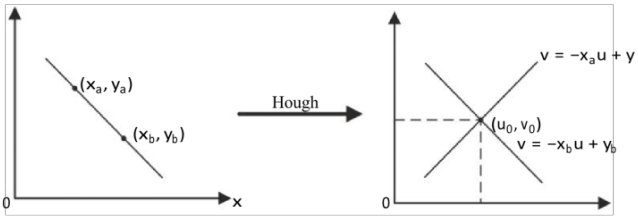

Figure1:(a) Figure1:(b)

Hough transform (a) A line in a Cartesian Co-ordinate System, and (b) Spatial parameters after Hough Transformation

4 Results

Figure 5(a) is an Input image obtained by plt.imshow(image), plt.show() code. By observing closely to the image in figure 5(b) the values on the x –axis goes from 0-1200 and on y axis values go from 700-0 in reverse fashion (because in matplotlib the values on y axis goes in reverse fashion). Our algorithm is going to mask the surrounding area and only focus on the lane in particular, for us the opposite lane is also an obstruction so we will mask the opposite lane too. So in Figure5(b)we can see that the image is now masked excluding our region of interest(lane).

Now we have to find out the edges so for that we first need to grayscale the image. The cropped image is converted in grayscale image by using cv2.color_RGB2GRAY.Then we applied canny edge detection onto the grayscale image (see Figure 4(b)).To draw the line onto the lanes Hough Line transform technique comes into the picture. We have drawn the lines on the blank image and then merged the image with the lines onto the original image.

As shown in the figure5(c) we get the lines on the image which the signal for the detection of the lane has been detected. As shown in the figure 5(c) the program completely neglects the surrounding and focuses on the lane.
Though there is a drawback that the program's accuracy decreases as the lanes curvature increases i.e the program wont be able to detect if the lane becomes more and more round. Majority of our work is based on the straight lane images i.e curved lane images has been ignored. The effect of fog in lane detection has also been ignored.

Figure 5(a): Initial stage

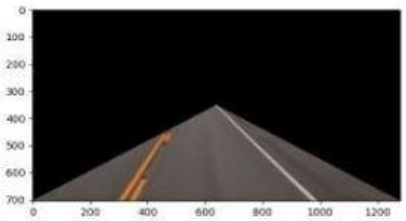

Figure 5(b): Intermediate stage . Focusing on ROI

Figure 5(c):Final stage. The lanes have been highlighted in fluorescent color.

5 Conclusion

In this algorithm we have used Open CV library and Canny edge detection function so as to detect the edges on the Image so chosen. Then we used the Hough Transform technique to detect the straight lines in the image and identified the lane lines. By using Hough Transform and Canny Edge detection functions we have drawn the lane lines on these lanes. The Hough Transform technique is only applicable or will provide successful result unless and until the lanes are straight, if the curvy lanes are to be determined then unfortunately Hough transform may fail to give the desired result.

References

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