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Apply Canny Detector and Hough Transform For Lane Tracking by Autonomous Type Vehicles

Gurpreet Kaur[1*], Deepinder Kaur[2]

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Abstract: In this Research we are using canny detector and Hough Transform algorithm for Lane detection. In this research Hough Transformation is use for Find all the edge points in the image using any suitable edge detection scheme and Canny detector for is to detect sharp changes in luminosity (large gradients), such as a shift from white to black, and defines them as edges, given a set of thresholds.

Keywords: edge detection, histogram, time complexity, accuracy, lane detection.

I. INTRODUCTION

In today's world, vehicles are the essential need of every human being. Vehicle's technology is improving day by day by using latest experiments like LIDAR-RIDAR in which we get to know about the nearer instruments, vehicles near our car or vehicle or we can say it protect the vehicle from accidents. As other things like phones our vehicles are going to be smart these kind of vehicles we called autonomous vehicles.

Autonomous type of vehicles is also called Robot car, driverless car or vehicles. Autonomous vehicles that can guide itself without any kind of human conduction. This kind of vehicle has become a concrete reality and may pave the way for future systems where computers take over the art of driving.

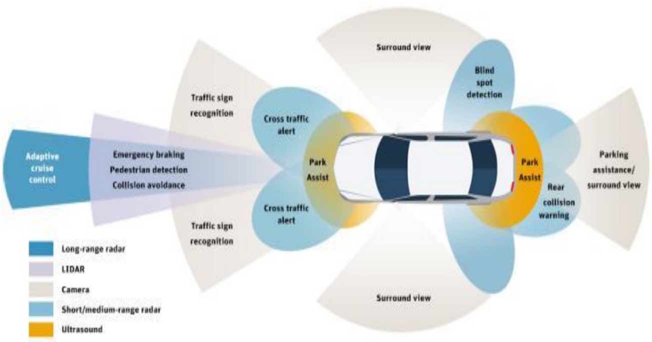


Figure 1 autonomous vehicle using LI][‘AR

1.1 Benefits of Autonomous vehicles:

Autonomous vehicles emit the low CO_2. In a recent study, experts identified three trends that, if adopted concurrently, would unleash the full potential of autonomous cars: vehicle automation, vehicle electrification, and ridesharing. By 2050, these "three revolutions in urban transportation" could:

- Reduce traffic congestion
- Cut transportation costs by 40% (in terms of vehicles, fuel, and infrastructure)
- Improve walk ability and livability
- Free up parking lots for other uses (schools, parks, community centers)
- Reduce urban CO_2 emissions by 80% worldwide

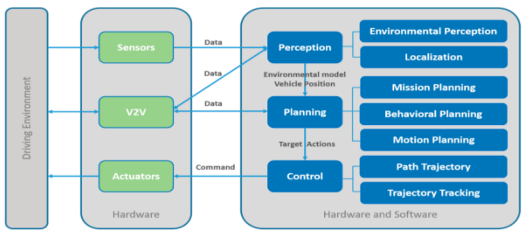


Figure 2 driving environment of autonomous vehicle

1.2 CHALLENGES IN AUTONOMOUS TYPE VEHICLES:

There are some challenges that are facing when we are using autonomous cars to detect the lane or we detect the lane on the road:

(i) Lidar and Radar: Lidar is expensive and is still trying to strike the right balance between range and resolution. If multiple autonomous cars were to drive on the same road, would their lidar signals interfere with one another the range is not enough to produce the mass production in autonomous cars.

(ii) Weather Conditions: What happens when an autonomous car drives in heavy precipitation there is a layer of snow on the road, lane dividers disappear. Then tracing of lane on road by camera or sensors it is impossible.

(iii) Accident Liability: Autonomous cars will not have a dashboard or a steering wheel, so a human passenger would not even have the option to take control of the vehicle in an emergency

1.3 TECHNIQUES FOR LANE DETECTION:

There are different lane detection algorithms, available such as such as B-snake; Histogram based segmentation, Edge linking and Hough transform

1. B-Snake: i) The CHEVP (Canny/Hough Estimation of Vanishing Points) algorithm has been developed to initialize the B-snake. The road is assumed to have two parallel boundaries on the ground, and in the short

horizontal band of image, the road is approximately straight.
ii) As a result of the perspective projection, the road boundaries in the image plane should intersect at a shared vanishing point on the horizon.

There are following five processing stages.
- Edge pixel extraction by Canny edge detection.
- Straight Lines Detection by Hough Transform.
- Horizon and Vanishing Points Detection.
- Estimate the mid-line of road and the parameter k by the detected road lines
- Initial the control points of the lane model to approach the mid-line detected by last step.

2. HOUGH-TRANSFORM: The Hough transform (HT), named after Paul Hough who patented the method in 1962, is a powerful global method for detecting edges. It transforms between the Cartesian space and a parameter space in which a straight line (or other boundary formulation) can be defined:
The steps are as follows:
- Find all the edge points in the image using any suitable edge detection scheme
- Quantize the (m,c) space into a two-dimensional matrix H with appropriate quantization levels.
- Initialize the matrix H to zero. 9
- Each element of H matrix, (,) H mi i c , which is found to correspond to an edge point is incremented by 1. The result is a histogram or a vote matrix showing the frequency of edge points corresponding to certain (m,c) values (i.e. points lying on a common line).
- The histogram H is thresholded where only the large valued elements are taken. These elements correspond to lines in the original image.

1.3.2.1Advantages and Disadvantages :
The advantage of the Hough transform is that the pixels lying on one line need not all be contiguous. This can be very useful when trying to detect lines with short breaks in them due to noise, or when objects are partially occluded.
As for the disadvantages of the Hough transform, one is that it can give misleading results when objects happen to be aligned by chance. This clearly shows another disadvantage which is that the detected lines are infinite lines described by their (m,c) values, rather than finite lines with defined end points.

3. HISTOGRAM BASED SEGMENTAION:
Histogram based segmentation is basically a region growing segmentation, where the growing is done based in histogram characteristics. This is one of the most important steps in the algorithm, and most of the computational savings are obtained from this step. It is assumed that in the lower scan lines of the image the only object present is the road. This is true in most situations of interest (driving on a highway in relatively good conditions and with no obstacles too close to the vehicle).

1.4 LANE DETECTION APLLICATION
The Lane Detection Algorithm supports various applications:
(1) **Lane departure warning** – give a warning when the vehicle is crossing the lane without any warning signal.
(2) Lane keeping assists – once the vehicle is crossing the lane unintentionally, automatically steering torque implemented to stop the vehicle from exiting the lane.
(3) Lane centering – In this, the steering wheel is always in control to keep the vehicle in the lane centre. This application is a crucial component in autonomous driving systems.
There are different lane detection algorithms, available such as such as B-snake; Histogram based segmentation, Edge linking and Hough transform

Canny Detection Algorithm:
Canny edge detection is a multi-step algorithm that can detect edges with noise supressed at the same time.
1.Smooth the image with a Gaussian filter to reduce noise and unwanted details and textures.

$$g(m,n) = G_\sigma(m,n) * f(m,n)$$

Where

$$G_\sigma = \frac{1}{\sqrt{2\pi\sigma^2}} exp\left(-\frac{m^2+n^2}{2\sigma^2}\right)$$

2. Compute gradient of $g(m,n)$ using any of the gradient operators (Roberts, Sobel, Prewitt, etc) to get:

$$M(n,n) = \sqrt{g_m^2(m,n) + g_n^2(m,n)}$$

and

$$\theta(m,n) = tan^{-1}[g_n(m,n)/g_m(m,n)]$$

3. Threshold M:

$$M_T(m,n) = \begin{cases} M(m,n) & \text{if } M(m,n) > T \\ 0 & \text{otherwise} \end{cases}$$

where T is so chosen that all edge elements are kept while most of the noise is suppressed.

4. Suppress non-maxima pixels in the edges in M_T obtained above to thin the edge ridges (as the edges might have been broadened in step 1). To do so, check to see whether each non-zero M_T(m,n) is greater than its two neighbors along the gradient direction $\theta(m,n)$. If so, keep $M_T(m,n)$ unchanged, otherwise, set it to 0.

5. Threshold the previous result by two different thresholds T1 and T2 (where T1<T2) to obtain two binary images T1 and T2. Note that T2 with greater T2 has less noise and fewer false edges but greater gaps between edge segments, when compared to T1 with smaller T1.

6.. Link edge segments in T2 to form continuous edges. To do so, trace each segment in T2 to its end and then search its neighbors in T1 to find any edge segment in T1 to bridge the gap untill reaching another edge segment in T2.
The Canny Detector is a multi-stage algorithm optimized for fast real-time edge detection. The fundamental goal of the algorithm is to detect sharp changes in luminosity (large gradients), such as a shift from white to black, and defines them as edges, given a set of thresholds. The Canny algorithm has four main stages:

A. Noise reduction: As with all edge detection algorithms, noise is a crucial issue that often leads to false detection. A 5x5 Gaussian filter is applied to convolve (smooth) the image to lower the detector's sensitivity to noise. This is done by using a kernel (in this case, a 5x5 kernel) of normally distributed numbers to run across the entire image, setting each pixel value equal to the weighted average of its neighboring pixels.

$$\mathbf{B} = \frac{1}{159}\begin{bmatrix} 2 & 4 & 5 & 4 & 2 \\ 4 & 9 & 12 & 9 & 4 \\ 5 & 12 & 15 & 12 & 5 \\ 4 & 9 & 12 & 9 & 4 \\ 2 & 4 & 5 & 4 & 2 \end{bmatrix} * \mathbf{A}$$

Gaussian kernel.

B. Intensity gradient

The smoothened image is then applied with a Sobel, Roberts, or Prewitt kernel (Sobel is used in OpenCV) along the x-axis and y-axis to detect whether the edges are horizontal, vertical, or diagonal.

$$Edge\_Gradient\ (G) = \sqrt{G_x^2 + G_y^2}$$

$$Angle\ (\theta) = \tan^{-1}\left(\frac{G_y}{G_x}\right)$$

Sobel kernel for calculation of the first derivative of horizontal and vertical directions.

II.LITERATURE REVIEW

In this chapter we will discussed about the previous techniques that used by some different researcher by using different techniques of algorithms:

1.**Sertap et.al[2019]** researched that the lane tracking of a road by using prototype autonomous vehicle by using digital image processing which only detect the lane in clear whether or we can say this type of technique only direct detect the lane. The accuracy and reliability of detected lane is very low.

2. **Narapareddy Ramarao et.al[2019]** researched an algorithm for autonomous vehicle with vision-based system. This Algorithm described here combine grey value difference and texture analysis techniques to segment the road from the image, contour processing algorithms used to produce road boundaries. This system is economical not feasible its cost is very high.[2]

3. **Farid Bounini et.al[2015]** researched an algorithm which detect the lane using RGB color detection. In this research it direct the edges and direct lane of road by using RGB color lane. But sometimes it is very difficult to detect the lanes by using color. The time complexity of this algorithm is very high.[3]

4. **Abdulhakam.AM.Assidiq et.al[2008]** showed a vision based research technique for Road detection. This technique only detects the roads but it is show complexity of lane on the road. This is the major drawback of this research.[4]

5. **Swaroop Darbha et.al[2018]** researched a algorithm which worked on vehicle to vehicle communication on road. This research depends upon the velocity of the vehicle. And only detect the front vehicles on the roads rather than the lane or back vehicles.[5]

III. PROBLEM FORMULATION

In existing technique there are some problems showed in lane detection like Lidar is expensive and is still trying to strike the right balance between range and resolution. If multiple autonomous cars were to drive on the same road, would their lidar signals interfere with one another the range is not enough to produce the mass production in autonomous cars. There are some other problems like Weather Conditions. In proposed technique we try to improve the lane detection by using Hough transform and kalman filter.

3.2 OBJECTIVES

1. Study and exploration lane detection by using the autonomous vehicles.
2. Study of different methods for lane detection in digital image processing
3. Development of a novel Algorithm for lane detection using HOUGH TRANSFORM and apply CANNY DETECTOR .
4. Implementation of the proposed Algorithm and compare the accuracy and noise reduction of previous research with our enhanced algorithm.

IV. RESEARCH METHODOLOGY

To implement the proposed methodology by using various step:

1. Select the dataset.
2. Find missing attributes.
3. Generate the histogram of the lane tracking from different directions.
4. Apply the HOUGH TRANSFORMATION.

5. For enhancement, apply the CANNY DETECTOR.
6. Show the enhanced Lane detection.

V. RESULTS AND EXPERIMENTS

For Removing the lens distortion coefficients were ignored, because there is little distortion in the data. The parameters are stored in a cameraIntrinsics (Computer Vision Toolbox) object.

camIntrinsics = cameraIntrinsics(focalLength, principalPoint, imageSize);

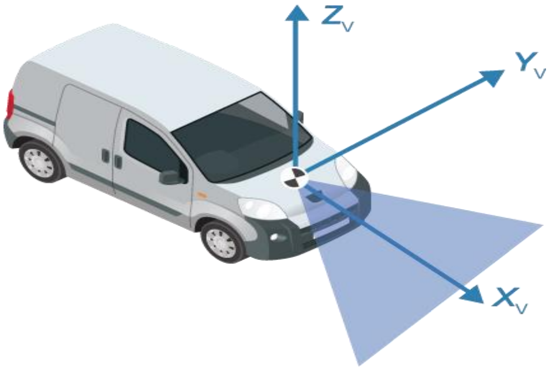
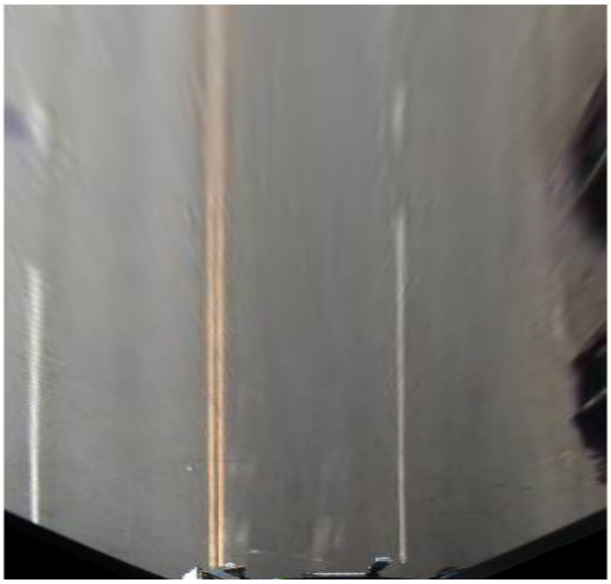
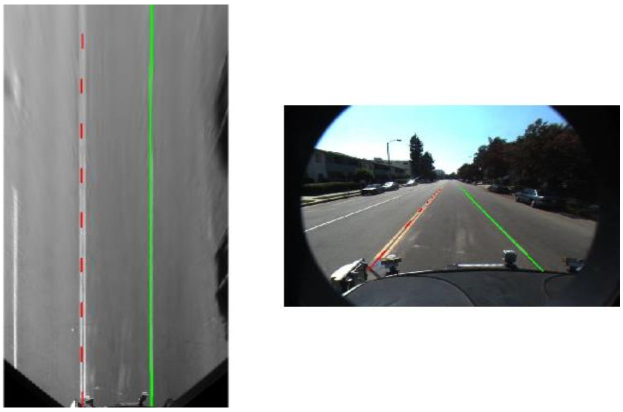


Figure 5.1
Step 1: Load a Frame of Video

Step 2 Create Bird's-Eye-View Image



3. Determine Boundaries of the Ego Lane



4. Locate Vehicles in Vehicle Coordinates

VI. CONCLUSION

Autonomous vehicles will not completely replace human drivers in the foreseeable **future**. However, they are likely to have a large impact in specific areas, such as urban ridesharing and long-haul freight transportation.Business Insider Intelligence reports that roughly 10million **cars** with **automated** navigation technology will be on the road in 2020. McKinsey has predicted that roughly 15% of automobiles sold in 2030 could be fully **autonomous**.

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