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Advanced Driver Assistance System for Autonomous Vehicle

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ABSTRACT

Autonomous vehicles are increasing day by day and have become more important as several techniques and sensors being applied for vehicle control. Autonomous vehicles, Intelligent and Advanced Driving Assistant Systems are promising and reliable solutions to enhance road safety, traffic issues and passengers' comfort. As increasing safety of the people and reducing road accidents and thereby saving lives is one of important concern in the context of Advanced Driver Assistance Systems. The most complex and challenging task of autonomous vehicles is road lane detection and road boundaries detection. Lane detection is the most difficult problem because of the varying road conditions. Such applications require advanced algorithms that demand powerful computers with high speed processing capabilities. Keeping intelligent vehicles on the road until it reaches its destination, remains a great challenge in some cases, particularly when someone is driving at high speed. The very first task in autonomous vehicles is the navigation that is based on system vision which will acquire RGB images of the road for advanced processing. The second task is the dynamic controller of the vehicle according to its position, speed and direction. In this paper we did the survey of various approaches and the algorithm techniques.

Keywords : Advanced Driving Assistant Systems, lane detection, Autonomous road vehicles.

I. INTRODUCTION

At present, the number of vehicle owners is increasing and the cars with autonomous driving function have attracted more and more attention. Self-driving vehicles are expected to outnumber conventional vehicles by 2050, most of them capable of autonomous driving at all times. Fully self-driving vehicles projected to hit widespread adoption by 2035 . Society of Automotive Engineers (SAE) classifies full automation as vehicles able to (a) Complete a journey from point A to point B without any input from the driver beyond setting the destination, (b) Drive at least as well as an average person, on any road, adhering to all the traffic laws of its time and (c) Handle any extreme situation without the driver taking over, thus foregoing the need to include any manual controls, i.e. a wheel and pedals.

With the demand on reducing traffic accidents, congestion, energy consumption and emission Autonomous Driving technology has been recognized as one of the promising solutions to these critical, social and environmental issues. In real time lane detection system for autonomous vehicles, a lane detection and changing system is to warn and notify the vehicle driver when the vehicle is about to cross the lane and its dedicated path without the signal to turn. These terms are designed in such a way that it can reduce accidents, traffic and other circumstances where the driver is not paying attention or is distracted by phone call or other things. These mechanisms are totally beneficial for road management and traffic controlling at a greater part. In this paper, we have introduced a computer vision-based technique that can perfectly detect the lanes in any suitable environment. Since most lanes on the road have clear lines whereas most of them are straight lines so that it is easy to detect the lanes and the lane detection technology for proper roads has reached a high milestone during these recent years. However, due to irregular surface and curved shape of the roads, and the unstructured roads are vulnerable to light, shadow, water and other factors that result in poor detection performance.

One of the earliest and most widespread adaptations of lane detection is in lane departure warning systems. The component alerts the driver when the car starts steering outside the lane, be it for the reason of drivers getting distracted or sleep deprivation. It is especially useful on highways where the monotony of driving may exacerbate inattention. Out of 13.5 lakh people who die each year in road accidents globally India accounts 1.5 lac deaths. According to the crashes caused by human factor including speeding, distractive driving alcohol and other behaviours take up to 93% of total crashes. By minimizing the involvement of human operation Autonomous vehicles have the potential to reduce car crashes.

II. PROBLEM DOMAIN AND MOTIVATION

As mentioned previously, the most appealing feature of self-driving cars is the ability to transport passengers and/or cargo, from point A to point B, autonomously in a safe manner. In order to achieve this goal, the vehicle should have some form of road following system, traversing through both rural and busy urban streets while abiding all the existing traffic laws. Two common ways for a car to follow a road, without modifying existing roads or attaching various sensors on other cars, is to either use GPS tracking or machine vision. According to the U.S. government, the accuracy of a GPS tracking unit is approximately 7.8m at 95% confidence level.

Lanes on average are between 2-4m width, so the accuracy of a GPS is not good enough to keep a car within its lane reliably. The other approach, machine vision, would rely on lane markings and other road features extracted from the footage of an on-board camera to enable lane detection and subsequent following. However, lane markings may not be always clearly defined, the camera view may get obstructed by on-road traffic or other obstacles and various weather and light conditions could affect the visibility of the camera.

Nevertheless, this approach provides the most accurate horizontal position of a car within a road and with well-thought algorithms and hardware add-ons, the aforementioned problems can be alleviated or downright eliminated. Ideally, you would use both methods to get to set point B, machine vision and other sensors to keep the car on its lane and avoid obstacles, and GPS tracking to identify the vehicle’s position in relation to the set final destination and derive a path to it.

The lane following discipline also includes intersection scenarios, missing lane markings and obstacles on the road. The parking discipline may also require lane following for the purpose of keeping the car in the middle of its lane.

Lane Detection	Extract and identify observed lane markings correctly.
Lane Following	based on the extracted lane markings or other approximations. The trajectory should lead to the middle of the lane the car is located in.

III. METHODOLOGY

The block diagram of a proposed lane detection system is shown in the figure below:

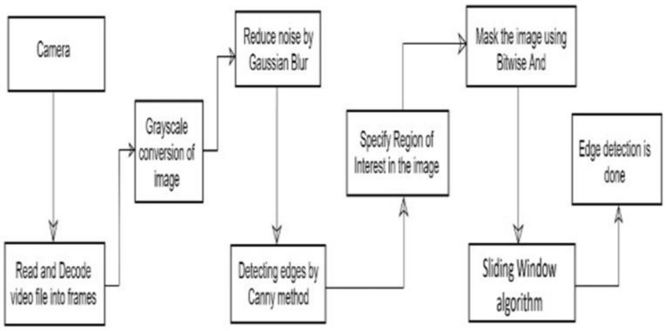


Figure 1: Block diagram of Lane Detection System

Each blocks of a block diagram are explained one by one below:

1. **Capture input image:** Hardware like Camera is used to take input image.

2. **Image Pre-processing:** To enhance the quality of image, we need to pre-process it. The processes like noise reduction, edge detection, contrast and colour management are applied.

3. **Region of interest:** In determining the computational complexity of lane identification and LDI system, ROI plays important role to detect it. Here only the selected are as is detected or taken for the next level of processing. These selected ROI images are then used for lane detection using a proposed algorithm. The selection of ROI reduces the processing time of the frames.

4. **Slide Window Search:** The sliding window algorithm will be used to differentiate between the left and right lane boundaries so that we can fit two different curves representing the lane boundaries.

   The algorithm itself is very simple. Starting from the initial position, the first window measures how many pixels are located inside the window. If the amount of pixels reaches a certain threshold, it shifts the next window to the average lateral position of the detected pixels. If not enough pixels are detected, the next window starts in the same lateral position. This continues until the windows reach the other edge of the image.

5. **Lane Detection:** Here, the Lane will be marked with a separate color. Two important algorithms Canny Edge Detection and Hough Transform are used to implement Lane Detection System which are explained below:

Two important algorithms Canny Edge Detection and Slide Window Search are used to implement Lane Detection System which are explained below:

❖ **Canny edge detection:**

Canny edge detection is a multistep algorithm that can detect edges with noise supressed at the same time. Smooth the image with a Gaussian filter to reduce noise and unwanted details and textures.

The Process of Canny edge detection algorithm can be broken down to 5 different steps:

1. Apply Gaussian Filter to smooth the image in order to remove the noise
2. Find the intensity gradients of the image.

3. Apply non-maximum suppression to get rid of spurious response to edge detection.
4. Apply double threshold to determine potential edges
5. Track edge by hysteresis. Finalize the detection of edges by suppressing all the other edges that are weak and not connected to strong edges.

❖ **SLIDE WINDOW SEARCH.**

Sliding window is one naive but effective approach to detect the objects in the surroundings. What we actually do is, we run a scan over the image and pick parts of it and then we input that portion of the image to a pre-trained classifier to check if it observes in it, what it is trained to observe.

A sliding window approach is used to detect lanes and their curvature. It uses information from previous histogram function and puts a box with lane at the center. Then puts another box on top based on the positions of white pixels from the previous box and places itself accordingly all the way to the top of the frame. This way, we have the information to make some calculations. Then, a second degree polynomial fit is performed to have a curve fit in pixel space. From each peak on the histogram, we initialize windows and then slide them vertically. Each window is horizontally centered in the end of each iteration by its detected pixels inside. Depending on the number of windows whose number of pixels inside requiring a minimum population, we can predict a confidence level of detected line to say if it's a line or not.

❖ **IMAGE PROCESSING**

readVideo()

First up is the readVideo() function to access the video file drive.mp4 which is located in the same directory.

processImage()

This function performs some processing techniques to isolate white lane lines and prepare it to be further analyzed by the upcoming functions. Basically, it applies HLS color filtering to filter out whites in the frame, then converts it to grayscale which then is applied thresholding to get rid of unnecessary detections other than lanes, gets blurred and finally edges are extracted with cv2.Canny() function.

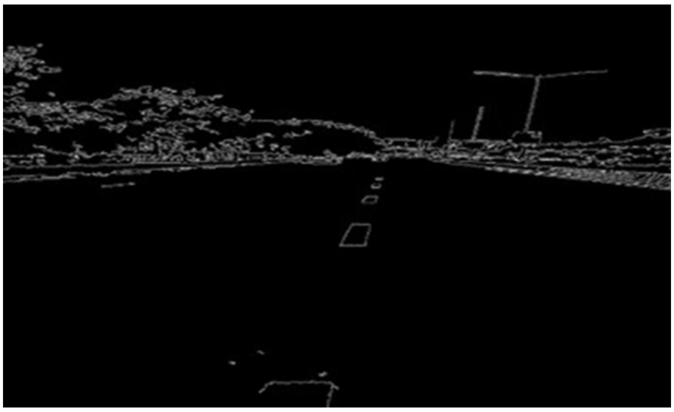
perspectiveWarp()

Now that we have the image we want, a perspective warp is applied. 4 points are placed on the frame such that they surround only the area which lanes are present, then maps it onto another matrix to create a Birdseye look at the lanes. This will enable us to work with a much refined image and help detecting lane curvature.

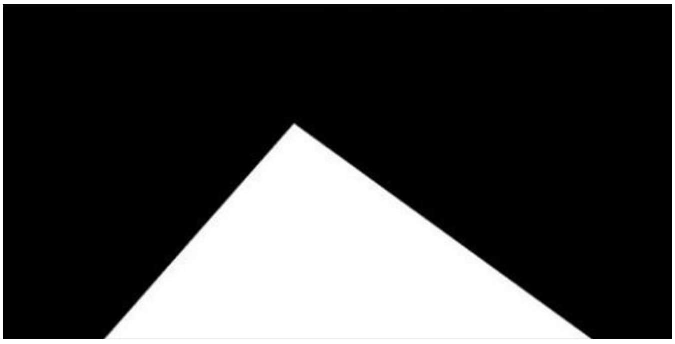
IV. RESULTS

ORIGINAL IMAGE

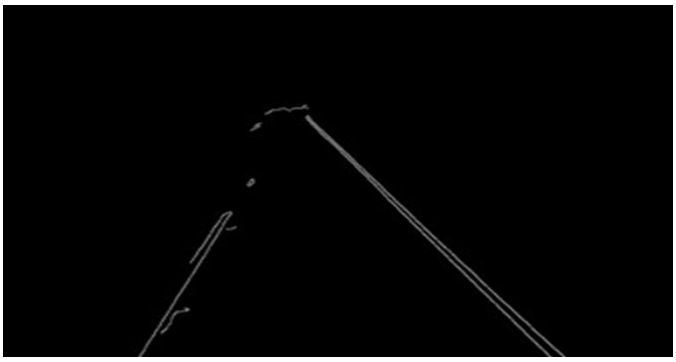
GRAYSCALE IMAGE



CANNY IMAGE



REGION OF INTEREST



BITWISE AND

FINAL IMAGE

V. CONCLUSION

So in this paper we have given the full implementation details of the project Lane line Detection for autonomous vehicles. This project was created to demonstrate how a lane detection system works on cars equipped with a front facing camera. Finding a place in more and more vehicles, this system is an essential part of the advanced driver assistance systems used in autonomous / semi-autonomous vehicles. This feature is responsible for detecting lanes, measuring curve radius or tightness of a curve and monitors the offset from centre. With this information, the system significantly improves safety by making sure the vehicle is centered inside the lane lines, as well as adds comfort if it is also configured to control the steering wheel to take gentle curves on highways without any driver input. This is a simplified version of what is used in production vehicles, and best functions if good conditions are provided clear lane lines, stable light conditions.

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