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Design and Simulation of Vehicle Lane Tracking Using Matlab

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ABSTRACT— ***This paper presents Vehicle Lane Tracking System based on real-time video to track lanes with minimal hardware and software requirements. The proposed system was designed to use low cost cameras and processing power of an on-board commodity laptop. The developed system was tested on different drives varying from a high speed drive on a high way to a low speed drive on the city roads. The system was able to detect the lane markings under various lighting conditions and on many types of roads ranging from unmarked roads to multi-lane national highways. The implemented system has an overall success rate of over 97% for lane detection.***

Keywords— Vehicle lane detection, Lane tracking, Hough transform, Video processing, SIMULINK

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1. INTRODUCTION

The influence of traffic density and the speed of driving play an important role on the driver's perception of the road. It is often observed that on roads with minimal traffic density, drivers tend to ignore lanes and traffic signboards. It is also observed that on roads with heavy traffic density, drivers pay more attention in ensuring a safe drive and less on the signboards. Vehicle Lane Tracking Systems that alert the driver about the lanes and signboards can be of great assistance lane change and signboard alters can prevent accidental changes of lane due to the lack of driver concentration. The alerts about the signboard can give the driver an opportunity to look at the signboards and pay attention to the same during driving.

Vehicle Lane Tracking (VLT) in an automobile is a key component of the Active Safety (AS) system. The main focus in AS is to prevent an accident from happening. Although the term VLT refers to a wide range of systems and functions, the system discussed in this paper focuses on the development of lane detection and tracking system. A video based system is all among many available sensors system meant for this application the main advantage of a video based system is that the amount of data a single camera can capture is much more than what an array of others sensors can do. Another advantage is that with nominal amount of code change, the functionality of the system can be extended.

The accuracy and the dependability of the results of VLT systems are determined by a number of factors like the location of the camera and the vehicle front lighting. This plays a major role especially during evening and night. The camera position too is very critical. If the camera is placed outdoors like on the bumper or on the roof top, then the image quality would greatly be affected by the climatic conditions. Positioning the camera within the cabin is ideal; even here the influence of various factors like the interference of the wipers in the image stream, fog formation on the windscreen and aesthetics need to be considered. Hence most of the manufacturers mount the camera along with the rain sensor.

In this paper, the detection of lane is proposed using Hough Transform and Hough Lines, since it requires less computational time to detect a lane marking over the entire frame .The tracking of the lane markers is done to find the likely location of the estimated lane markers. A simple and yet powerful means of avoiding the interference of the obstacles on the lane identification is to limit the range of the video frame so that only the lower section containing the road marking is considered. The detection of signboards is proposed using different image processing algorithms like Edge Detection, Blob analysis based Template matching.

2. SYSTEM REQUIREMENTS

Although lane tracking is a challenging task, it is essential for autonomous road following and hence there are a plethora of approaches in the literature. Lane tracking can be formally expressed as the estimation of two sets of parameters over time: the vehicle pose with respect to the road and the road structure. A real time video processing based

Vehicle Lane Tracking System can provide the driver with vital information that can reduce the risk of an accident. It is also important to provide only the correct and required information to the driver and only when required. Too much or too little information can both be equally useless. The proposed system should work on real time. The system should be able to identify and track the present lanes. The system should be robust against shadows, jerks movements and other changes in the road surface. The system should be able to detect the shifting of lanes and should be able to notify the lane departure.

3. METHODOLOGY

The following methodology was adopted to develop the system.

3.1 Creation of Input Video Stream

The video containing different road segments under different lighting conditions is captured. The captured video sequence is collated to form a short sequence but with many features from different conditions.

3.2 Definition of Lane Marker Positions

The lane markers and their likely places are defined in the system on the basis of their angle with the reference image plane. These ranges of angle are defined considering the position of the camera in the vehicle and the vehicle relative position to the lane.

3.3 Lane Detection and Departure Warning

The lane change is detected by identifying the change in lane angles. The direction of movement and the likelihood of departure are estimated. The crossing of lane markers triggers the lane departure warning system.

4. DESIGN PROCEDURE

The block diagram of vehicle lane tracking system is shown in Figure 1 and the overall solution is presented in the flowchart image tracking in Figure 2. The lane detection and departure warning is implemented using the methodology shown in the flowchart of Figure 3 and vehicle lane tracking system flowchart is shown in Figure 4.

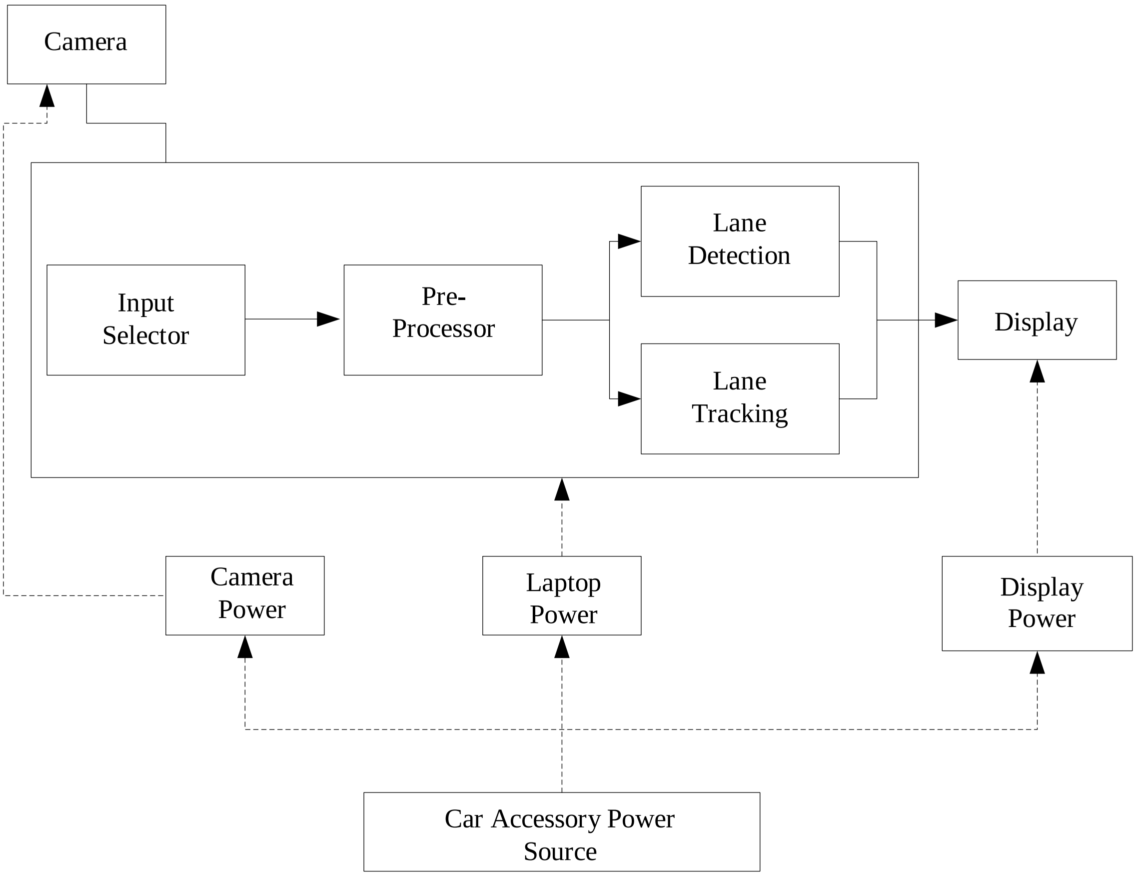

Figure 1: Block Diagram of Vehicle Lane Tracking System

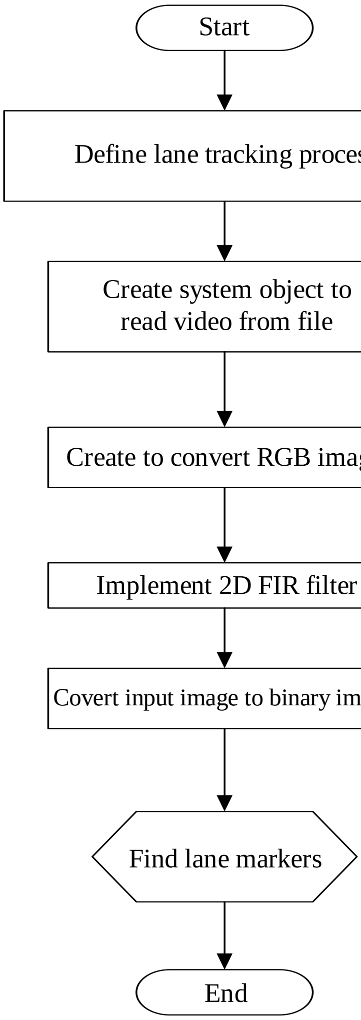

Figure 2: Flow Chart of Image Tracking System

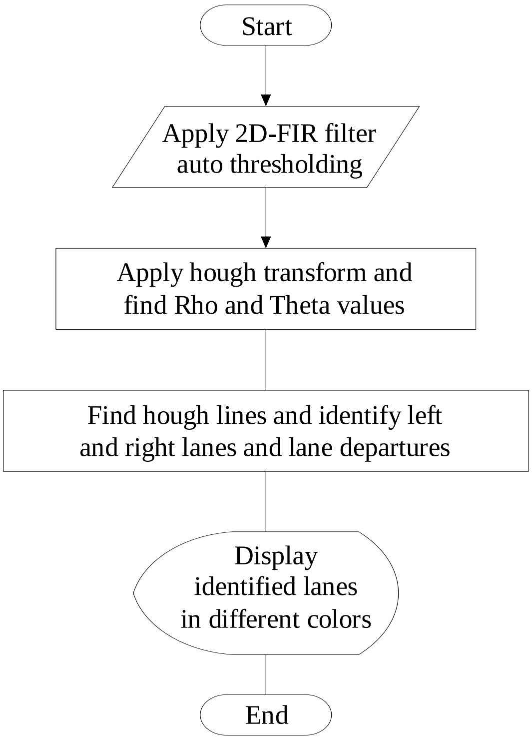

Figure 3: Flow Chart of Lane Detection System

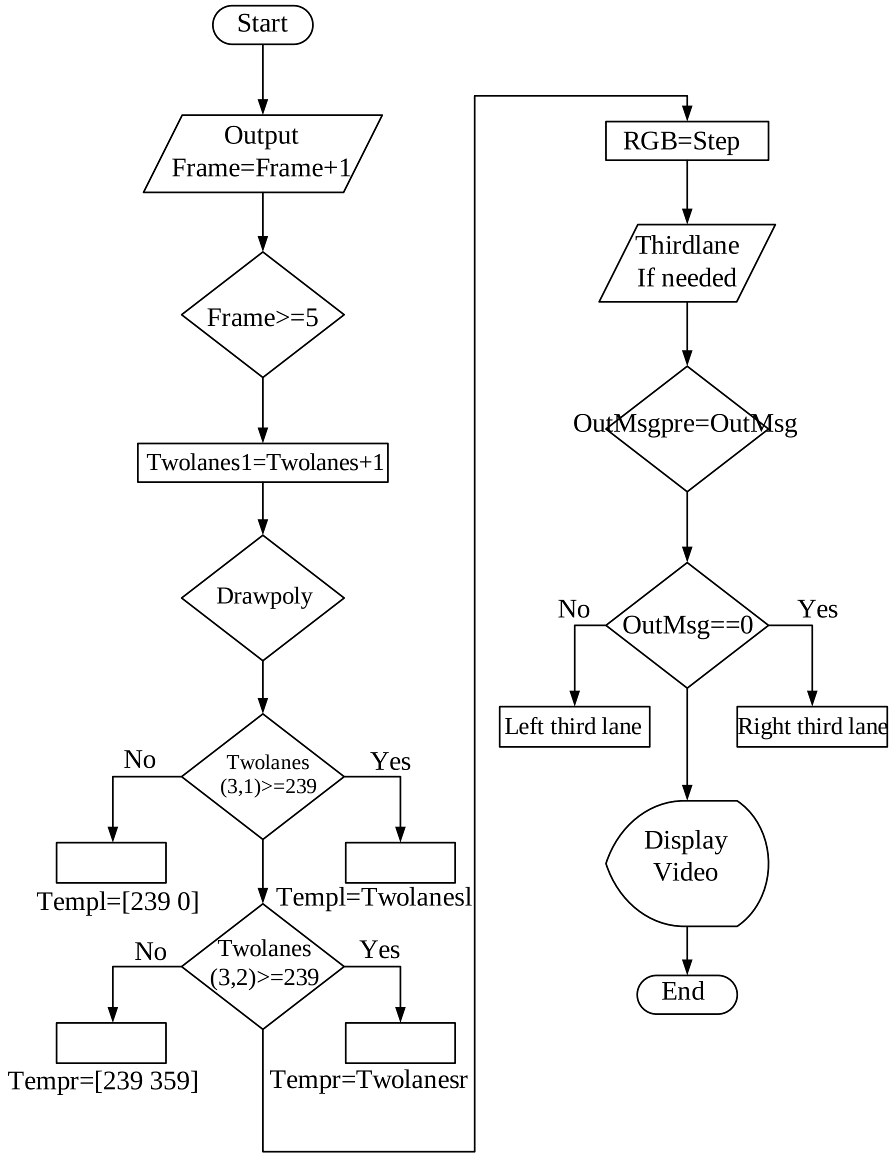

Figure 4: Flow Chart of Vehicle Lane Tracking System

5. SYSTEM DESIGN

The subsystems for performing the pre-processing and processing operations for lane detection is designed individually and integrated. The system was developed using MATLAB/Simulink.

5.1 Pre-processing of Lane Detection System

In the pre-processing section the image is resized to meet the system requirement. Since it is essential to have the flexibility to have different video sources as input, it's essential to have the ability to rotate and resize the image. In order to reduce the processing time the input frame is divided into two sub frames. The frame is divided such that the lower half of the frame where most of the road is visible is used for lane tracking and the rest is used for the sign detection.

The equalization is done by applying a 2D FIR filter. The filter removes most of the noise and spurious interference of the shadows. Since the applied filter is a two dimensional filter, the filtering is done once along the columns and then along the rows of the input image. The auto thresholding operation is performed on the filtered image. Such that the overall luminance is normalized this converts the input grayscale image to binary image. This helps in identifying lane markers under various lighting conditions.

6. RESULTS AND DISCUSSION

The system was tested on different drives varying from a high speed drive on a highway to a low speed drive on city roads. The overall success rate of the designed system with regard to lane detection and departure warning is around 95%.

6.1 Analysis of Results

As can be seen from the result tabulations the percentage of faulty detection of lanes is very less. The detection rate depends greatly on the lighting conditions. It uses a passive stereo camera pair mounted on the dashboard of the vehicle to capture 60Hz video images of the driver's head. These images are processed in real-time to determine the 3D position of matching features on the drivers face. The features are then used to calculate the 3D pose of the person's face (±1mm, $\pm 1^{o}$) as well as the eye gaze direction ($\pm 3^{o}$), blink rates and eye closure. The technology has been developed for driver safety systems, particularly driver fatigue and inattention measurement.

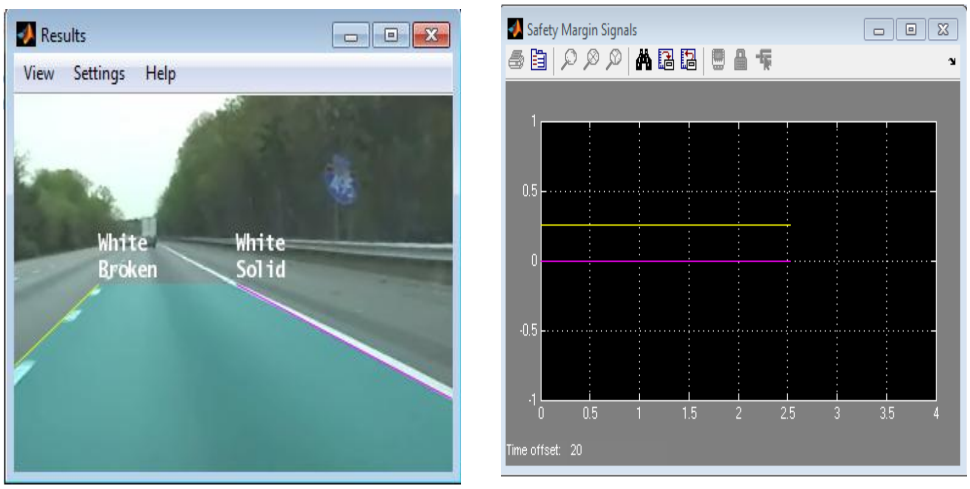

Figure 5: Lane Tracking by the Direction of Center

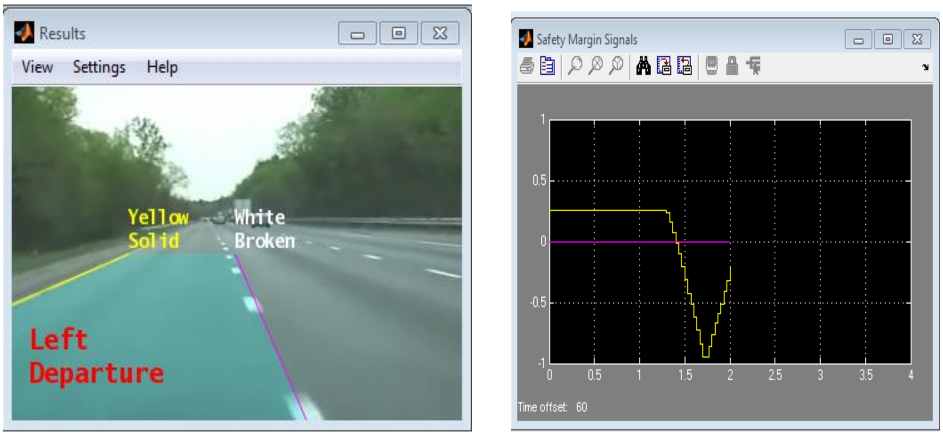

Figure 6: Lane Tracking by Left Departure

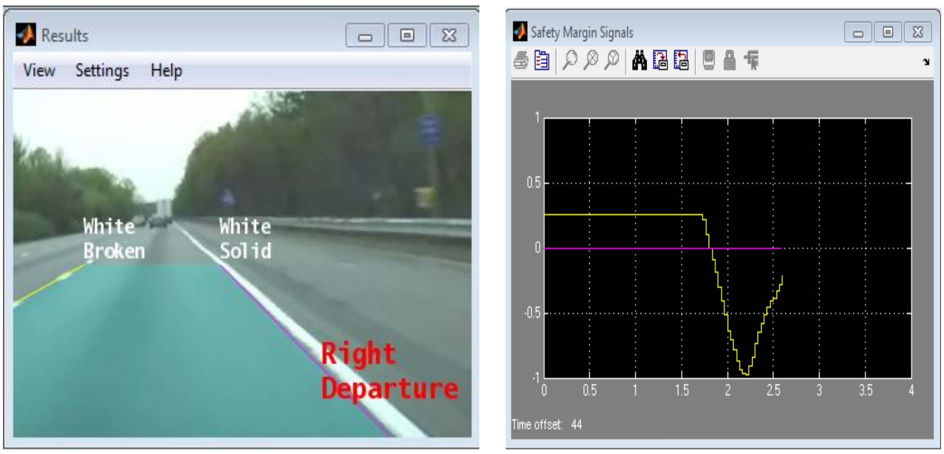

Figure 7: Lane Tracking by Right Departure

6.2 Discussion of Results

From the above results figures, the signal is shown with straight line when vehicle departure to the center road. Then, vehicle has departure at left and right direction of the road, the signal is shown with curves. So, driver can be known about the direction of car. Robustness is an essential characteristic for obvious reasons, but is also desirable with respect to discontinuous changes in road structure that can often occur on moderately structured roads and at road junctions. A real-time system requires the efficient use of computational resources and this is handled at a fundamental level in the distillation algorithm, such that the best statistical result is obtained given the computational resources available. The modularity of the cue processor allows the lane tracker to be extendible while being generic enough to be applied to a variety of tracking problems.

7. CONCLUSION

In this paper, a successful development of a video processing based driver assist system is reported. The system works quite well under most test conditions. It is able to detect the lane marking irrespective of the lane in which the vehicle is present and under different lighting conditions. It also succeeded in detecting and tracking lanes overlapped by shadows or passing vehicles. The experimental data presented in this section is the result of two different versions of the lane tracking system. A prototype was originally implemented in MATLAB to test the detection and tracking algorithm and to develop a suite of cues. Lane detection and cue performance were characterized during this stage.

8. ACKNOWLEDGEMENT

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