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Survey on Real Time Road Lanes Detection of Autonomous Vehicles

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ABSTRACT

Autonomous road vehicles are increasingly becoming more important and there are several techniques and sensors that are 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. An increasing safety and reducing road accidents, thereby saving lives are one of great interest in the context of Advanced Driver Assistance Systems. Apparently, among the complex and challenging tasks of future road vehicles is road lane detection or road boundaries detection. However, lane detection is a difficult problem because of the varying road conditions that one can encounter. Such applications require advanced computer vision algorithms that demand powerful computers with high speed processing capabilities. Keeping intelligent vehicles on the road until its destination, in some cases, remains a great challenge, particularly when driving at high speeds. The first principle task is robust navigation, which is often based on system vision to acquire RGB images of the road for more advanced processing. The second task is the vehicle's dynamic controller according to its position, speed and direction. In this paper we survey the approaches and the algorithmic techniques devised for the various modalities over the last 5 years. We present a generic break down of the problem into its functional building blocks and elaborate the wide range of proposed methods within this scheme.

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

I. INTRODUCTION

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, actors that result in poor detection performance. Therefore, the unstructured and irregular road lane detection technology is still in the research phase. The main deadlock in the implementation of such mechanisms is the prediction of problems which has two of the following factors: road lane assumption and obstacle assumption (i.e. vehicles and hurdle objects) detection. In this mechanism study we consider the first. Colour of road and texture, boundaries of roads, and lane markings are the main considerable criteria for human driving process. Semiautomated and fully automated vehicles are expected to share the same road and path with human drivers and therefore are most likely to rely continuously on the same assumed path that humans follow. While there can be different infrastructure assuming human drivers and vehicles like lane marks for humans and some kind of vehicle-infrastructure communication for vehicles it is unethical to expect the huge investments required to construct and maintain such infrastructures and road mechanisms, with the associated risk in mismatching and misguided marking .Road and lane presumption through the traditional ways remains therefore the most likely path for autonomous driven vehicles. Roads and lanes understanding includes detection the extent of the road, the number and position of lanes, merging, dividing and ending lanes and roads, in cities, villages and highways scenarios. Although there has been much progress in recent years, this type of understanding is beyond the reach of current detection systems. There are many detection modules used for road and lane understanding and detection, including monocular vision which is one video camera, stereo, LIDAR, vehicle dynamics information which is obtained from the car odometer or inertial measurement unit (IMU) with global positioning information obtained from global positioning system (GPS) and digital maps. Vision is the most primary research area in lane and road detection mechanism due to the fact that markings are made for human vision, while LIDAR and global positioning are important complements.

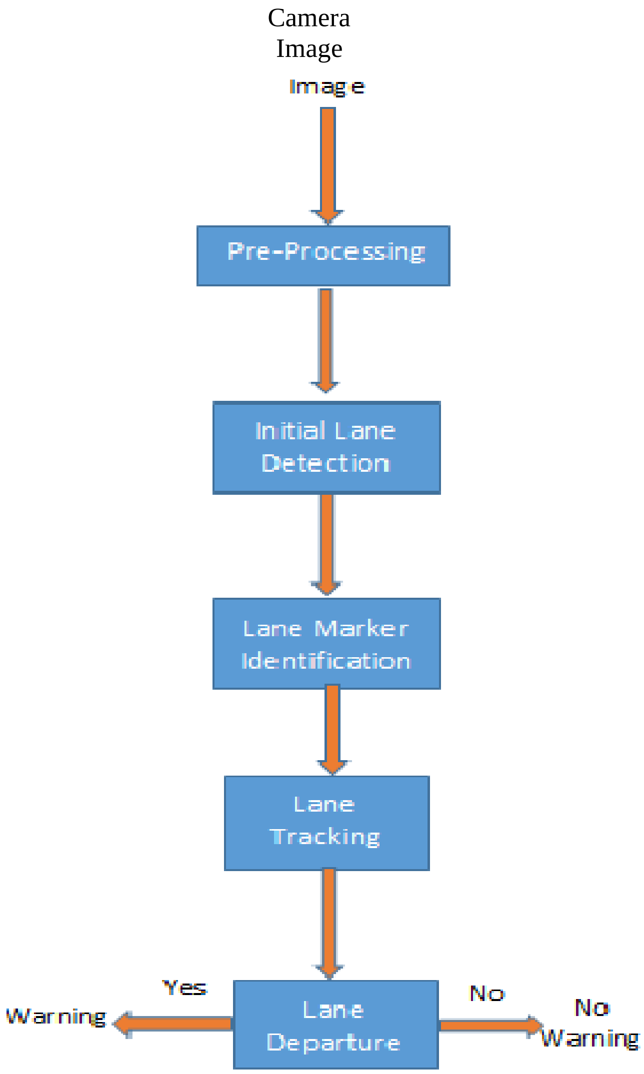


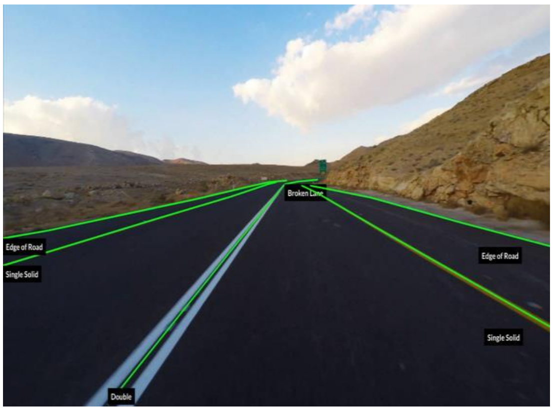
Figure.1. Block diagram of a simple Lane Departure Warning System (LDWS)

II. SURVEY ON LANE DETECTION ALGORITHMS

Optimal straight-line detection is a considerable step for several embedded vision applications, and now the largest research focus is based on the Hough Transform (HT). The straight line detection has been widely used in many industrial applications like image analysis, smart robots, intelligent vehicles, and pattern recognitions. Now a day's we observe that most researchers focused on increasing need for traffic safety systems to reduce the risk of accidents. There are large numbers of vision based systems for vehicle control, collision avoidance and lane departure warning, which have been developed during the last two decades. Recently, many Driver Assistance systems (DAS) are emerging to work in harmony with human drivers, e.g. Forward Collision Warning System (FCWS) and on-board Lane Departure Warning System (LDWS). Such systems can be used to help preventing driver's mistakes and reduce traffic accidents effectively.

Many researchers have worked on lane detection algorithm techniques. Various methods for lane detection algorithm are conferred as follow:

1) Y. Wang, E. K. Theo, and D. Shen introduced lane detection and tracking of Autonomus vehicles using b-snake. Using B-snake technique the lane detection and tracking of vehicles was done without using any cameras parameters. B-Spline can form any arbitrary shape by a set of control points. B-Snake based lane model is able to describe a wider range of lane structures. By using the knowledge of the perspective parallel lines the problems of detecting both sides of lane markings have been merged here as the problem of detecting the mid-line of the lane. This method is robust against noise, shadows, and illumination variations in the captured road images. It is applicable to the dash and the solid paint line roads also to the marked and the unmarked roads.



2) M. Aly proposed a Real time detection of lane markings in urban streets. It is a real time, efficient and robust algorithm in urban streets for detecting lanes. In this algorithm firstly a top view of the road is produced and then it is filtered using various selective which is associated with Gaussian filters. In this algorithm there is a work on the red channel, which gives better images for white and yellow lanes than converting it to gray scale.

3) Kim developed a lane detection and tracking algorithm which is capable of handling various challenging scenarios such as faded lane markers,lightly marked lines, lane curvatures and splitting lanes. Firstly , a gradient detector and an intensity bump detector is used to removethe non-lane markers. Artificial Neural Networks (ANN) is applied on remaining samples for lane detection. The detected lane markers pixels are grouped together using cubic splines. Hypotheses are produced from random set of line segments. RANSAC algorithm helps in validating the hypotheses. In this paper Particle filtering was also used for lane tracking.

4) Yim and Oh developed a three feature based lane detection algorithm. There were various features used in this paper like starting position, orientation and intensity value. Firstly, a Sobel operator is applied to get the edge information. The lane boundary is represented as a vector comprising of the three features. The current lane vector is calculated based on the input image and the previous lane model vector. Two windows, one for each, is used for left and right boundaries. Assuming N pixel in each horizontal line, N lane vector candidates are generated. The best candidate is selected based on the minimum distance from previous lane vector using a weighted distance

5) metric. For equalization each feature is assigned a different weight. Then a lane inference system is used to predict the new lane vector. If the road width changes abruptly, the current vector calculated is discarded and the previous one is taken as current vector.

6) Borkar et al. developed a method based on the parallel nature of lane markers. Firstly the Inverse Perspective Mapping is performed. Then the IPM image is converted to gray scale image. Then the image is filtered using Normalized Cross Correlation. Now find out a collection of straight lines using Polar Randomized Hough Transform .To determine if two lines are parallel lines peaks with identical θ value can be paired. Usually the lane markers are parallel but due to some imperfections in lens, captured image variation in lane marker placements etc. So the constraint of identical θ value needs to be loosened. This can be achieved by applying a tolerance window. The video is tested in real time videos and obtained good results. Common difficulties face in lane detection such as presence of shadows neighbouring vehicles and surface irregularities are greatly reduced in this approach. There is difficulty in detecting worn out lane markers.

III. COMPARISON OF LANE DETECTION ALGORITHMS

Sr.No	Used Method	Advantages	Disadvantages
1.	Lane Detection And Tracking Using B-Snake.	This algorithm is proposed without using any cameras parameters	Processing time depend on the number of edge pixels and pre-specified road model
2.	Real Time Detection of Lane Markers in Urban Streets	It is a real time, efficient and robust algorithm in urban streets for detecting lanes	It does not give well accurate results
3.	Robust Lane Detection And Tracking In Challenging Scenarios	Deals with a lane curvature, lane changes, worn lane markings and emerging, merging, ending, and splitting lanes.	Faulty detection in curvy roads and wrong detection due to shadows
4.	Lanes Detection Based on	algorithm can be implemented	It cannot detect changes in line

	Unsupervised And Adaptive Classifier and pipelining structure	in smart phones	
5.	Hough Transform Algorithm for Lane Detection	It is robust against noise, high speed algorithm	High computational complexity

Table.1 Comparison of different techniques

IV. DRAWBACKS OF VARIOUS PAPERS

1. Gurveen Kaur proposed Lane detection Techniques: Here various techniques such as Canny Edge detector, Hough Transform are used. It is not suitable for various environmental conditions like rainy day, foggy day etc.

2. Farid Bounini, Denis Gingras proposed Autonomous Vehicle and Real Time Road Lanes Detection and Tracking. Here Least Square method, Kalman Filter techniques were used. The disadvantage of this system is it can work for a vehicle with a maximum speed of 70 km/h.

3. M. Aly proposed Real time detection of lane markers in urban streets.RANSAC fitting technique is used in this proposed system. The drawback of this algorithm is it does not give accurate results for the lane detection.

4. Zu Andras F. Cela, Luis M. Bergasa, Franklin L. Sanchez and Marco Aa introduced Lanes Detection Based on Unsupervised and Adaptive Classifier. Hough transform algorithm and Kalman filters are used. The drawback is that it cannot detect the changes in line.

5. Zu Whan Kim proposed Robust Lane Detection and Tracking in Challenging Scenarios. Lane-detection and-tracking algorithm is used in this system. The drawback of this system is there is faulty detection in curvy roads and wrong detection due to shadows.

6. Hyo-Kyun Jeong, Yong-Jin Jeong, and Yi-Fan Lin proposed a design of Hough transform hardware accelerator for Lane detection. Hough transform algorithm is used here. The disadvantage of Hough transform is it has high computational complexity.

V. CONCLUSION

In this review, a detailed analysis of various lane detection and tracking algorithms is discussed. The different methodologies investigated by different authors for lane detection and tracking during the last decade are presented in the paper. Lane detection is important because it is an integral part of autonomous vehicle control system. A survey of existing methods for detection and marking of lanes is provided in this work. The previous methods proposed for detection and marking have several shortcomings. A lane departure warning system and lane marking detection using Hough Transform has been proposed. By incorporating a departure warning system, the functionalities of the lane marking system can be enhanced therefore, further improvements can be done to enhance the results. In the near future, one can modify the existing Hough Transformation so that it can measure both the curved and straight roads. Hough transform can be implemented on FPGA board. FPGA implementation consumes less power also it is very compact and fast.

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