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A Robust Lane Detection Method Based on Vanishing Point Estimation

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Abstract

Although lane detection technology has been developed for decades ,however, many challenging issues remain unresolved. In this paper, we propose a robust vanishing point-based lane detection method. Due to the perspective effect, the two parallel straight lines in 3-D space intersect at the 2-D plane. For the lane line extraction , we use lane shape features to extract lane lines . Firstly, we use LSD (line segment detectors) to extract the straight line segments in each frame of image. Secondly, we use a direction priority search method to remove the most of the interference information. This algorithm makes reference to the directional and shape features of lane lines in 2-D images. Finally, using the remaining straight line segments after filtering out the noise straight line to calculate the vanishing point of the lane line, we use a score function to remove non-candidate lane markings, the score function is constructed using the shape features, direction of the line segments. The experimental results show that the validity and robustness of our new algorithm under complex structured road scenes.

Keywords: lane detection; line segment detectors; vanishing point; direction priority search method; Vehicle Assisted Driving System;

1. Introduction

In recent years, the number of traffic accidents is on the rise[1]. These accidents are often caused by the driver's carelessness or fatigue, the vehicle deviates from its own lane. Lane detection is very important for vehicle assisted driving (including vehicle warning deviation system, vehicle lane change system, etc.) and autonomous guided

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vehicles[2]. With the rapid development of computer and machine vision, the method of lane detection based on machine vision has drawn the interest of scientists and scholars[3] .We have to extract lane boundaries from worn lane markings, various shades, lighting conditions and other external disturbances.

Vision-based lane detection can generally be divided into two categories: feature-based and model-based approaches. Feature-based methods generally use lane line width, edge, color, texture, and gradient features. Since these characteristic information of lane lines generally comes from the pixel level, this leads them to be more sensitive to noise such as various shades and different light intensity. Canny edge detection[4] uses gradient magnitudes to get edge information . The controllable Gaussian filter[5] uses the gradient direction information to extract the edge features. However, the thresholds for getting lane boundaries in these methods need to be manually set . This determines the method does not apply to a variety of scenarios. The model-based approach first chooses the right geometry for the lane. Model parameters were then calculated by Hough Transform (HT)[6-7], least squares or random sample identity (RANSAC)[8-9]. Although model-based approaches are effective for noise and lost data. However, because the model building a scene may not be suitable for other scenarios, they are not well adapted.

Inverse perspective mapping is also a new method of lane detection[10]. It converts 2-D images taken by the camera into 3-D image information. In 3-D images ,the lane lines are parallel and this feature is used to extract lane markings. However, the use of this method also has some disadvantages. Since its transformation matrix needs correction, it must be assumed that the road is flat. Otherwise it will lead to wrong detection. In addition, if there are obstacles on the road, the effectiveness of the map will be reduced.

Therefore, in order to extract the lane mark correctly, In this article, we use the shape and orientation features of lane lines extract the lane markings. LSD is different from other detection algorithms such as edge detection ,it is robustly and accurately extract lane lines under a variety of conditions. The direction priority search algorithm can effectively filter out most of the interference line segments through directional constraints. It can effectively reduce the estimation error of vanishing point. Obtain the dynamic ROI(region of interest) by calculating the estimated vanishing point to further narrow the extraction range of the lane line. In the ROI, we use a score function to calculate the lane markings in each direction through the vanishing point, and the lane mark in the two directions with the highest score as our lane mark.

The flow chart of this paper is shown in Figure 1.

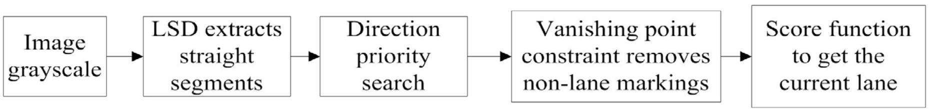

Fig. 1.The flow paper of this article

2. Lane detection algorithm

2.1. Image grayscale

For vision-based lane-line inspection systems, the source of the image data is captured by a vision sensor (CMOS or CCD camera) mounted in the windshield in front of the vehicle. The road image that is usually obtained using a vision sensor is an RGB color image. This paper uses lane shape features and directional features to extract lane lines. Therefore, the color feature information does not make any sense to us, and the amount of data is very large. In this paper, the obtained color image is converted into a grayscale image to facilitate subsequent processing of the image.

Common RGB color image grayscale method is as follows:

$$I(x) = 0.299R(x) + 0.587G(x) + 0.114B(x) \quad (1)$$

The above formula uses the traditional weighted average method. Lane line color is usually white or yellow, the road surface is gray. As a result, we use red and green channel information to expand contrast between lane