

Research on Lane Line Detection and Tracking under Complex Road Conditions

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Abstract

Aiming at the problem that the traditional feature-based and Model-based lane line detection methods have poor robustness in complex environment, and the cost of machine learning method is large, this paper proposes an improved sliding window search algorithm and an improved Soobel algorithm, a lane line detection method based on machine vision specifically for complex environment. In view of the fact that the traditional Hough transform linear detection algorithm cannot deal with the scene where the lighting conditions change dramatically and the curves are too large, this paper introduces a lane line detection technology with better universality and robustness, which is used to deal with the scenes where the light changes dramatically, the shadow of the roadside obstacles and the curves are common in the autonomous driving. A large number of experiments have proved that this algorithm can obtain more accurate and more robust lane information.

Keywords

Lane Line Detection; Machine Vision Improved Sliding Window Search Algorithm.

1. Introduction

With the rise of intelligent driving and the frequent occurrence of traffic accidents, as well as the rapid development of intelligent driving in the past decade or so, a large number of companies and enterprises have joined the industry, and the basis of intelligent driving is assisted intelligent driving, so assisted intelligent driving has a great prospect of development [1]. The occurrence of road traffic accidents not only causes huge economic losses to individuals, families and even the whole country, but also seriously threatens people's personal safety. According to the statistical analysis of traffic accidents by the Ministry of Public Security, about 50% of major traffic accidents are related to lane departure, which in turn is closely related to lane line detection [2]. In this context, in order to ensure the safety of the staff in the car, the lane keeping system is favored by more and more drivers, along with the lane line detection in the lane keeping system has a very large application prospect. The camera calibration, projection transformation, color channel, sliding window and other technologies that will be used in this project have been widely applied in the field of computer vision, promoting the development of science and technology and economy and society. In this paper, the improved sliding window search algorithm is used to obtain more accurate and more robust lane line information.

1.1. Lane line detection and tracking framework

First, a frame of image is passed in, and then the image is preprocessed. Then, the improved Sobel algorithm is used to perform Sobel operation on the preprocessed image in the vertical direction, horizontal direction and diagonal direction respectively, and the edge information is obtained by fusion of them, the lane information is extracted, and the lane line is fitted by cubic curve. Finally, the improved sliding window search algorithm is used to track the lane line, and

the results of the lane line detection are visualized. Figure 1 is the flow chart of the lane line detection and tracking frameworks.

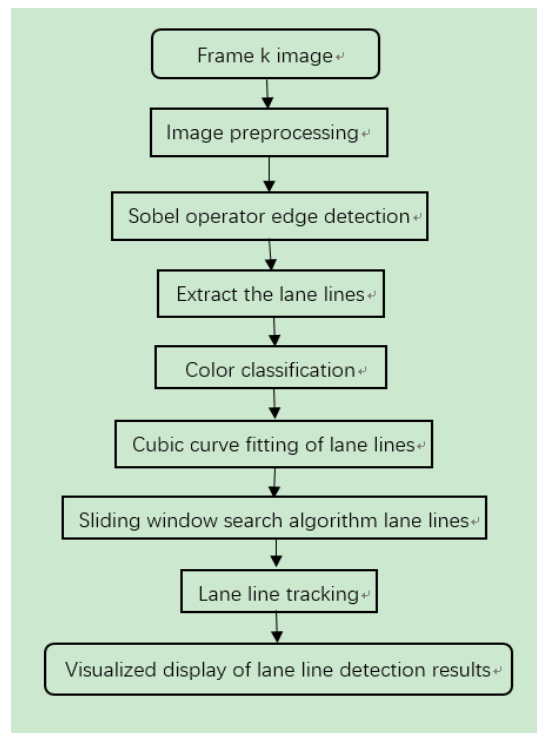


Figure 1. Lane line detection and tracking framework

1.2. Image preprocessing

In the preprocessing part of lane detection, we first need to extract the interested part and filter out the unnecessary part, which can save a lot of time and calculation for the subsequent detection algorithm, at the same time, it can also reduce the noise and improve the detection efficiency. The specific method is to first gray the image and binary processing, and then extract the edge of the lane line, and finally extract the part of the image we need, that is, the part of interest [3].

Based on the principle of perspective transformation, the camera imaging will make the lane lines parallel to each other on the ground intersect at one point in the image, which will interfere with the subsequent work. This phenomenon can be eliminated by using the inverse perspective transformation method [4]. Calculate the projection matrix and the transformed image using the OpenCV function that calculates the projection matrix. In this paper, there are also good recognition results for such complex situations as no shadow, no color shading, small area shadow, straight road from dark to light, no shadow, no color shading, unclear road sign line, large area shadow, dark to light, and dark to dark detour.

1.3. Extraction, detection and tracking of lane lines

In this paper, I propose an improved Sobel edge detection algorithm, which can select the horizontal and vertical extraction, especially the diagonal edge extraction. The image after edge extraction is processed in binary, so that the pixels of lane line and non lane line can be distinguished well. The lateral Sobel edge extraction algorithm can achieve better processing results on the road with obvious light dark alternation caused by the occlusion of trees and houses[5]. However, on the road surface without alternating light and shade, it is not easy to extract the effective lane line. In shaded areas, some noise is introduced even if the rough outline of the lane line can be extracted. When Canny and Sobel edge extraction methods are

not suitable, the color space transformation method is used. No matter how many complex conditions such as light and shade alternations or shadow overlaying occur, lane lines always have yellow and white, so as long as the yellow and white are separated for color detection operation, better results can be obtained.

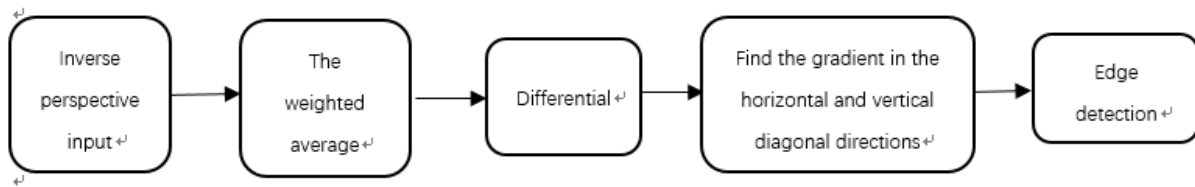


Figure 2. Flow chart of lane line extraction

In the part of lane detection and tracking, the first step is to fuse the noise graph and histogram. The left lane line of the histogram generated by Lane extraction algorithm corresponds to the left half peak value, so does the right lane line. After roughly determining the position of the left and right lane lines, the improved sliding window search algorithm is used to search the left and right lane lines and find the starting point. Taking two starting points as the midpoint of the bottom edge of the window, the abscissa of all the white points in the square is stored, and then the abscissa is taken as the mean value. The column where the mean value is located and the position where the upper edge of the first window is located are taken as the midpoint of the bottom edge of the next window, and the search continues. Finally, the curve is fitted cubic, The curve equation of lane line can be obtained.

2. Results and discussion

In order to better reflect the effectiveness of the lane line detection and tracking algorithm, this paper chose Tusimple consecutive frames and caulane data set as test data, in the video to extract the complex working conditions under different scenarios, the vehicle will be bumpy, lane line is not clear, the road color mutation, complex conditions, such as roadside barriers shadow interference. They are straights with no shadow and color without light and shading, curves with no shadow and color without light and shading, straights with small shadow and color from dark to light, curves with no shadow and road markings that are not clear, curves with large shadow and color from dark to light, curves with large shadow and color from light to dark, Corresponding to 1234567 in the table below. Figure 3 shows the four-lane detection result obtained by the lane line detection algorithm. From the analysis of the results, it can be seen that the lane detection algorithm can accurately fit the corresponding lane lines under various complex driving environments, and its robustness is good.



Figure 3. Visualization results display of lane line

In order to more quantitatively describe the accuracy of lane detection, this paper uses the formula accurate frame to express, accurate frame = (total frame number error frame) / total frame number. Through the comprehensive analysis of a large number of experiments, The average accuracy of the papers was 96 percent.

Table 1. Experimental data of lane detection accuracy

working condition	Total frames	Error frame	Accuracy
1	4052	80	98.02%
2	3634	102	97.19%
3	3138	111	96.46%
4	2953	121	95.90%
5	2816	130	95.38%
6	2134	145	93.20%
7	18727	689	96.32%

3. Conclusion

Detection of lane lines in complex scenes can improve the robustness of lane line detection, the accuracy of lane line tracking, the accuracy of lane curvature and vehicle offset. For complex scenes, the threshold binary image, perspective transformation, extraction of lane line feature points, histogram drawing, polynomial fitting algorithm, using the sliding search window algorithm to detect lane line, lane line tracking. In the process of extracting lane lines, Canny edge extraction algorithm and the improved Sobel edge extraction algorithm are analyzed and compared to get the waiting points of lane lines. Because Sobel algorithm has a poor ability to deal with road shadows and alternating light and shade, and then uses RGB,HSL and LAB color space transformation method, this method can effectively extract lane lines, and also reduce the introduction of noise points. In the process of detecting and tracking lane lines, the improved sliding search algorithm is used to search continuous frames in order to reduce the cases of missing, unchecked and multi-checked, and the results are good.

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