Method of Lane Markings Detection in Real Time

To cite this article: Yali Wang and Ye Tian 2018 IOP Conf. Ser.: Mater. Sci. Eng. 423 012047

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Method of Lane Markings Detection in Real Time

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Abstract. As for the lane detection problem of the aided driving, a fast detection method was proposed in this paper. The lane markings were isolated from background after image preprocessing. Based on the method proposed in the paper, the coordinate values of the lane markings were stored respectively and the corresponding linear equations were fitted. The straight slopes of the lines could be calculated, and as a basis for predicting accurately the direction of the road in front. The lane markings could be detected quickly and be used to detect lane markings in real time.

1. Introduction
Lane markings detection is the precondition of the vehicle assistant driving and automatic guidance. In the research of the lane markings detection, several problems need to be taken into account. Firstly, interference from roadside trees, buildings and sky need to be filtered. Secondly, influence from image noise should be reduced. Thirdly, lane markings should be extracted quickly under the different condition of illumination. Fourthly, what kind of modle should be used to fit the lane markings after extracting the lines. Fifthly, how to predict the road in the front after getting the lane markings equations. As for the lane marking extracting, there were a lot of researches. Homm[1] detected the lane markings using radar sensor. This method was easily influenced by meteorological conditions such as rainwater, snow and sand. Sensor fusion technique[2-4] were used to extract lane markings accurately. This method has high accuracy, however, the internal parts of equipment are complex and have complex connection with various sensors. Hough straightline detection algorithm and Kalman filtering algorithm[5-7] were used to detect lane markings, however, calculation in these methods were complicated and computation time were long which could not satisfy the request of real time. Wendong Cheng[8] categorized lane markings by a straight line fitting method to fit straight lines in area-of-interest dynanically. Wenchao Shen[9] detected lane markings using Hough straightline detection algorithm to get straight line equation. After getting vanishing point of the straight lines, lane markings of all the road could be determined by the vanishing point and prior knowledge.

In this paper, a single camera is used and lane markings can be extracted from the camera images. The straightline equations can be acquired in real time by straightline fitting method and the road in the front can be estimated by straight slopes and vanishing point.

2. Image preprocessing
The ultimate goal of image processing is to get the lane markings, so image preprocessing is necessary based on influential factors from the images to extract lane markings quickly. The image preprocessing consists of the following steps.
2.1 Speckle noise reducing
There are a lot of speckle on the images because of illumination and road potholes. The speckle noise can be reduced by median filtering. If the speckle noise is not reduced, the subsequent image processing will be influenced.

![Figure 1. The images before and after filtering.](image)

2.2 Region of interest extraction
The region of interest in this paper is the road portion of the image except sky area. The road portion is usually in the bottom of the image, so the lower half of the image is used as the region of interest. In the region of interest, some influences need to be eliminated such as skid marks, earth at the side of the road, trees and highway median. The pixel values of all the influences are less than the pixel value of road. So, the pixel values which are less than road pixel value are replaced by road pixel value.

To eliminate the influences is necessary. The skid marks on the road usually appear as gobbets, and after the edge processing the edges of the skid marks cause a big impact on the lane markings. So it is necessary to have road pixel value instead of the skid marks pixel value.

In dealing with the noise, the pixel value of the highway road should be settled in the first place. The part in the middle of the driveway which is shown in red rectangular box in picture 2 is chosen to calculate the road pixel average value. And the average road pixel value is used to replace the pixel values which is less than it in the region of interest. The result where the lower pixel values are replaced is shown as figure 3.

![Figure 2. The region to calculate road pixel value.](image)
3. Lane markings extraction

The image is changed to be gray level from color, and then edge detection is carried out. Because the lane markings are usually vertical, the new edge detection template is proposed in the paper as follows.

\[
\begin{bmatrix}
1 & 1 & 0 & -1 & -1 \\
2 & 2 & 0 & -2 & -2 \\
5 & 5 & 0 & -5 & -5 \\
2 & 2 & 0 & -2 & -2 \\
1 & 1 & 0 & -1 & -1
\end{bmatrix}
\] (1)

Vertical straight lines can be extracted and horizontal straightness can be filtered by using this template, and the result is shown as figure 4.

The lane markings are obvious, but there is a lot of noise. So firstly, the pixel values which are lower than average pixel value of the nonzero pixels are considered as noise and taken away. Secondly, isolated points should be taken away using the template as shown in figure 5. The template can strengthen the center point and points at 45 and 135 degree angles. The result is shown in figure 5.

\[
\begin{bmatrix}
1 & 0 & 0 & 0 & 1 \\
0 & 1 & 0 & 1 & 0 \\
0 & 0 & 3 & 0 & 0 \\
0 & 1 & 0 & 1 & 0 \\
1 & 0 & 0 & 0 & 1
\end{bmatrix}
\] (2)
4. Lane marking linear equation calculation
The lane markings points are storaged separately, and each linear equation are calculated separately. The solution procedure is as follows.

From point A, search nearest nonzero points left and right in the image, as shown in figure 6.

After the nonzero point is found, the corresponding coordinate is recorded. Search nonzero points in the eight neighborhood region of the recorded point, and the recorded point pixel value is set zero. Calculate the average value of nonzero points in the eight neighborhood region of X direction and Y direction. The round down value of X direction and Y direction are the center coordinate of the next eight neighborhood region. As shown in figure 7, the red points are nonzero points. In the green rectangle, point 1 is the center point. Firstly, set the point 1 as 0. In the green rectangle, point 2 and 3 are nonzero points, so next center can be calculated. So point 2 is the next center point, and the blue rectangle is the eight neighborhood region. In this region, point 3 and 4 are nonzero points, so the next center is point 3. In the third eight neighborhood region, point 4 and 5 are nonzero points, and so on. All the nonzero points in neighborhood region can be found. When the point number is larger than a threshold value, the points coordinates are recorded, otherwise, the nonzero points are considered as noise points.
The extracted edge coordinate values are stored in different two-dimensional arrays. By using least square method, these points can be fitted into different linear equations by line fitting.

5. Result processing and prediction
By using the above method, the lane line in the image can be identified and the line after fitting can be drawn. According to the characteristics of the line, the auxiliary guidance of the vehicle can be carried out. For different road conditions, the following three situations will occur.

(a) (b) (c)

Figure 8. Result processing and prediction.

In figure a, the slope of the two lines is positive and negative, indicating that the car is in the middle of the road. In figure b, the slope is negative, indicating that the car should turn left. Conversely, if both slopes are positive, the vehicle should turn right.

Figure 9 shows the actual road condition lane line and the result after treatment. In general, the lane is in the middle of the image, so the situation given in figure 9 represents the processing result under normal circumstances.
6. Conclusion

The method of real-time fast detection of lane lines proposed in this paper can realize fast real-time detection of lane lines. After image preprocessing such as removing light, converting the blue sky, the roadside trees, mark into road pixels, interested area including roads and lanes can be extracted easily. Then, the lane lines are extracted, and the different lane lines are stored separately. According to the coordinate values of the stored lane lines, the equation of the line is fitted. Determine the direction of the vehicle according to the slope of the linear equation. This algorithm is applied to different light environments, and its processing speed can meet the real-time requirements, and it has high robustness, which is of great value in the research of real-time auxiliary driving.

Acknowledgment

This paper is supported by Research and seedling raising fund for young teachers of Zhonghuan information college, and the project number is KYLG05.

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