

Lane Markers Detection based on Consecutive Threshold Segmentation

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Abstract. This paper proposed a simple and robust lane markers detection method for intelligent vehicle navigation. It needs not calculate inverse perspective map. The method uses multiple threshold segmentation instead of single threshold segmentation. And straight and curve lane markers are directly extracted in Run-Length accumulation (RLA) images. It performs well in various complex conditions and costs less than 50 ms for a 352 by 288 image. Experiments on many kinds of real complex image sequences demonstrate the effectiveness and efficiency of the proposed method.

Keywords: Automatic land vehicle Lane markers detection Weighted Hough Transformation

1. Introduction

Lane markers detection is a key technique for Automatic lane vehicle (ALV) navigation, intelligent traffic, driving safety and so on. Most of the previous researches were focused on the detection of lane markers on structured road such as highway roads. However, lane detection in non-structured or semi-structured road is a more challenge task due to parked and moving vehicles, bad quality lines, shadows cast from buildings, trees, and other vehicles, sharper curves, irregular/strange lane shapes, emerging and merging lanes, sun glare, writings and other markings on the road (e.g. pedestrian crosswalks), different pavement materials, and different slopes. The method proposed by Ref. [1] is based on generating a birds-eye view of the road by inverse perspective mapping (IPM), which needs camera calibration. Ref. [2] uses three-feature based method to detect and track lane markers, which can only adapt to the slow varying of lanes. Color segmentation method is applied to preprocess and highlight lane pixels in [3,4], but it is sensitive to the change in ambient light color. In this paper, we propose a simple but robust lane markers detection method for intelligent vehicle navigation without generating inverse perspective map. The method uses multiple threshold segmentation instead of single threshold segmentation [9]. Straight and curve lane markers are directly extracted in Run-Length accumulation (RLA) images. It performs well in various complex conditions and costs less than 50 ms for a 352 by 288 image. Experiments on many kinds of real complex image sequences demonstrate the effectiveness and efficiency of the proposed method.

2. Proposed algorithm

The flowchart of the proposed algorithm is shown in Fig.1:

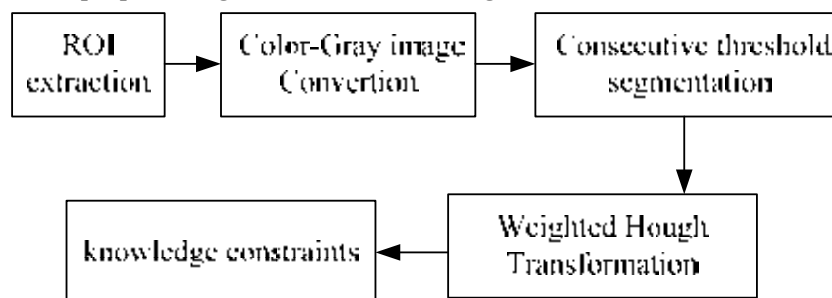


Fig.1 flowchart of the proposed algorithm

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We aim to detect all potential lane makers which exist in a road image. Before detection, we need suitable preprocessing for alleviating distractions and improving processing speed. As is shown in Fig.2, we first select a rectangle-like region as region of interest (ROI) in order to remove the sky region and the region corresponds to the front part of vehicles. For each image, see Fig.2, all the following processing are then done within this ROI region. We call this region as original image without special explanation. Secondly, we transform color ROI image to a gray ROI image using Equation (1):

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

It is known that there are both white and yellow lane markers in general road scene. However, our algorithm is designed to detect them in a unified way. In RGB color space, white corresponds to (255, 255, 255) and yellow to (255, 255, 0), thus we ignore blue channel and using equation (2) instead of equation (1) to make the yellow markers being white ones. Therefore, we consider only white lane markers.

$$I = (R+G)/2 \quad (2)$$



Fig.2 ROI extraction, the green rectangle is ROI region.

2.1. Consecutive threshold segmentation

In order to detect lane makers, we usually need to find an optimal threshold which can separate lanes and background perfectly and use the threshold to segment an original image, result in clustering the background points to one class, and lane marker points to the other. It is hard to select such an optimal threshold to make sure the lane marker points be segment totally because of uneven illumination and cast shadows. Fortunately, if we use multiple thresholds in certain intensity range to binary an original image, where each binary image corresponding to each threshold may include parts of lane marker points. Fig.3 gives such an example, (a) is an original image, three binary images of (a) which corresponding to threshold 94,128,194 are shown in (b), (c) and (d) respectively. We can clearly observe that different parts of the two lane markers appear in different binary images. Therefore, by using a set of consecutive thresholds, we can collect all parts of lane marker points to obtain an integrated lane marker. In this section, we use consecutive threshold segmentation to detect lane marker points. Instead of selecting single threshold, consecutive threshold segmentation uses multiple thresholds and collects useful information from each segmented images.



Fig.3 (b),(c),and (d) are binary results of original image (a) with binary threshold 94, 128, 194 respectively.

Given a threshold t , we binary a gray original image I to a binary image B , which is:

$$B(x, y) = \begin{cases} 255 & I(x, y) > t \\ 0 & \text{else} \end{cases} \quad (3)$$

Suppose all gray intensity of lane markers vary from g_1 to g_2 , if we select a threshold t , if $t > g_2$, all lanes are included in background, if $g_1 < t < g_2$, we can obtain parts of lane marker points, if $t < g_1$, all lane