Lane Detection with Moving Vehicles Using Color Information

Nasim Arshad, Kwang-Seok Moon, Seung-Seob Park, and Jong-Nam Kim

***Abstract*— An increasing safety and reducing road accidents, thereby by 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 even road boundaries detection. We present a robust and real time approach to lane marker detection in urban streets. A lane-detection method aimed at handling moving vehicles in the traffic scenes is proposed in this brief. First, an adaptive region of interest ROI is set. The ROI is mainly in the bottom half of the image since the main lane information only appears in the bottom of the image. Then the lane marks are extracted based on color information. The extraction of lane-mark colors is designed in a way that is not affected by illumination changes and the proportion of space that vehicles on the road occupy.**

***Index Terms*— lane identification, eccentricity, vehicle detection, lane detection**

I. Introduction

In intelligent transportation systems, intelligent vehicles cooperate with smart infrastructure to achieve a safer environment and better traffic conditions [1]. Intelligent vehicles are expected to be able to give route directions, sense objects or pedestrians, prevent impending collisions, or warn drivers of lane departure [2], [3]. Therefore, lane detection is a crucial element for developing intelligent vehicles. Lane detection based on machine vision is accomplished by taking images from cameras mounted on the intelligent vehicles. There are many related research works on this issue in recent years. These works generally used different strategies aimed at certain kinds of surroundings and road conditions. One category of methods used intensity images as the basis of lane detection.

Kluge and Lakshmanan [4] used a deformable template model of lane structure to locate lane boundaries without thresholding the intensity gradient information.

Yim and Oh [5] developed a three-feature-based automatic lane-detection algorithm using the starting position, direction, and gray-level value of a lane boundary as features to recognize the lane. However, most of these techniques were focused on detection of lane markers on highway roads, which is an easier task compared to lane detection in urban streets. Lane detection in urban streets is more challenging. We use segmentation information for the detection purpose. The lanes can be easily detected by comparing the gray intensity with the road surface color. The images are taken by a digital camera with different distances ranging from 10 m to 50 m.

This paper is organized in the following order: Section II presents the proposed algorithm including lane detection procedure. Section III addresses the experimental results. The conclusion and future work are given in Section IV.

II. Proposed Algorithm

In our system, the height of the camera is 1 m and the images used are in the distance range of 10 m to 50 m. The captured images are shown, respectively, in Fig. 1. Initially, after reading the images an adaptive region of interest (ROI) is selected, the ROI is mainly in the bottom half of the image since the main lane information only appears in the bottom of the image. We now apply segmentation on the selected ROI; segmentation is employed with an appropriate value of threshold. Threshold setting is one of the important factors in determining the detection result. The Threshold we have used is fixed and it is adaptive for all the image frames used.

Next we apply morphological operations which assist in segmentation. In other words to complete the segmentation procedure, we employ the morphological '*Cleaning'* and '*Thinning'* algorithms to remove the small objects of the image.

We have to clear the border of the image in order to reduce the noise and the unwanted area. Clearing the borders generates the approximate positions of the lanes (as white patches). In order to track and detect the lines we should be able to count the number of lines in one image frame.

We apply a counting and labeling algorithm onto the resultant images to count the number of lanes. Lane markings are connected rectangles, by finding all the connected components we eliminate any other object in the image which is not of our interest. On the other hand lane marks are straight lines painted on the streets. We know that the eccentricity of a straight line is always 1. Hence the lanes will have eccentricity close to 1. Estimating the eccentricities of all the connected components and setting a suitable value of threshold will result in all the lane markings in our ROI. The flow chart and architecture of the lane mark detection algorithm is illustrated in Fig. 2.

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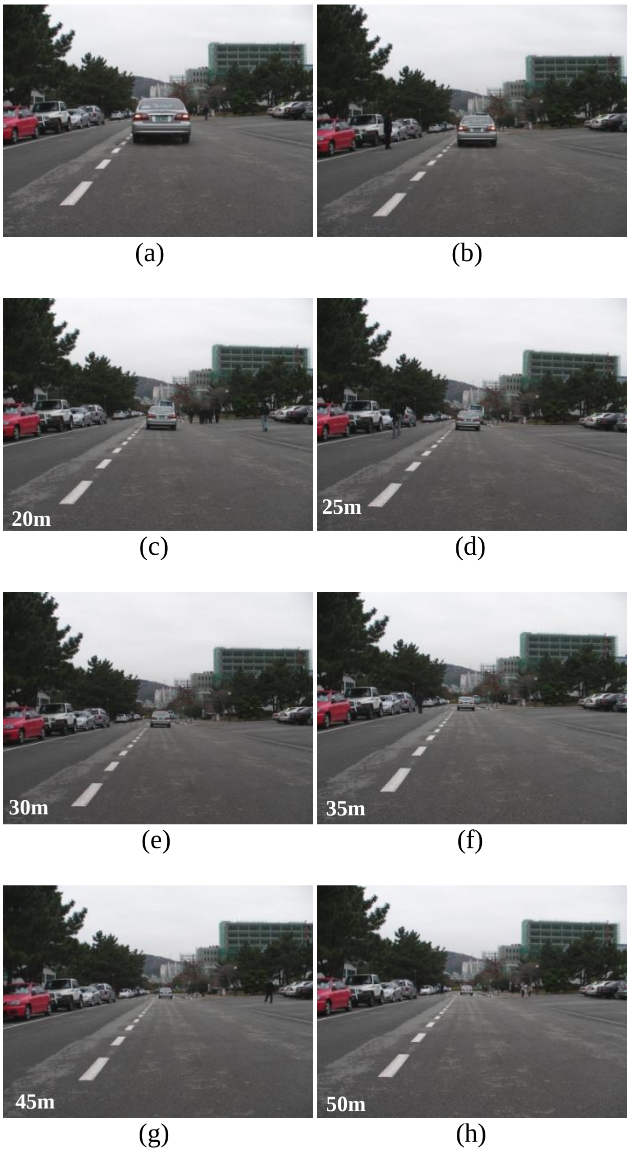

Fig. 1. Car images in the distance range of 10 ~ 50 m from the camera.

III. Experimental Results

The proposed algorithm was executed on an Intel E2200 @ 2.20GHz CPU, with 1 GB RAM. All our algorithms were implemented in the MATLAB environment. The system was built up on recorded RGB images from a digital camera in 3264×2448 format.

The experiment is performed on a specific vehicle shooting in an urban street, with different distances ranging from
10 ~50 meters.

The experimental results of the lane mark detection and the time complexity of the algorithm is summarized in TABLE I. As observed from the table the detection rate for the tested images is 98.8 %.The intermediate resultant images for the lane marking are represented in Fig. 3. The red line marks in these images denote the result of the preprocessing steps. The preprocessing step includes (segmentation, Morphology operation and noise removal). Although the lanes are detected accurately in red lines, but there also exist some noise which need to be eliminated and that is done in the next phase of the algorithm. Fig. 4.shows the final result for lane identification. The green lines in the images show the result of the final processing of lane detection. As observed from the figures, the lanes can be easy detected in different distances.

We also tested this algorithm on different lane images with different background; the results achieved were quite promising. Fig. 5. Shows lane mark detection for different images.

The results reveal that the proposed algorithm is not affected by the environment of the street; hence the ROI selected is suitable for any set of frames recorded by the camera.

However, some problems did not solved yet such as sharp curves in the foreground of the image and the accurate detection of the lanes under heavy rain.

On the other hand the captured image frames are not that stabile due to the vehicle movement and therefore, we need to improve the algorithm to overcome these problems.

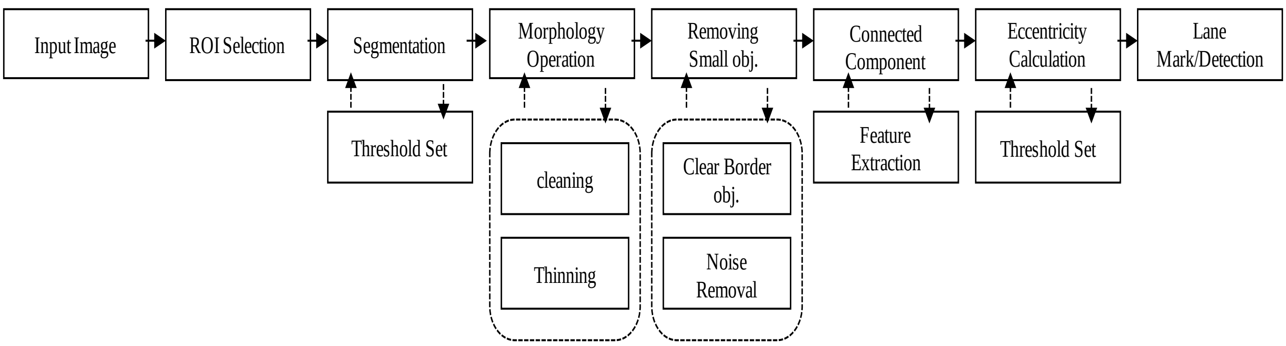

Fig. 2. System Structure Overview

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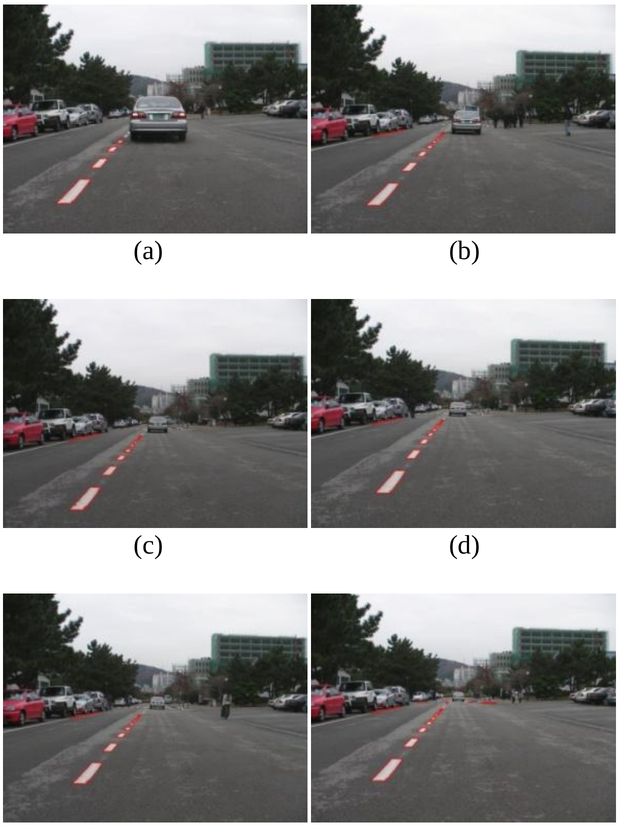
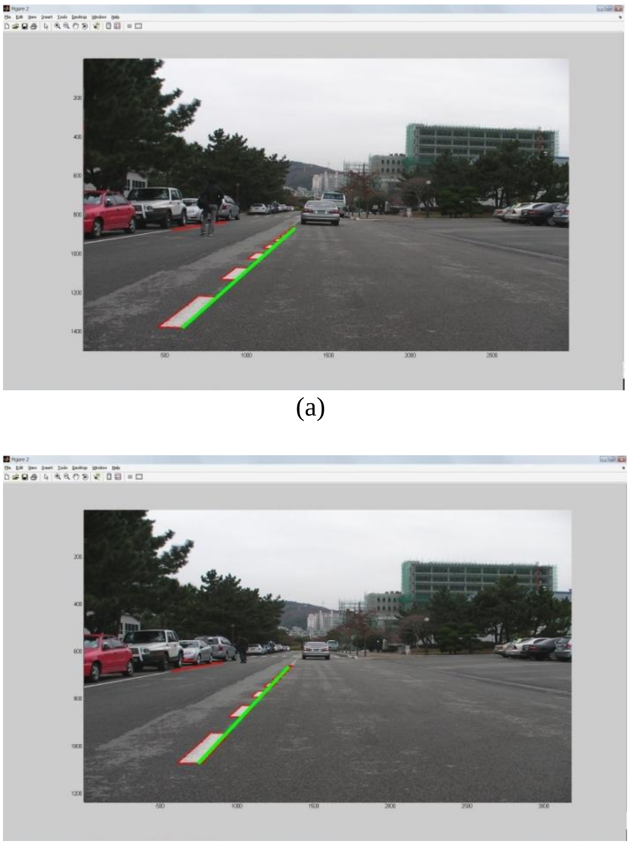


(a) (b)

(c) (d)

(e) (f)

Fig. 3. Intermediate result for images with 10, 20, 30, 35, 45 and 50 meters distant.



(a)

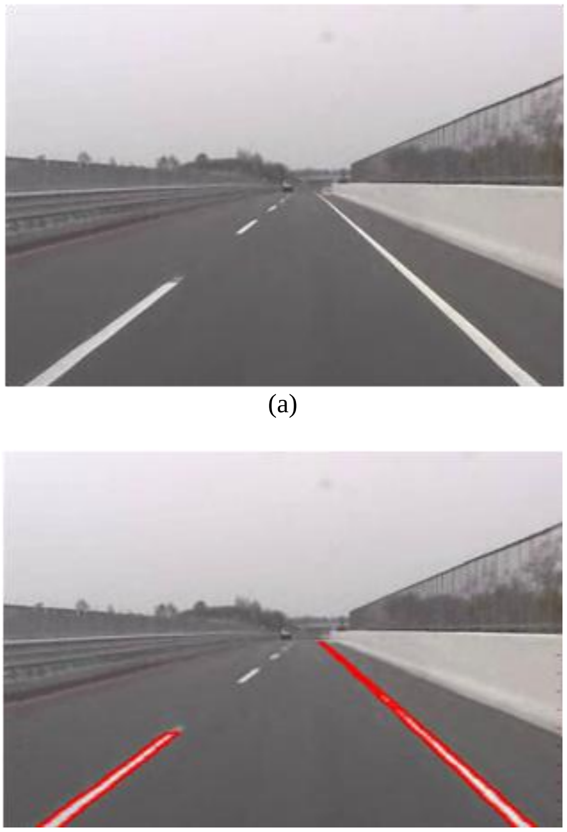
(b)

(c)

Fig. 4. final resultant images for 30, 35, and 45 meters distant.

TABLE I.
Experimental results of the proposed algorithm.

Input Images	Distance in meters	Time complexity	Detection Rate %
a	10	0.28	100
b	15	0.35	100
c	20	0.43	100
d	25	0.48	100
e	30	0.57	100
f	35	0.59	99
g	45	0.66	97
h	50	0.71	95



(a)

(b)

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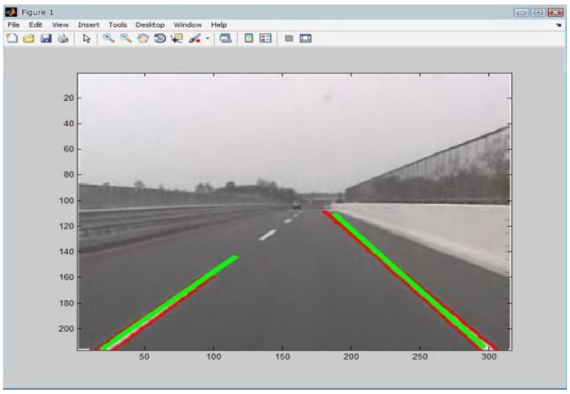

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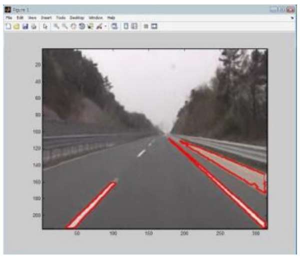
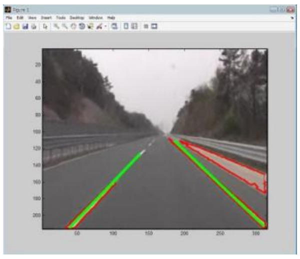

(d) (e)

Fig. 5. Lane identification and detection for different images with different backgrounds

IV. Conclusion

In this paper a robust lane-detection method based on the images taken from a digital camera in an urban street was proposed. As mentioned above the system uses a series of images with different distances. The system is also tested on different set of images. The result achieved for some of the test images are depicted in Fig. 4. and Fig. 5. The algorithm conducts image segmentation and removes the shadows of the road.

By extracting lane marks based on color information, we can eliminate many articles on the road that might interfere with lane-detection process. Since the lanes are normally long and smooth curves, we consider them as straight lines within a reasonable ROI. The lanes were detected using segmentation and morphological operations in restricted search area. The proposed lane detection algorithm can be applied in both painted and unpainted road, as well as slightly curved and straight road. There remained some problems in the lane detection due to shadowing, the moving vehicles and the environment. The algorithm will be improved for boundary lines, curved roads and moving vehicles in close future.

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