Global Journal of Computer Science and Technology
Volume 12 Issue 6 Version 1.0 March 2012
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

Automated Road Lane Detection for Intelligent Vehicles

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GJCST Classification: J.7

AUTOMATED ROAD LANE DETECTION FOR INTELLIGENT VEHICLES

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Automated Road Lane Detection for Intelligent Vehicles

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Abstract - Automated road lane detection is the crucial part of vision-based driver assistance system of intelligent vehicles. This driver assistance system reduces the road accidents, enhances safety and improves the traffic conditions. In this paper, we present an algorithm for detecting marks of road lane and road boundary with a view to the smart navigation of intelligent vehicles. Initially, it converts the RGB road scene image into gray image and employs the flood-fill algorithm to label the connected components of that gray image. Afterwards, the largest connected component which is the road region is extracted from the labeled image using maximum width and no. of pixels. Eventually, the outside region is subtracted and the marks or road lane and road boundary are extracted from connected components. The experimental results show the effectiveness of the proposed algorithm on both straight and slightly curved road scene images under different day light conditions and the presence of shadows on the roads.

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I. Introduction

Real-time automated road lane detection is an indispensable part of intelligent vehicle safety system. The most significant development for intelligent vehicles is driver assistance system. This driver assistance system holds great promise in increasing safety, convenience and efficiency of driving. The driver assistance system involves camera-assisted system which takes the real-time images from the surroundings of the vehicle and displays relevant information to the driver. Thus, intelligent vehicles automatically collect the road lane information and vehicle position relative to the lane. Consequently, the system used by the intelligent vehicles provides the means to alert the drivers which are swerving off the lane without prior use of the blinker. So, intelligent vehicles will clearly enhance traffic safety if they are extensively taken into use. Fatalities and injuries resulting from road accidents have become the common phenomenon in Bangladesh and Asian countries.

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Hence, intelligent vehicle safety system can offer the reduction of fatalities and injuries by means of giving warning to the unaware drivers about the danger. Computer Vision based on image processing deals with the issues for sensing the environment in intelligent transportation system. The vision-based automated road lane detection approach emphasizes to identify the road lane markings along with road boundaries. Simultaneous detection of road lane markings and road boundaries is necessary for proper orientation of intelligent vehicles. This detection process is likely to be obstructed by the presence of other vehicles on the same lane and shadows on the road caused by trees, buildings etc. before a vehicle. This approach can also be affected on curved roads instead of straight roads and under different day light conditions. So, road lane detection attracted many researchers in recent decades and researchers had carried out many works to detect road lane from intelligent vehicles. According to research [1], a novel road lane detection approach was proposed based on lane geometrical features associated with the geometrical relationship between camera and road that reduces the computation cost. The method using HSI color model was also proposed in lane-marking detection [8]. In [5], authors suggested a framework fusing color, texture and edges to recognize the lane of country roads. A computer vision-based approach was proposed to detect multiple lanes on straight and curved roads in [2]. The occlusion conditions of road lane detection were ignored there. Authors applied Hough transformation to detect lane in various cases [2, 4, 9]. However, the algorithm based on Hough Transform requires more memory and high computational time. For traffic safety, lane detection for moving vehicles was designed in [6] despite having the same color of vehicles as the line marks and passing traffic. Apart from that, distribution of color components was measured to detect urban traffic images in [7]. However, in case of various meteorological and lighting conditions (day, night, sunny, rainy, snowy) and road conditions (occlusion, degraded road markings), noises significantly undermine the estimation result of road parameters in previous methods. To resolve this problem, Chen [3] proposed a robust algorithm for lane detection under various bad scenes. For road scene image, we can divide it into two main parts: the upper part and the lower part. It is true that the lower part usually contains more important objects than the upper

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one does. Conventionally, road lane detection algorithms ignore the upper part directly to reduce searching area and to aim for shortening its processing time.

This paper presents road lane detection algorithm using labeling based on flood-fill algorithm, feature extraction and filtering. This algorithm is capable to detect lane on straight and curved roads under different day light conditions, shadows and other noises. Here, the whole road scene images are employed. The paper is organized as follows. In Section II, we introduce the environmental conditions assumed in this paper. The road lane detection algorithm is proposed in Section III. In Section IV, we provide experimental results to evaluate the performance of our algorithm. Eventually, we conclude this paper in Section V.

II. Environmental Conditions

Environmental conditions play an important role while road lanes are being detected. Road scene images can vary for different weather conditions like

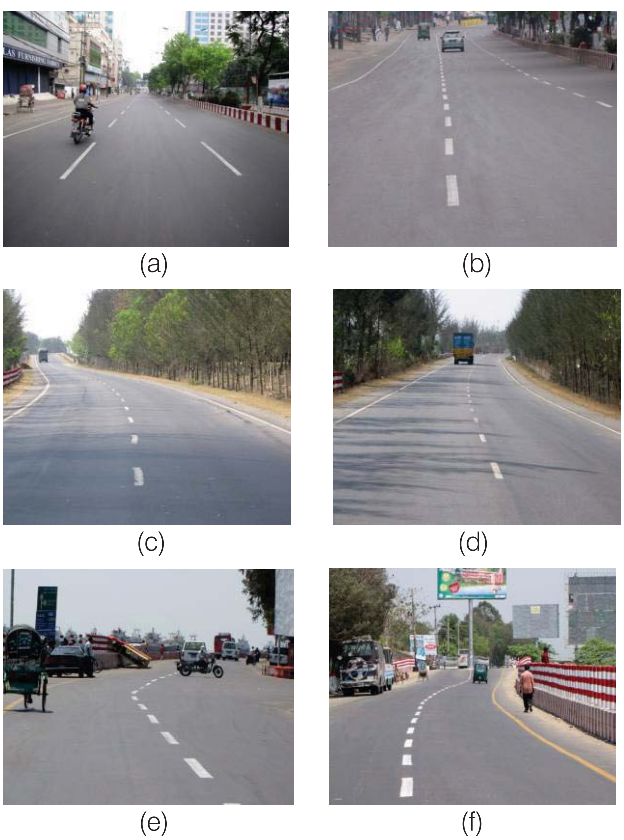

Fig. 1: Diversity of road scene images

different barriers, or even nothing are the marks of road lane and road boundary. The road surface consists of light or dark pavements or combination. Different road scene images on various day light and shadowing conditions are shown in Fig. 1. Solid and dashed lane marks on road scene images under good day light conditions are easy for detection. Detection of same lane marks on road scene images under bad day light and obstruction conditions will be difficult which is the challenge of this lane detection problem. So, an effective lane detection algorithm for intelligent vehicles has to address the problem.

III. Road Lane Detection Alorithm

In our proposed system, the road lane detection algorithm is divided into three stages. The first stage is to convert the RGB image into grayscale image and label connected components of that gray image. At second stage, features of road region from labeled image are extracted based on the width and no. of pixels of a connected component. After having connected component of road region, unwanted region of the image is subtracted and road region is filtered to detect road lane, respectively at third stage. The overall architecture of the system is illustrated in Fig.2.

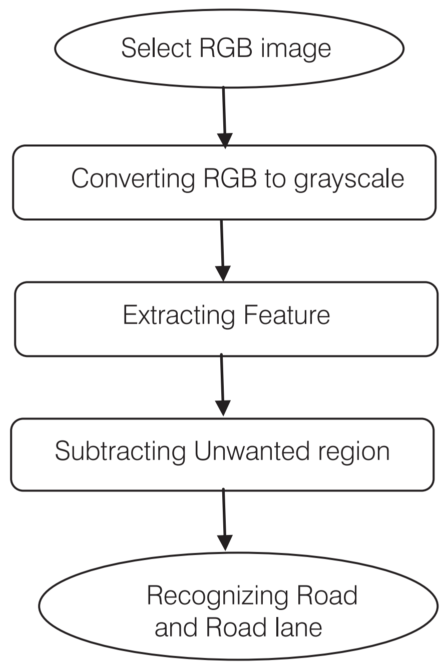

Fig.2 : Architecture of the system

a) *Connected Component Labeling*

Connected component labeling is the initial stage of our algorithm. At this part of our algorithm, we firstly convert the color image into grayscale image. Next, we employ flood-fill algorithm to label connected component. We have assumed that all the pixels are 8-connected neighborhood and a pixel is connected to its neighbor if the intensity difference between them is less than 8. After labeling, the algorithm looks up large connected component region from the label image. Actually the large connected component is a road region because if images are taken from the vehicle, large portion of these images is road region. Based on this concept, we take large region and mark it with red color. More importantly, we have marked the road region but not any object on the road.

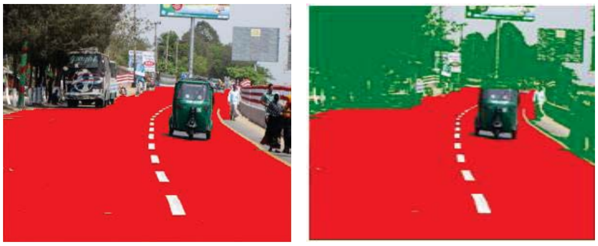

Fig.3 : Road region marked by red color (a) and outside region marked by green color (b)

A road region marked by red color is shown in Fig. 3(a). The outside environment of road region does not belong to the region of interest. The algorithm searches pixels horizontally from left to right and from right to left simultaneously, marks those pixels by green color which is not part of red region and looks for red region as search goes on. After finding red region, it stops searching in this row and goes to the next row and does the same task. Outside region marked by green color is shown in Fig. 3(b).Outside region is not subtracted properly yet and will be subtracted by using some attributes in the next stage. The flowchart of labeling is depicted in Fig. 4.

i. *Conversion from RGB to Gray Image*

RGB images are composed of three independent channels for red, green and blue primary color components. So, for RGB to grayscale conversion, primarily we take three channel values of each pixel and make an average of those values which is the gray-level value for the corresponding pixel in the grayscale image. Pixels throughout the RGB image are scanned and this procedure is applied to convert it into grayscale image.

ii. *Apply Flood-fill Algorithm*

Flood fill is an algorithm that determines the connected area to a given node in a multi-dimensional array. We have used flood fill algorithm to detect different connected components. The algorithm takes three parameters: a start node, a target intensity value and a replacement integer value. We utilize the algorithm to check all nodes in the array that are connected to the start node by a path of the target intensity value and modify them by the replacement integer value. Thus, we figure out the region of relatively similar intensity.

b) Feature Extraction

Feature extraction is the next stage of our algorithm. At this stage, width of each connected component is calculated. For finding the width, the algorithm searches the grid of pixels horizontally and keeps track of current width if it is greater than previously stored width for a connected component. Next, we consider number of pixels in each connected component. For finding total number of pixels in a connected component, it searches throughout the labeled image and counts the number for each connected component in the labeled image. Finally, connected component of maximum width and highest no. of pixels is extracted in feature extraction stage.

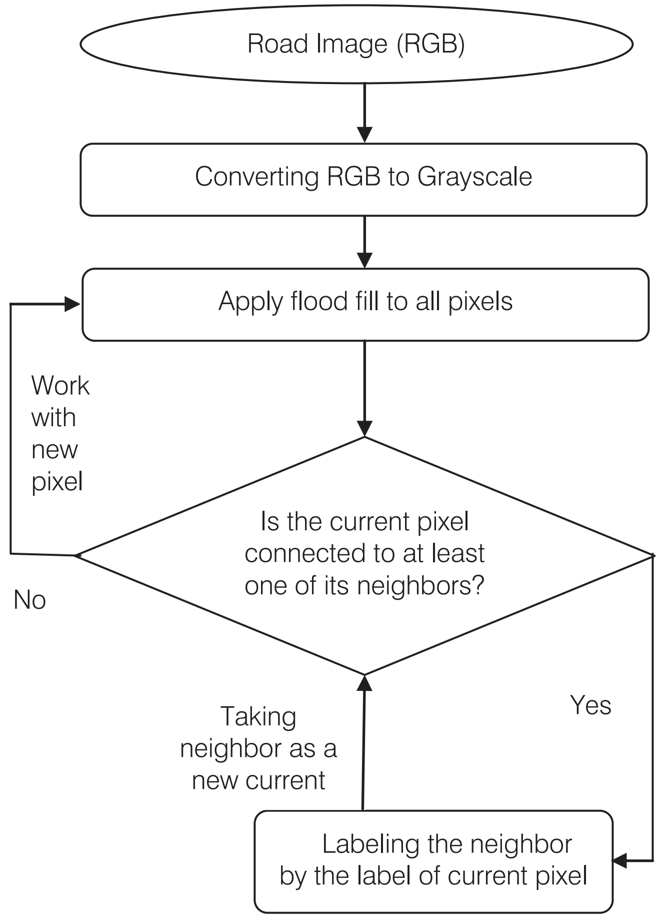

Fig.4 : Flowchart of labeling

c) Unwanted Region Subtraction

Unwanted region subtraction along with filtering extracted connected component is the final stage of our algorithm. It plays a significant part of road lane detection. Using the feature, we find regions from the labeled image and we subtract many regions from those. The outer-side of the road is subtracted because we do not have any concern with the region which does not belong to the road. Hence, we work with the regions that are on the road.

Table 1: Filtering parameter

Parameter	Values
Connectivity (intensity difference)	<8
Lane width (ratio)	< $(1/18)^{th}$ times of original image width
Lane intensity	> 170

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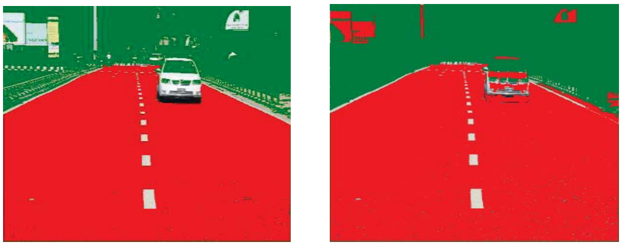
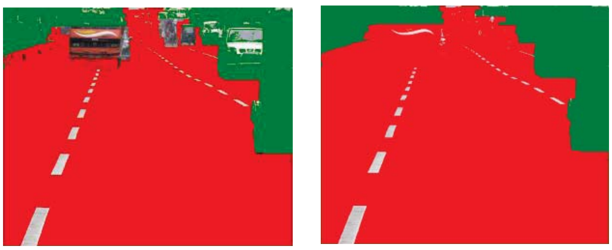


(a) (b)

Fig.7 : Labeling image (a) and output taking width as an attribute (b)



(a) (b)

Fig.8 : Labeling image (a) and output taking intensity as an attribute (b)

On the road, lots of unwanted region may be found. To subtract those regions we use two attributes, one is lane width and another is lane intensity. In Fig. 7(a), if any regions width is greater than one by eighteenth times of original image width then subtract the region because width of road lane lies inside this value. The output using this attribute is shown in Fig. 7(b). And if any pixel has lower intensity value than 170 then subtract these pixels because road lanes are white. The output using this attribute is shown in Fig. 8(b).

IV. Experimental Results

All experiments are done on Pentium-D 2.80GHz with 512MB RAM under Microsoft Visual Studio 2008 environment. Image with resolution minimum of 400*400 and maximum of 600*600 are used. A database along with a growing number of images is used for the experiment. All these images are taken in highways and normal roads with dashed road lane and solid road boundary markings on straight and curved roads under different daylight conditions (sunny, cloudy and shadowing).

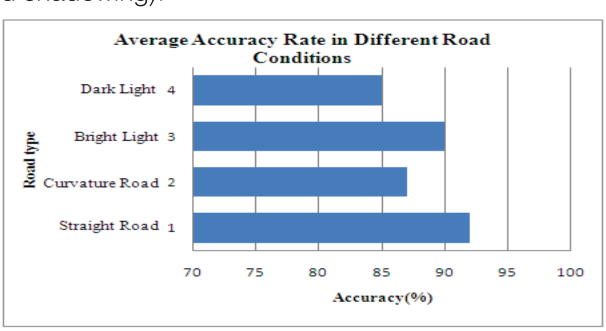
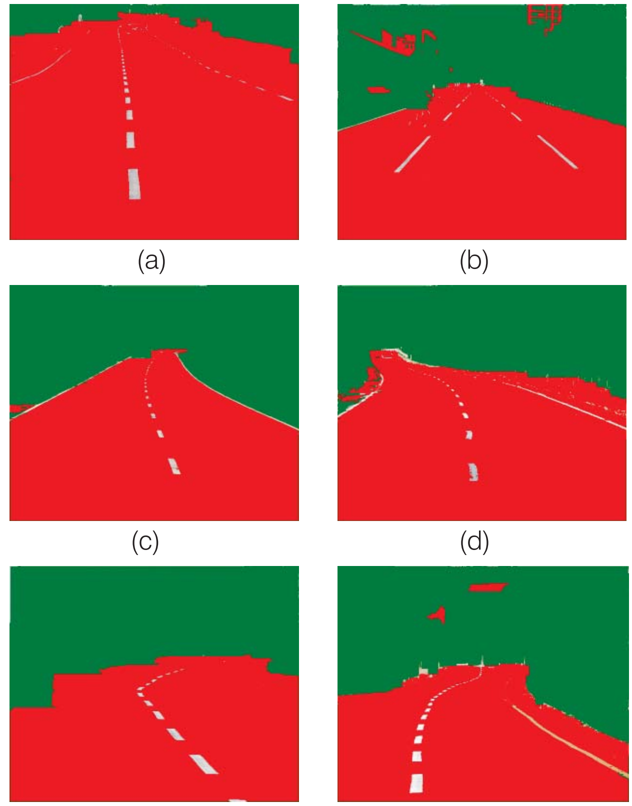


Fig.9 : Average accuracy of lane detection in different road conditions



(a) (b) (c) (d) (e) (f)

Fig.10 : Road lane detection in different scenes

Figure 9 illustrates the performance of the system under different road conditions. We had taken 50 pictures under each condition and got the above results. Additionally, Fig. 10(a) and 10(b) are the output of Fig. 1(a) and 1(b) which are taken at good illumination condition, Similarly, Fig. 10(c) and 10(d) present the output of Fig. 1(c) and 1(d) which are taken in shadow condition. On the other hand, Fig. 10(e) and 10(f) shows output for Fig. 1(e) and 1(f) which are taken in bad illumination condition .We can observe that the marks of road lane and boundary are successfully extracted, which indicates the good performance of our algorithm.

V. Conclusion

An automated road lane detection algorithm on images taken from an intelligent vehicle is proposed in this paper. The algorithm starts with the conversion of color (RGB) road scene image to grayscale image. The flood-fill algorithm is used to label the connected components of grayscale image. The largest connected component is extracted from labeled image subsequently. Finally, the unwanted region of road scene image is subtracted and the extracted connected component is filtered to detect white marks of road lane and road boundary. The algorithm is tested on a good number of road scene images. These images are taken from straight and slightly curved road under different day light and occlusion (of vehicles and people) conditions. Experimental results show that the algorithm achieves good accuracy despite the shadow conditions of road. However, the road lane detection algorithm still has some problems such as critical shadow condition of the image and color of road lanes other than white. Therefore, our future work will be the improvement of the algorithm to overcome these problems.

References Références Referencias

1. Shengyan Zhou, Yanhua Jiang, Junqiang Xi, Jianwei Gong, Guangming Xiong, Huiyan Chen, "A novel Lane Detection based on Geometrical Model and Gabor Filter" In Proc. of the IEEE Intelligent Vehicles Symposium, June, 2010.
2. Yan Jiang, Feng Gao, Guoyan Xu "Computer Vision-Based Multiple-lane Detection in a Straight road and in a Curve" In Proc. of the IEEE Image Analysis and Signal Processing, April, 2010.
3. Huan Shen, Shunming Li, Fangchao Bo, Xiaodong Miao, Fangpie Li, Wenyu Lu "Intelligent Vehicle Oriented Lane Detection Approach under Bad Road Scene" In Proc. of the Computer and Information Technology, IEEE, October, 2009.
4. Abdulhakam.AM.Assidiq, Othman O. Khalifa, Md. Rafiqul Islam, Sheroz Khan."Real Time Lane Detection for Autonomous Vehicles". Computer and Communication Engineering, IEEE, 2008.
5. Franks, U. Loose, H. Knoppel, C. "Lane Recognition on Country Roads". Intelligent Vehicle Symposium, IEEE, 2007.
6. Hsu-Yung Cheng Bor-Shenn Jeng Pei-Ting Tseng Fan, K.-C. "Lane Detection With Moving Vehicles in the Traffic Scenes" Intelligent Transportation Systems, IEEE, 2006.
7. Yinghua He Hong Wang Bo Zhang. "Color-based road detection in urban traffic scenes". Intelligent Transportation Systems, IEEE, 2006.
8. Tsung-Ying. Sun, Sheng-Jeng Tsai and Vinchent Chan "HSI Color Model Based Lane Marking Detection" Intelligent Transportation Systems, IEEE, 2006.
9. Prakash, J. Meenavathi, M.B. Rajesh, K. "Linear Feature Extraction using combined approach of Hough transform, Eigen values and Raster scan Algorithms" Intelligent Sensing and Information Processing, IEEE, 2006.

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