THE INTERNATIONAL JOURNAL OF SCIENCE & TECHNOLEDGE

Performance Evaluation of Integrated Lane Colorization Using Canny Edge Detector & Relaxed Median Filter

Anjali Goel
Department of Computer Science, Guru Nanak Dev University, Amritsar, Punjab, India

Abstract:
Lane coloration has become popular in real time vehicular ad-hoc networks (VANETs). Automated road lane detection has been 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, presents an algorithm for detecting the lanes on the road with a view to the smart navigation of intelligent vehicles. So in order to reduce the limitations of the existing researchers we have proposed a new strategy which uses bilateral filter as preprocessing stage which has ability to reduce the noise from images before further processing. Firstly, it converts the RGB road scene image into gray image and filter using relaxed median filter. Then the gray scale image is scaled to particular level to obtain the binary image. Canny edge detector has been applied to outline the road lanes and colored. The proposed algorithm has been designed and implemented in MATLAB. By passing different images it has been shown the significant improvement of the proposed algorithm over the existing algorithms.

Keywords: *VANET, Intelligent vehicles, lane detection, Relaxed Median Filter*

1. Introduction

Traffic accidents have become one of the most serious problems in today's world. Roads are the mostly chosen modes of transportation and provide the finest connections among all modes. Most frequently occurring traffic problem is the negligence of the drivers and it has become more and more serious with the increase of vehicles. Increasing the safety and saving lives of human beings is one of the basic function of Intelligent Transportation System (ITS). Intelligent transportation systems are advanced applications which aim to provide innovative services relating to different modes of transport and traffic management. This system enables various users to be better informed and make safer, more coordinated, and smarter use of transport networks.

These road accidents can be reduced with the help of road lanes or white markers that assist the driver to identify the road area and non-road area. A lane is a part of the road marked which can be used by a single line of vehicles as to control and guide drivers so that the traffic conflicts can be reduced.

Fig 1 Road scene image (adapted from [2])

Most roads such as highways have at least two lanes, one for traffic in each direction, separated by lane markings. Major highways often have two roadways separated by a median, each with multiple lanes. To detect these road lanes some system must be employed that can help the driver to drive safely.

Lane detection is an area of computer vision with applications in autonomous vehicles and driver support systems.

Fig 2: Lane detection (adapted from [2])

Despite the perceived simplicity of finding white markings on a simple road, it can be very difficult to determine lane markings on various types of road. These difficulties can be shadows, occlusion by other vehicles, changes in the road surfaces itself, and different types of lane markings. A lane detection system must be able to detect all manner of markings from roadways and filter them to produce a reliable estimate of the vehicle position relative to the lane.

Image noise contains various random variation of brightness or color information in images. The addition of the noise in the digital image is during the image acquisition or when the image is transferred to some other place through some medium. As the image is acquired through some sensor. So the performance of the image sensor can be affected by various environmental conditions or by the quality of the sensing element themselves.

2. Literature Survey

Saha et al. [2012] [1] discussed an algorithm for detection of marks of road lanes and road boundary by using intelligent vehicles. 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. It converted the RGB road scene image into gray image and employed 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. The unwanted region was detected and subtracted like outer-side of the road. The extracted connected component was filtered to detect white marks of road lane and road boundary. The road lane detection algorithm still had some problems such as critical shadow condition of the image and color of road lanes other than white.

Tseng et al. [2005] [2] gave a lane marking detection algorithm by using geometry information and modified Hough transform. In that algorithm the captured image was divided into road part and non-road part by using camera geometry information. The color road image was quantized into a binary image. The modified Hough transform with road geometry consideration was used to detect the lane markings. The histogram of intensities was applied to quantize the road image into a binary image. A modified Hough transform method has been developed to detect the lane markings in road image by using the road geometry information. It was time consuming because Hough transform was a full search algorithm in parameter space. It also failed when the lane boundaries intersected in a region which was a non-road part.

Shen et al. [2012] [3] discussed a monocular vision system that could locate the positions of the road lane in real time. An algorithm proposed for lane detection using single camera. The algorithm worked in five steps. Initially edge detection was done to find all present edges from road image as road line required was included in it. Canny approach has been used to achieve the edge map from road image for its accurate edge detection. Then matching was done to eliminate unwanted figures. A priority and orientation based searching method has been used for enhance and label potential lane segments from edge map, degrading unwanted edge features. Based on results from search, a linking condition was used to assemble matched segment that further strengthen the confidence of the potential lane line. Finally a cluster algorithm was used to localize the road-lane lines.

M. Dhana Lakshmi et al. [2012] [4] discussed a novel algorithm to detect white and yellow colored lanes on the road. An automatic lane marking violence detection algorithm was designed and implemented in real time. The lane detection method was robust and effective in finding the exact lanes by using both color and edge orientations. The color segmentation procedure identified the yellow and white colored lanes followed by edge orientation in which the boundaries were eliminated, regions were labeled and finally the lanes were detected. As the height of the camera was relatively constant with respect to the road surface, the road portion of the image can be exclusively cropped by providing the coordinates, so that identifying the lanes became much more efficient.

Cuong Le et al. [2012] [5] discussed the task of finding the pedestrian lanes that are indicated by painted markers for the vision impaired people. An assistive navigation system has been developed for the blind by employing geometric figures like straight line, parabola, or hyperbola. By combining color and local intensity information, this method detected correctly pedestrian marked lanes in different illumination and weather conditions (sunny, cloudy, strong shadows, times of day). This method has also been evaluated and compared with existing approaches. It has been found that the potential of the method in challenging environmental conditions.

Shan Xu et al. [2012] [6] discussed a method of structured road lane detection for blind travel aid. Median Filter has been implemented to process image firstly, then mark off the region of interesting in the initial image. Using Canny Edge Enhancement, threshold has been used to segment the image, road lane was fitted by modified Hough Transformation. Finally, according to the detected region, it judged whether racing course of bind has a deviation. It has been proved that this algorithm was very robust and real-time.

Zhao et al. [2013] [7] discussed lane detection and tracking method based on annealed particle filter algorithm which combined multiple images with annealed particle filter. It has been found that the time cost of annealed particle filter algorithm for each frame is largely reduced compared with conventional particle filter algorithm.
Rajandeep et al. [2014] [8] discussed the techniques for lane coloration and explores the benefits and limits of existing lane colorization problems. It has been found that most of existing researchers has neglected the filtering and restoration techniques. However it is also found that existing researchers has also neglected the overheads of existing techniques. So in order to reduce the limitations of the existing researchers we have proposed a new strategy which uses bilateral filter as preprocessing stage which has ability to reduce the noise from images before further processing. By doing so it has started working fine even for noisy images. The proposed algorithm has been designed and implemented in MATLAB. By passing different images we have shown the significant improvement of the proposed algorithm over the existing algorithms. Due to the non-availability of the real time environment the simulation environment has been used to implement and verify the proposed algorithms accuracy. In near future we will use embed programming to validate the proposed work in efficient manner. However in this work; canny edge detection is used, but now many edge detectors has been developed so far which works more accurately and detect edge in more efficient manner. So in near future we will use fuzzy logic based edge detectors to improve the performance and accuracy of the proposed algorithm further.

3. Proposed Algorithm

Median Filter is a simple and powerful non-linear filter which is based order statistics. It is easy to implement method of smoothing images. Median filter is used for reducing the amount of intensity variation between one pixel and the other pixel. In this filter, we do not replace the pixel value of image with the mean of all neighboring pixel values, we replaces it with the median value. Then the median is calculated by first sorting all the pixel values into ascending order and then replace the pixel being calculated with the middle pixel value. If the neighboring pixel of image which is to be considered, contains an even numbers of pixels, than the average of the two middle pixel values is used to replace. The median filter gives best result when the impulse noise percentage is less than 0.1 %. When the quantity of impulse noise is increased the median filter not gives best result.

	10	5	20			
	14	80	11			
	8	3	22			

Fig 3: Method of Median Filter
Median of 3, 5, and 8,10,11,14,20,22,80 is 11 so 80 will be replaced by 11

4. Experimental Results

By taking different road images for experimental purpose we have seen the results of the integrated and existing approach. It is shown in the following figures why proposed algorithm is more beneficial over existing in case of noisy images. Figure below is showing the noisy input image. It is clearly shown that the visibility of the image is quite poor.

Fig 4: Input noisy image

When the input noisy image is filtered without the relaxed median filter, it contains disturbance in the image and the image filtered image is not clear as seen in the image below. But when the image is filtered by using the relaxed median filter, it is free from all noises.

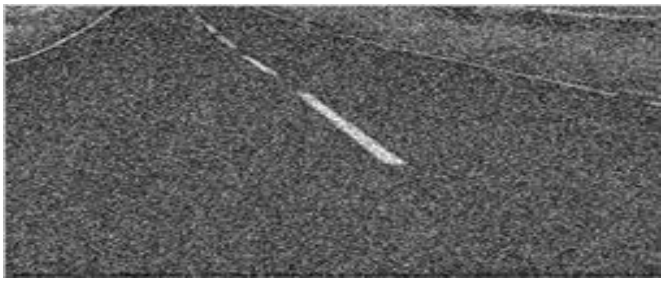

Fig 5: Filtered image without using RM filter

Fig 6: Filtered image using RM filter

When the noisy filtered image is inputted to the canny edge detector, the road lane detection is not accurate with disturbed outlines. But when the filtered image using relaxed median filter is inputted to the canny edge detector, the outlining is clear and straight.

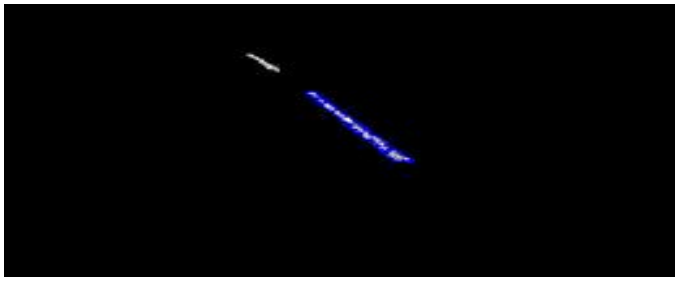

Fig 7: Canny edge detection output without using RM filter

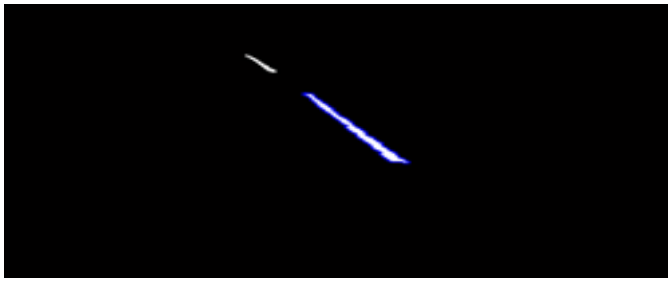

Fig 8 :Canny edge detection output using RM filter

The lane colorized image is shown in figures below. The image shown in figure is without bilateral filter so have some artifacts i.e. not visibility too accurate and even lanes are not properly detected. But image shown in Figure is showing the smoothed image even the colorized lanes are properly shown. Thus proposed algorithm is quite better than the existing algorithm.

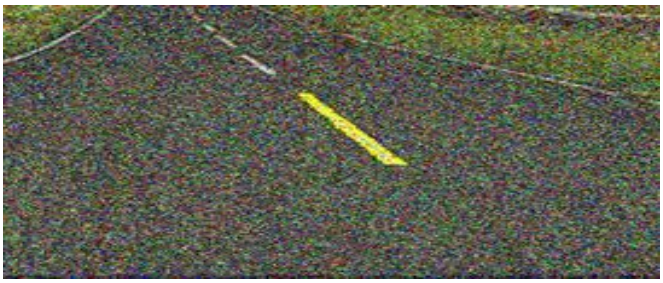

Fig 9: Final output without using RM filter

Fig 10: Final output using RM filter

5. Performance Analysis

Four different types of analysis charts are obtained in order to analyze the comparison between two different lane detection techniques.

In old technique, the image is noised by salt and pepper. Edges are detected by using canny edge detector to detect the road lanes.

In new technique, the image is similarly noised by salt and pepper. Then edges are detected by using random median filter.

The overall objective of this chapter is to prove that the proposed algorithms provide more accurate results than the existing algorithms.

Images	Old Method	Proposed Method
1	94.63078	99.93947
2	94.98510	99.97380
3	96.92357	99.79114
4	95.42833	99.94644
5	95.25176	99.92373
6	95.52354	99.93994
7	96.07468	99.85708
8	95.73188	99.84499
9	90.32801	99.47410
10	90.32612	99.49882
11	95.90131	99.84606
12	98.03525	99.88050
13	94.58866	99.91942
14	96.64389	99.96089
15	96.11809	99.83521

Table 1: Accuracy Analysis

Table 1 shows the accuracy analysis of the proposed and exiting technique. It is found that the accuracy of the proposed algorithm for the input image has shown quite effective results than that in existing method. The accuracy of the proposed technique is more than 99.84 in the most of cases therefore the proposed algorithm is quite accurate than the others.

Images	Old Method	Proposed Method
1	0.09151	0.90499
2	0.30321	0.99029
3	0.81766	0.98887
4	0.31073	0.97828
5	0.62060	0.99216
6	0.03697	0.75574
7	0.25975	0.91497
8	0.59206	0.97997
9.	0.27423	0.88504
10	0.27306	0.89117
11	0.71018	0.98781
12	0.09665	0.63952
13	0.24952	0.64505
14	0.07033	0.86382
15	0.07758	0.63595

Table 2: Specificity Analysis

Table 2 has shown the Specificity exploration of the proposed and available technique. As specificity needs to be maximized therefore it is proved that the Specificity of the proposed technique in case of the input images has given objectively effective results than the surviving technique. It is clearly shown that in many cases we have achieved specificity up to .90. Therefore we can justify in terms of specificity that the proposed algorithm is quite effective and giving accurate results.

Images	Old Method	Proposed Method
1	45.42475	4.75027
2	34.83942	0.48530
3	9.11706	0.55649
4	34.46345	1.08591
5	18.97003	0.39210
6	48.15141	12.21297
7	37.01273	4.25137
8	20.39679	1.00141
9	36.28839	5.74811
10	36.34693	5.44139
11	14.49112	0.60945
12	45.16729	18.02395
13	37.52381	4.56137
14	46.48346	31.08989
15	46.12088	18.20250

Table 3: Bit Error Rate Analysis

Table 3 has shown the BER investigation of the proposed and exiting procedure. It is found that the BER of the proposed procedure in case of the input images shown in has given fairly effective outcomes than the existing technique. As required BER need to be reduced. It is clearly shown that BER is quite less in proposed algorithm reason behind this is the O (1) relaxed median filter.

Images	Old Method	Proposed Method
1	9.96208	29.22212
2	10.37643	33.03334
3	13.27090	25.16857
4	10.75099	29.90825
5	11.02638	28.93545
6	10.68481	29.22233
7	11.33178	25.57637
8	11.35645	25.70521
9	7.81570	20.13988
10	7.81338	20.35240
11	11.80396	26.08899
12	14.15900	26.23970
13	10.03131	29.26635
14	11.89599	31.08989
15	11.29186	24.85242

Table 4: PSNR Analysis

Table 4 has shown the PSNR examination of the planned and traditional method. It is proved that the PSNR of the proposed technique in case of the input images has specified quantitatively improved consequences than the persisting technique.

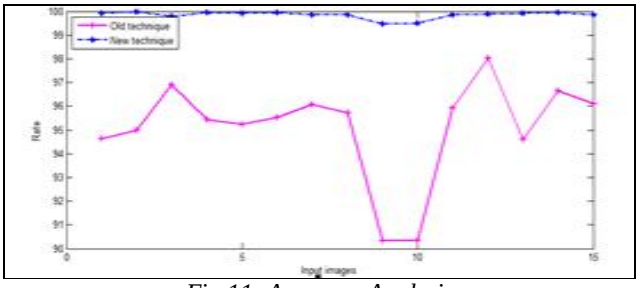

Fig 11: Accuracy Analysis

It has shown the accuracy analysis of the proposed and exiting technique. Magenta color shows the result of old technique whereas new technique is shown by using blue color. Y axis has shown the accuracy rate or percentage. X axis has shown the input set of images from 1 to 15. Figure 8 has demonstrated that the accuracy of the proposed algorithm in case of the input images has shown quite effective results than the existing method. Accuracy is need to as much as possible. The accuracy of the proposed technique is more than 99.54 in the most of cases therefore the proposed algorithm is quite accurate than the others.

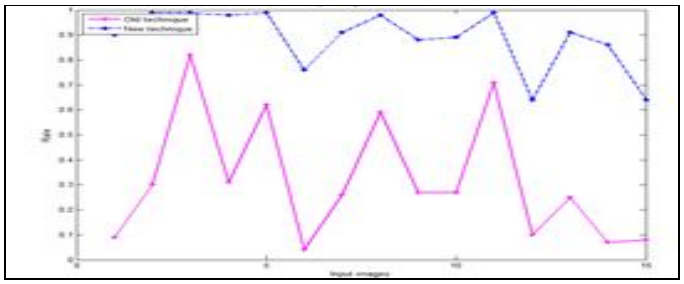

Fig 12: Specificity Analysis

It has shown the Specificity exploration of the proposed and available technique. As specificity needs to be maximized therefore it is proved that the Specificity of the proposed technique in case of the input images has given objectively effective results than the surviving technique. It is clearly shown that in many cases we have achieved specificity up to .90. Therefore we can justify in terms of specificity that the proposed algorithm is quite effective and giving accurate results.

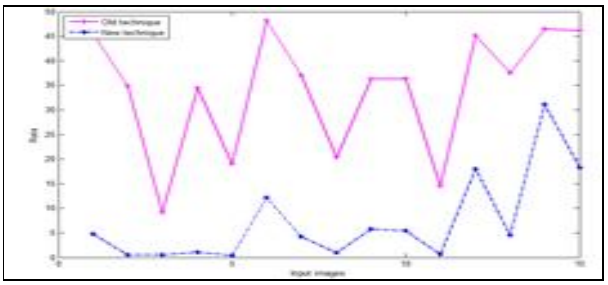

Fig 13: Bit Error Rate Analysis

It has publicized the BER exploration of the projected and exiting procedure. It is established that the BER of the proposed technique in case of the input images has specified objectively effective outcomes than the existing technique. As required BER need to be reduced. It is clearly shown that BER is quite less in proposed algorithm reason behind this is the O (1) relaxed median filter. Therefore the proposed algorithm has shown quite effective results in case of the BER.

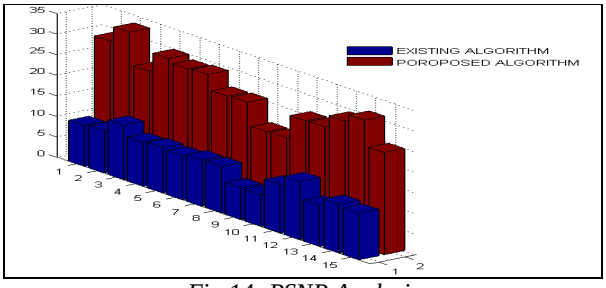

Fig 14: PSNR Analysis

It has shown the PSNR examination of the planned and traditional method. It is proved that the PSNR of the proposed technique in case of the input images has specified quantitatively improved consequences than the persisting technique.

6. Conclusion and Future Work

Lane coloration is becoming popular in real time vehicular ad-hoc network. The methods developed so far are working efficiently and giving good results in case when noise is not present in the images. But problem is that they fail or not give efficient results when there is any kind of noise in the road images. The noise can be anything like dust, shadows, puddles, oil stains, tire skid marks, etc. So in order to reduce these problems a new strategy is proposed which has integrated Hough transform based lane colorization with the bilateral filter. The integrated approach has shown significant improvements over the existing methods especially when noise is present in the images. The performance evaluation is also done by considering various well known image parameters. The parameters evaluation has also shown quite effective results. In proposed algorithm, there are some experiments that can better be executed with the help of fuzzy logic.

In future embed programming can be used efficiently to validate the proposed work. However in proposed algorithm canny edge detection is used, but now many edge detectors has been developed so far which works more accurately and efficiently and to detect edge. So in near future we will use fuzzy logic based edge detectors to improve the performance and accuracy of the proposed algorithm further.

7. References

1. Saha, Anik, Dipanjan Das Roy, Tauhidul Alam, and Kaushik Deb. "Automated Road Lane Detection for Intelligent Vehicles." Global Journal of Computer Science and Technology 12, no. 6 (2012).
2. Tseng, Chien-Cheng, Hsu-Yung Cheng, and Bor-Shenn Jeng. "A lane detection algorithm using geometry information and modified Hough transform." 2005 IPPR.
3. Xiaodong Miao, Shunming Li, Huan Shen. "On-board lane detection system for intelligent vehicle based on monocular vision." International Journal on Smart Sensing and Intelligent Systems 12, no. 4 (2012).
4. M DhanaLakshmi and B.J. Rani Deepika, “A brawny multicolor lane coloration method to Indian scenarios”, IJRET OCT, pp. 202 – 206, 2012.
5. Le, Manh Cuong, Son Lam Phung, and Abdesselam Bouzerdoum. "Pedestrian lane detection for assistive navigation of blind people." In Pattern Recognition (ICPR), 2012 21st International Conference on, pp. 2594-2597. IEEE, 2012.
6. Xu, Shanshan, Jie Ying, and Yanbin Song. "Research on road detection based on blind navigation device." In Cyber Technology in Automation, Control, and Intelligent Systems (CYBER), 2012 IEEE International Conference on, pp. 69-71. IEEE, 2012.
7. Zhao, Hongying, Zhu Teng, Hong-Hyun Kim, and Dong-Joong Kang. "Annealed Particle Filter Algorithm Used for Lane Detection and Tracking." Journal of Automation and Control Engineering 1, no. 1 (2013).
8. Singh, Rajandeep, and Prabhdeep Singh. "Evaluating the performance of integrated lane colorization using hough transformation and bilateral filter."

9. Zhou, Shengyan, Yanhua Jiang, Junqiang Xi, Jianwei Gong, Guangming Xiong, and Huiyan Chen. "A novel lane detection based on geometrical model and Gabor filter." In Intelligent Vehicles Symposium (IV), 2010 IEEE, pp. 59-64. IEEE, 2010.
10. Jiang, Yan, Feng Gao, and Guoyan Xu. "Computer vision-based multiple-lane detection on straight road and in a curve." In Image Analysis and Signal Processing (IASP), 2010 International Conference on, pp. 114-117. IEEE, 2010.
11. Shen, Huan, Shunming Li, Fangchao Bo, Xiaodong Miao, Fangpei Li, and Wenyu Lu. "Intelligent vehicles oriented lane detection approach under bad road scene." In Computer and Information Technology, 2009. CIT'09. Ninth IEEE International Conference on, vol. 1, pp. 177-182. IEEE, 2009.
12. Assidiq, Abdulhakam AM, Othman O. Khalifa, R. Islam, and Sheroz Khan. "Real time lane detection for autonomous vehicles." In Computer and Communication Engineering, 2008. ICCCE 2008. International Conference on, pp. 82-88. IEEE, 2008.
13. Franks, U., H. Loose, and C. Knoppel. "Lane recognition on country roads." In Intelligent Vehicles Symposium, 2007 IEEE, pp. 99-104. IEEE, 2007.
14. Cheng, Hsu-Yung, Bor-Shenn Jeng, Pei-Ting Tseng, and Kuo-Chin Fan. "Lane detection with moving vehicles in the traffic scenes." Intelligent Transportation Systems, IEEE Transactions on 7, no. 4 (2006): 571-582.
15. He, Yinghua, Hong Wang, and Bo Zhang. "Color-based road detection in urban traffic scenes." Intelligent Transportation Systems, IEEE Transactions on 5, no. 4 (2004): 309-318.
16. Sun, Tsung-Ying, Shang-Jeng Tsai, and Vincent Chan. "HSI color model based lane-marking detection." In Intelligent Transportation Systems Conference, 2006. ITSC'06. IEEE, pp. 1168-1172. IEEE, 2006.
17. "Bilateral Filter", [online available]: wikipedia.org
18. Mallick, Rajendra Nath. "Implementation of Canny Edge Detection Algorithm." PhD diss., 2012.
19. "Hough Transform", [online available]: wikipedia.org