COMPARATIVE STUDY OF IMAGE APPROACHES FOR LANE DETECTION

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Abstract : Today, one of the largest areas of research and development in the automobile industry is road safety. Many deaths and injuries occur every year on public roads from accidents. However, the most dramatic fact is that, nearly all of the accidents are caused by driver mistakes. The main goal of the lane detection system is to reduce the number of these accidents. Remarkable amount of the current researches in this field focus on building autonomous driving systems. This research work presents an approach for comparing the performance of lane detection algorithm by using different image processing techniques.

***KeyWords:** preprocessing, Filtering, Segmentation, Hough Transform.*

1.INTRODUCTION

Nowadays, the growing volume of the traffic all around the world requires higher levels of the traffic safety. On the road, there are so many unsafe driving cars that the driver requires more careful while driving. Important for driver is being careful when he/she must change lane, especially in new driver who absolutely cannot keep too much information at once and has no confidence for driving. Driver may be loss of concentration and Control car. In fact, human behaviors are indeed hard to recognize, predict and handle by current available equipment. Therefore, a monitoring and warning system focusing on the vehicle behaviors is needed while the car is moving on the road.

A lane-detection system is an important component of many intelligent transportation systems. In intelligent transportation systems, intelligent vehicles cooperate with smart infrastructure to achieve a safer environment and better traffic conditions. Driver support system is one of the most important features of the modern vehicles to ensure driver safety and decrease vehicle accident on roads. . Lane detection has attracted more and more researchers because it is a basic and important subtask which analyzes the road and extracts all kinds of road characters. Generally speaking, lane detection is processed by using road image and all kinds of image processing algorithms.

Apparently, the road lane detection or road boundaries detection is the complex and most challenging tasks. It includes the localization of the road and the determination of the relative position between vehicle and road. 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.

In the majority of the cases, the lane markings exist on both sides of the road, in others, the road is not marked. The lane detection consists of detecting the lane marking limits. This task is relatively easy when the texture of the road is uniform and when the lane presents very clear markings. However, it becomes non trivial particularly with the presence of various markings (Figure 1.a), the presence of obstacles that cover lane markings (Figure 1.b), the effects of weather conditions (Figure 1.c) and the time of acquisition (Figure 1.d). Its difficulty gets further accentuated in cases of camera movements, blur effects, and abrupt or unexpected actions of conductors, which are likely to distort the result of detection.

Fig. 1 Different environment conditions

The main properties that must be possessed by a solution of lane detection are:

- The quality of lane detection should not be affected by different brightness and shadows that can be cast by trees, buildings, etc
- Lane detection algorithms should be capable of processing painted and unpainted roads.
- Lane detection algorithms should handle the curved roads rather than only the straight roads.
- Lane detection algorithm should process fast and robustly.

2. LITERATURE SURVEY

There are large numbers of vision based systems for vehicle control, collision avoidance and lane departure warning, which have been developed during the last past years (Seonyoung L in [1], Jia, Hui, Jinfeng, Wei in [2] and Vijay, Shashikant in [3]). Recently, many Driver Assistance systems (DAS) are emerging to work in harmony with human drivers McCall J, Trivedi M.[4], e.g. Forward Collision Warning System (FCWS) and on-board Lane Departure Warning System (LDWS). Such systems can be used to help preventing driver's mistakes and reduce traffic accidents effectively proposed Hussain, Hannan, Mohamed, Sanusi, Ihsan in [5].

The authors in [6] combined the knowledge-based methods such as shadow detection, entropy analysis and horizontal symmetry measurement for mid-range and distant vehicle detection without prior knowledge about the road geometry. The mentioned systems have lacked of accuracy and environmental effects depending on their production. Therefore, these systems were failed in providing a full collision avoidance system to the vehicle. The systems having higher accuracy and technology need expensive investment and good maintenance.

Many digital devices were developed and implemented. Most of them were costly electronic devices; the categories of these devices are vehicular-based driving aids such as GPS navigation systems, Transponders and Mobile phones (Stephan Sarath in [7]). Road-based driving aids are inductive loop detectors and sensors, traffic surveillance systems such as closed-circuit television (CCTV) [8][9]. with the availability of GPS systems, it is practical to locate a vehicle with certain accuracy. However, at the time of lane departure the GPS data do not provide the exact positions of vehicles, due to degradation or multipath problems. Therefore, it is challenging to determine the exact lane position that a vehicle is departing [10], [11].

A lane departure problem is defined using the origin destination matrix, with the objective of reducing the unnecessary crossings on the road [12]. Their lane departure strategy assigned a lane to each vehicle based on its origin and destination. The simulation results showed the effects of scenario on costs, but a distributed control strategy for individual car was not presented. The authors in [13] presented another approach to the lane departure problem. They used tools from network theory to represent a road with arcs and nodes. The network representation of a highway in their work has potential in modeling traffic in road systems. However, their paper does not deal explicitly with the lane change effect on the road capacity.

Intelligent vehicles are expected to be able to detect lane directions, sense objects or pedestrians and transmit to vehicular network for the prevention of impending collisions, or warn drivers of lane departure

[14],[15]. Therefore, the transmission of lane departure warning over the vehicular network is a crucial element for developing intelligent vehicles. Lane departure warning system based on machine vision algorithm is developed by taking video from cameras mounted on the intelligent vehicles. There are many research works on this issue in recent years [16]. These works generally used different strategies aimed at certain kinds of surroundings and road conditions at different times of day. While this paper proposed software base method for transmission of lane departure warning system under various lighting conditions.

Most of the lane detection algorithms are edge-based and relied on thresholding of the image intensity. The intensity information is utilized to detect potential lane edges, followed by a perceptual grouping of the edge points to detect the lane markers of interest. In many road scenes, it isn't possible to select a threshold which eliminates noise edges without eliminating the lane edge points of interest under various light conditions [17].

Author [18] presented segmentation algorithms for both grayscale and color images based on the watershed transform and concepts from computational topology. In the grayscale case the algorithm produces useful results for simpler images even in the very straightforward way we have implemented it, although the threshold parameter requires tuning by trial-and-error for each image.

3. METHODOLOGY

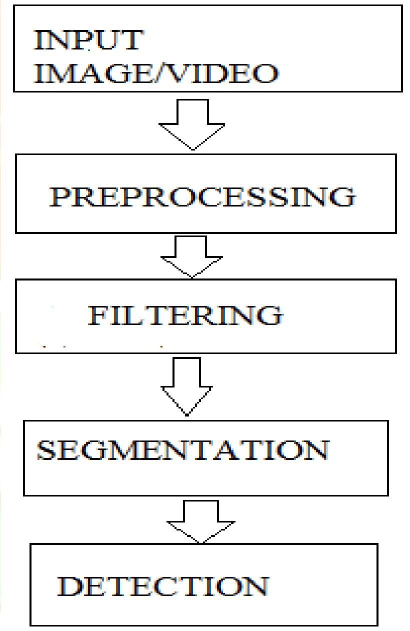


Fig 2: General Lane Detection Methodology

Creation of Input Image/Video Stream: The Image/video containing different road segments under different lighting conditions is captured. The captured video sequence is collated to form a short sequence but with many features from different conditions.

Preprocessing: Image pre-processing techniques are necessary, in order to find the orientation of the Lane detection, to remove the noise and to enhance the quality of the image.

Filtering: Noise reduction of the images is done at first. Considering salt and pepper noise in the images, noise will be reduced by using different filtering techniques i.e. median filter, wiener filter, and hybrid median filter.

Segmentation: Segmenting an image to meaningful parts is a fundamental operation in image processing. Image segmentation is the process of partitioning a digital image into multiple segments.

Detection: Detecting lane using Hough transform algorithm.

3.1 Methodology-1: Lane Detection Algorithm Using Median Filter and Thresholding

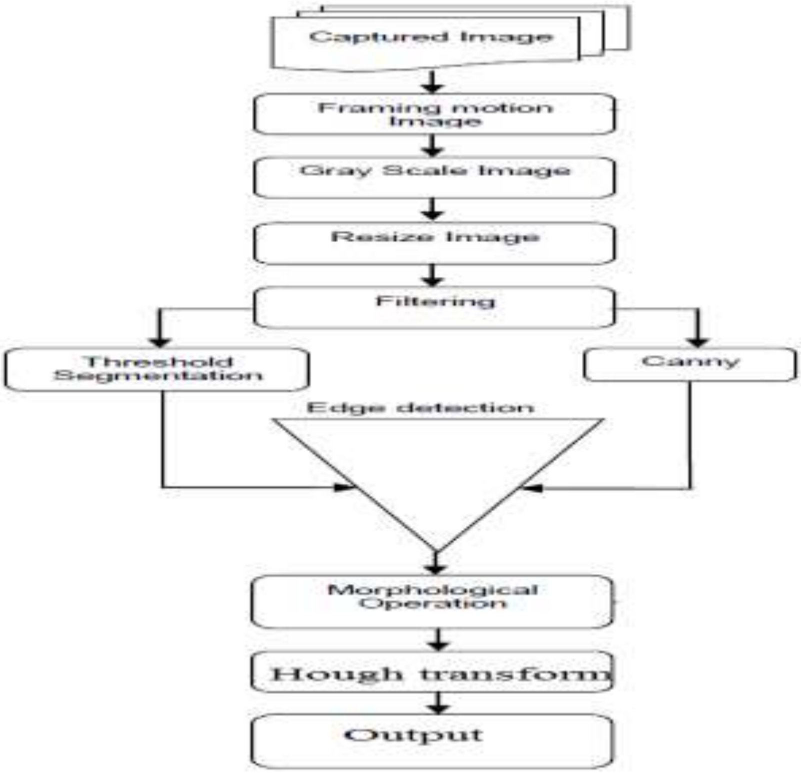


Fig 3 : Method 1

3.2 Methodology-2: Lane Detection Algorithm using Watershed Transform

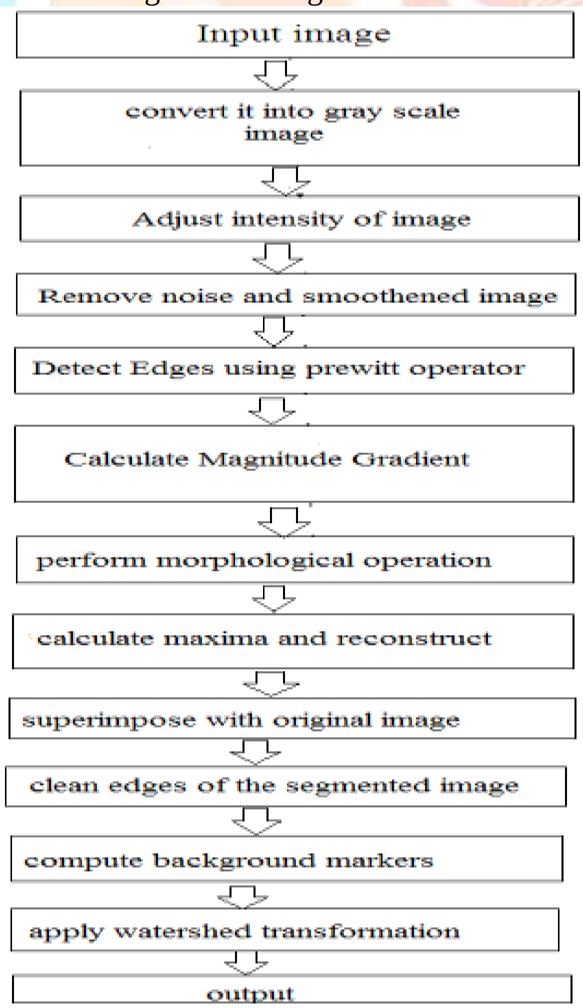


Fig 4 : Method 2

3.3 Methodology-3: Lane Detection Algorithm Using Wiener Filter and Thresholding

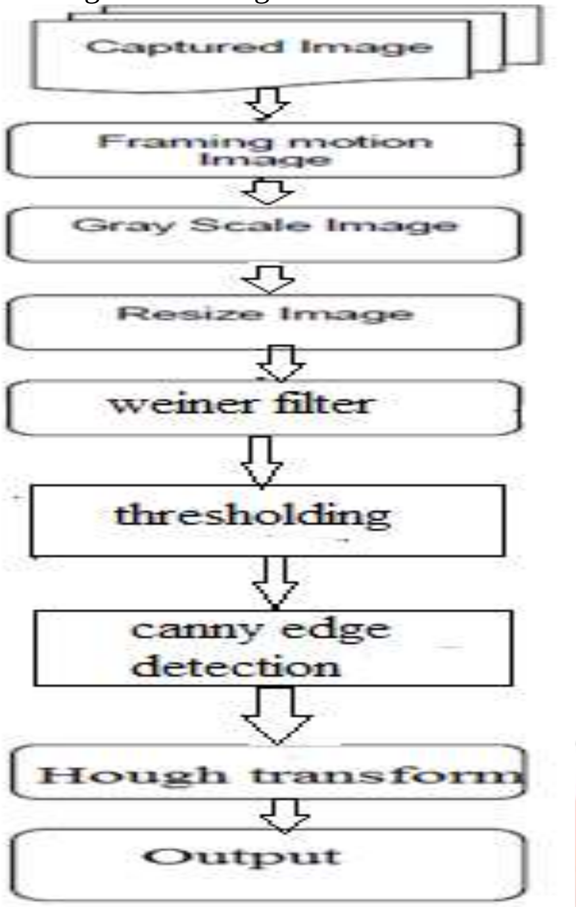


Fig 5 : Method 3

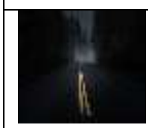
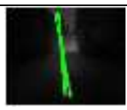
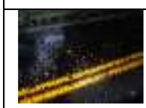
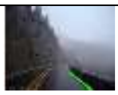
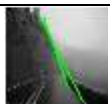
4. EXPERIMENTATION AND RESULTS:

4.1 Data collection:

The image database that we used in our project contains 8-bit uncompressed bit map images and jpeg images that have been randomly selected from the World Wide Web.

4.2 Experimental Results:

For the model-based approach, implement lane detection using wiener filter, global thresholding, Canny, and Hough transform (Method A), the lane detection method using median filter and global thresholding Hough transform (Method B), the lane detection using watershed segmentation (Method C) and lane detection using Gaussian filter and region growing segmentation (method D).

Images	Method A	Method B	Method C	Method D
				
				
				

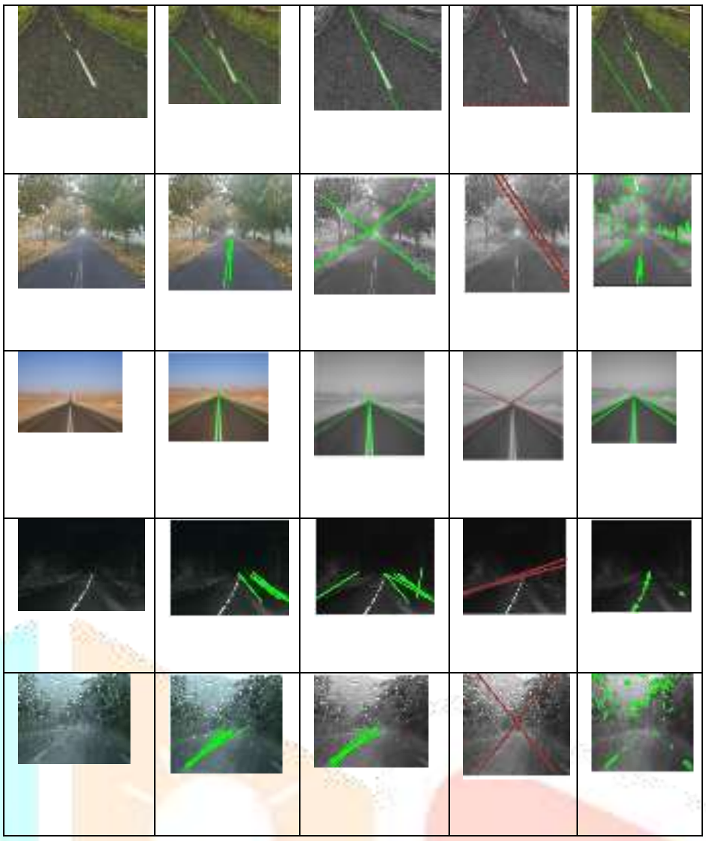


Fig 6: Experimental Results

The images of above figure illustrate the detection results of the different environment conditions. The first column indicates the images of different environment conditions. The second column illustrates lane detection using wiener filter and global thresholding. The third column illustrates lane detection using median filter and global thresholding. The fourth column illustrates watershed segmentation. The fifth column illustrates lane detection using Gaussian filter and region based segmentation including Eigen values. All the methods give good results in normal conditions (6^{th} row in above figure).

With method A, misalignment was caused by obstacles and some misdetections were caused by strong shadows, object reflection, intense lighting where the lane markings have a very low contrast. With method B is good compare to method A in all environmental conditions except shadow or objects reflection. With method C uses watershed segmentation; this method is not suitable for lane detection. Compare to other three methods poor performance for lane detection with method D is good compare to method C and method A. it detects line in a road exactly and also detects extra line or edges by applying sobel edge detector.

Method	Normal condition	Early morning	Rainy day	Shadow and object reflection
Wiener filter and global thresholding	Good	Good	Medium	Poor
median filter and global thresholding	Good	Good	Good	Poor
Gaussian filter and region based	Good	Good	Good	Good
Watershed segmentation.	Good	Poor	Poor	Poor

Table 1: Comparison Results

Based on the above table, I have obtained approximately 99.6% of good accuracy in normal condition, 99% of good accuracy in early morning condition, 99% of good accuracy in rainy situation and 99% of good accuracy in shadow and object reflection condition using Gaussian filter and region based thresholding segmentation. In method B 99.3% of good accuracy in normal condition, 98% of good accuracy in early morning condition, 98.6% of good accuracy in rainy situation and 90% of good accuracy in shadow and object reflection condition using median filter and global thresholding (ostu) method. In method A 96% of good accuracy in normal condition, 98% of good accuracy in early morning condition, 97% of good accuracy in rainy situation and 90% of good accuracy in shadow and object reflection condition using wiener filter and global thresholding method.

In method C 99.3% of good accuracy in normal condition, 50% of good accuracy in early morning condition, 70-80% of good accuracy in rainy situation and 60% of good accuracy in shadow and object reflection condition using watershed transform method.

Images	Methods	Good	Moderator	poor
	Method A	✓		
	Method B	✓		
	Method C	✓		
	Method D	✓		
	Method A	✓		
	Method B	✓		
	Method C			✓
	Method D	✓		
	Method A	✓		
	Method B	✓		
	Method C			✓
	Method D		✓	
	Method A		✓	
	Method B		✓	
	Method C	✓		
	Method D	✓		
	Method A		✓	
	Method B	✓		
	Method C			✓
	Method D	✓		

Table 2: comparative accuracy of lane detection using different images

5. CONCLUSION

The lane detection is becoming popular in real time vehicular ad-hoc network. Intelligent transportation systems are now available for improving the security of the vehicles and prevent accident ratio. The methods developed so far are working efficiently and giving good results in case when noise is not presented in the video/image. 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, object reflection etc and some environmental conditions. So in order to reduce these problems a new strategy is proposed which has integrated lane detection technique with many filters and segmentation techniques. The comparison among lane detection using different filters and image segmentation has shown quite effective results. The experimental results show the effectiveness of the algorithms on both straight and slightly curved road scene images under different day light conditions and the presence of shadows on the roads.

As per above methods median filter, Gaussian filter and thresholding segmentation method provide good accuracy of results. Watershed transform segmentation is not suitable for lane detection because it provide less accuracy compare to remaining methods.

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