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PROPOSED METHOD FOR ROAD DETECTION AND FOLLOWING BOUNDARIES

[1] DR.HAZEEM B. TAHER ,[2] DR.KADHIM M. HASHEM ,[3]FATIMA A. SAJET
University Of Thi-Qar, Collage Of Education For Pure Science, Computer Of Science, Iraq[1,2,3]
E-mail: [1]hazeem.sci@utq.edu.iq, [2]Kadhimmehdi63@gmail.com ,[3]fatimasajet1994@gmail.com

ABSTRACT

Lane detection and following is a significant component of vision-based driver assistance systems (DAS), lane detection and tracking methods are the state of the art in present intelligent transportation systems and intelligent vehicle applications. It is however very challenging since the road is in an outdoor scenario imaged from a moving platform. in this paper, we suggest and implement an effective algorithm of real-time line detection and following lane signals to detect the left and right lane boundaries of the line .The proposed algorithm consist of two phases, In the first phases the road is isolation from the image, so, the proposed algorithm in this phase will detect the edges and marks on the road using image processing techniques, also, apply this phase in image taken or video in real time. The second phase in this research, is for how to follow the lines that represent the road signs for a way to take the angles of the neighborhood of each pixel on the line, to be able to know the road is straight or rotate. Lane detection algorithm which is simple, robust, and efficient. Thus, suitable for real-time processing. The main objective of this paper is to implement an effective lane detection and following system, the approach presented here was tested on image and video sequences downloaded from https://www.shutterstock.com/search. All the detection and tracking programs developed using the MATLAB R 2015 b platform.

Keywords: *Driver Assistance Systems, Lane Detection, Lane Following, Intelligent Vehicle, Neighborhood*

1. INTRODUCTION

Visual navigation is an important technology for Autonomous Guided Vehicles, and the road detection is the essential prerequisite, the position of a vehicle relative to the road lane is one of the most crucial information for an autonomous vehicle to navigate itself in an urban road environment or in a large factory to automate components and tools deliveries. Edge and line detection are important steps in one category of image segmentation methods[1].

Lane detection and Obstacle Avoidance Technique plays the most important roles in Advanced Driver Assistance Systems (ADAS). ADAS acts as an assistant to the driver while driving. Many Car Manufacturers, Universities, Research Institutes and Companies have focused on using various kinds of ADAS systems such as ACC (Autonomous cruise control), CACC (Cooperative Adaptive Cruise Control), LDW (Lane departure warning), FCW (forward collision warning) [2].

computer vision has three tasks in order to make a road vehicle fully autonomous. Under the “road detection and following” titles are those algorithms that allow a vehicle to drive on roads and highways, Lane detection and tracking is a popular in the computer vision area. Various techniques for vision-based lane markings detection system have been developed over the past decade to scan for the lane edges under different kinds of road sceneries. also, In driver assistance systems, lane detection and tracking are very crucial treatments to locate the vehicle and to track its position on the road.

A lane-detection system is an important component of many intelligent transportation systems, and detection is used in intelligent cruise control systems, for lane departure warning, road modeling, and so on. Typically, lane detection and tracking are used for localizing lane boundaries in given road images. Ideally, lane markings are white lines on a dark pavement [3].

The detection of lane boundaries in images of road scenes, captured from a ground-level visual sensor, is an important ability for navigation and guidance of mobile autonomous robots [4]. Lane detection is the process to locate lane markers on the road and then present these locations to an intelligent system. In intelligent transportation systems [5].

Intelligent vehicles cooperate with smart infrastructure to achieve a safer environment and better traffic conditions. The applications of a lane detecting system could be as simple as pointing out lane locations to the driver on an external display, to more complex tasks such as predicting a lane change in the instant future in order to avoid collisions with other vehicles. Some of the interfaces used to detect lanes include cameras, laser range images, LIDAR and GPS devices [6].

Lane detection system represents not only a useful driver aid, but an important component in autonomous vehicles also. To resolve lane detection and departure warning problems, key element is to detect road lane boundaries (horizontal road signalization and width of the whole road). In work described in [7]. The road recognition ability, also known as “lane detection”, “road detection” and “road following”, is one of the very desirable skills adopted to improve autonomous vehicles systems [8].

Lane detection also can be used to infer the position and orientation of the vehicle within a lane and can provide a reference system for locating other vehicles or obstacles in the path of that vehicle which can be applied to further development of the Obstacle Avoiding System [9]. Road marking extraction is a key component to lane position detection. Road and lane markings can vary greatly, making the generation of a single feature extraction technique difficult. Edge based techniques can work well with solid and segmented lines and can even be extended to attempt to compensate for circular reflectors [10].

Road color and texture, road boundaries, and lane markings are the main perceptual cues for human driving. Semi and fully autonomous vehicles are expected to share the road with human drivers and would therefore most likely continue to rely on the same perceptual cues that humans do. While there could be, in principle, different infrastructure cuing for human drivers and vehicles (e.g. lane marks for humans and some form of vehicle-to-infrastructure communication for vehicles) it is unrealistic to expect the huge investments required to construct and maintain such double infrastructure, with the associated risk in mismatched marking [11]. An efficient vehicle tracking system is designed and implemented for tracking the movement of any equipped vehicle from any location at any time [12].

Lane detection is a crucial element for developing intelligent vehicles in Advanced Vehicle Control and Safety Systems (AVCSS). Lane boundaries have to be determined accurately in order to warn drivers of lane departure or impending collisions. Lane detection based on machine vision is accomplished by taking images from cameras mounted on the intelligent vehicles. The challenges of lane detection include the ability to deal with various road types, obstacles, passing traffic, shadows, and achieving real-time requirement at the same time. In current literature, researchers often use different strategies to deal with various road types. Edge or intensity-based methods [13]

2. RELATED WORKS

In this section we discuss related work to lane detection and tracking using different techniques (Hough, template matching, neural networks, etc.):

Bottazzi et al, in [14] proposes a histogram-based illumination invariant lane detection method. A dynamic region of interest (DROI) is defined using a prior triangle model. First the histogram of the whole image and road frame are calculated. The difference between the two is used to find out the illumination changes. From the ROI lane markers are segmented. The algorithm uses Lucas Kanade tracking to track the lanes.

Tsai, et al. [15] proposes a novel boundary determination algorithm for lane detection. It is based on local gradient direction. Sobel edge detector is used for finding out the gradient magnitude and direction. Then two circular masks namely tracing mask and probing mask, are used to collect limited samples of gradient orientation. The initial gradient is determined based on the largest histogram bin for orientation. The probing circular mask is used to avoid deviation. A third order polynomial fitting is also used.

Borkar et al. in [16] developed a method based on the parallel nature of lane markers. First Inverse Perspective Mapping is performed. Then the IPM image is converted to gray scale image. Then the image is filtered using Normalized Cross Correlation. Now find out a collection of straight lines using Polar Randomized Hough Transform (RHT). Each best fitting lines have high scoring coordinates or peaks in (ρ,θ) space. To determine if two lines are parallel lines peaks with identical θ value can be paired. Usually the lane markers are parallel but due to some imperfections in lens, captured image variation in lane marker placements

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it may not be parallel always. So, the constraint of identical θ value needs to be loosened. This can be achieved by applying a tolerance window. The video is tested in real time videos and obtained good results.

Gopalan et al. [17] models the contextual information shared between lane marker with the surroundings are modeled using a pixel hierarchy feature descriptor. Here lane detection is done using a learning-based approach. The situation can be modeled as a two-class detection problem corresponding to lane marker and non -lane marker. Instead of using the local features of object in isolation here the information shared by the object with its surrounding scene is used. The pixel hierarchy-based descriptor is used to hierarchically analyze several visual features like intensity patterns, textures and edges based on the region surrounding each pixel corresponding to the object. Then from the contextual features the relevant features are selected using a robust boosting algorithm. For tracking the lane markers in subsequent frames particle filter is used. For tracking a static motion model is used to represent the state of particles.

Daigavane et al. in [18] developed a lane detection method based on ant colony optimization (ACO) is proposed. Initially, the input image is resized to 255 X 255 pixels for reducing the computation time. The three channel RGB image is converted to single channel grayscale image. Then, median filter is used to filter out noise and to preserve the edges. Next the edges are detected using Canny edge detector. The output binary image is given as input to ant colony optimization. It generates the additional edge information that is lost in Canny edge detection. ACO uses a number of ants which move based on the intensity variation in the image. Using a probabilistic approach, each ant moves until it reaches another line segment. After those edges are properly connected Hough transform is used to find out straight lines. The lines corresponding to highest peaks in Hough space is extracted as lanes.

Borkar et al. in [19] proposed lane detection based on Hough transform and iterated matched filters. RANSAC algorithm is used to avoid outliers due to noise and other artifacts in the road. Kalman filter is used to track the lanes. The first step in the algorithm is to convert the color image to gray scale and temporal blurring then on that image inverse perspective mapping (IPM) is applied. An adaptive threshold is applied on the IPM image to generate a binary image. Each binary image is split into two halves and each one contains one lane marker. A low-resolution Hough transform is applied on the binary images. A 1- dimensional matched filter is applied at each sample along the line to find the approximate center of each line. After estimating the center, RANSAC algorithm is applied to the data points for lane detection.

Kumar S. in [20] image and video processing module are used from OpenCV library for road lane detection problems. In proposed lane detection methods, low-level image processing algorithms and methods are used to extract relevant information for lane detection problem by applying contrast analysis at pixel level intensity values. Furthermore, the work at hand presents different approaches for solving relevant partial problems in the domain of lane detection. The aim of the work is to apply contrast analysis based on low-level image processing methods to extract relevant lane model information from the grid of intensity values of pixel elements available in image frame. The approaches presented in this project work are based on contrast analysis of binary mask image frame extracted after applying range threshold. A set of points, available in an image frame, based lane feature models are used for detecting lanes on color image frame captured from video.

3. STAGE OF THE PROPOSED SYSTEM

The objective to develop lane detecting and tracking systems is to provide safety and warning feature to the driver while vehicles moving on the road. lane-vehicle detection and tracking system is proposed in this paper as the flow diagram is depicted in figure 1.

Where proposed system consists of two algorithms important to in driver assistance systems. First stage of system is video stream from phone camera in real time then convert video to frame. take frame and apply lane detection algorithm then apply lane following or tracking algorithm. last stage is features extraction to guide the car to correct direction.

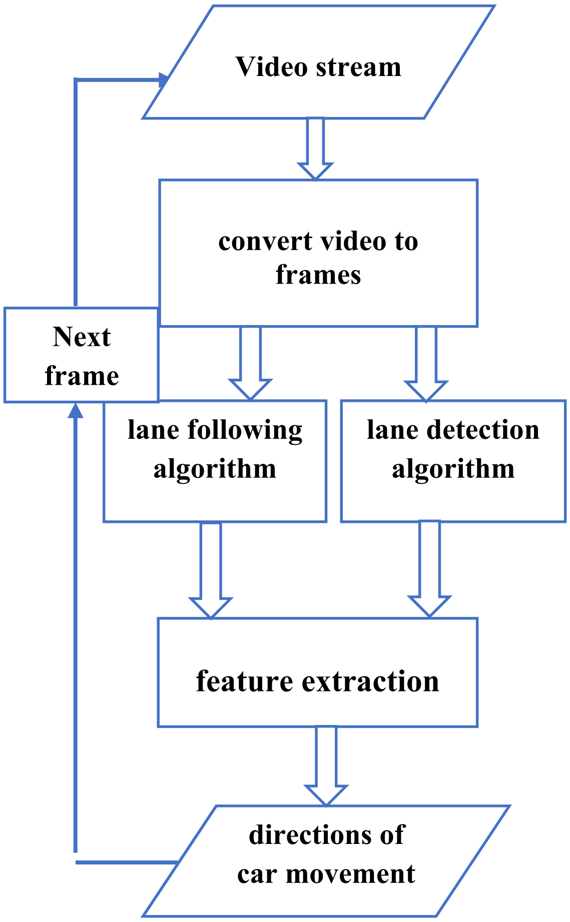

Figure 1: flow diagram for stage of the proposed system

3.1 Algorithm for Lane Detection

The methods applied in advanced driver assistance system applications based on image processing and computer vision methods.
In this stage explain lane detection algorithm. The method of lane detection comprises of many steps. The first take an image of road using a camera fixed on the car. The following flowchart describe the algorithm steps in Figure 2.

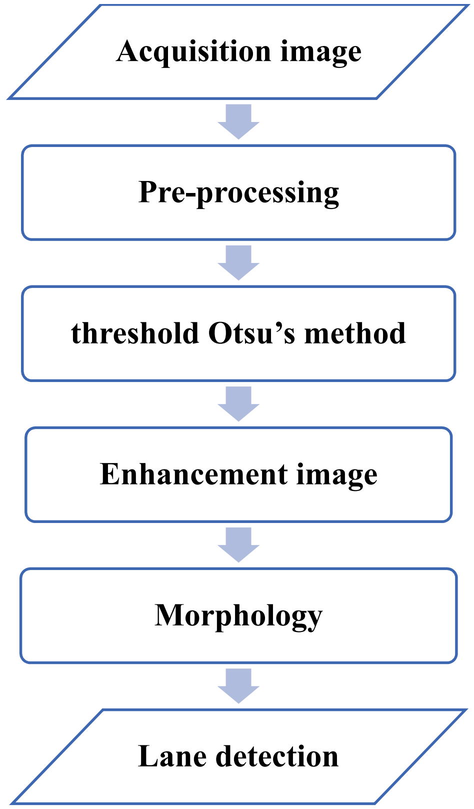

Figure2: flowchart for lane detection algorithm

3.1.1 Acquisition image/live video

The first task in image processing algorithm is to get live video feed from the phone camera or Image. This has also been converted to live video feed Sequence of frames which are used to apply image processing anther steps, as show in figure3.

Figure3: Original frame road

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3.1.2 Preprocessing image

The first functional module in the generic pipeline is image pre-processing [21]. Image processing algorithms can be distinguished to two levels, a low-level image processing and high-level image processing. The low-level image processing algorithms also called pre-processing algorithms usually used to perform basic image processing operations including converting image into different data structure, applying threshold methods, extracting relevant information like lines, circles, or different type of shapes and measuring image related parameters, for example, contour detection, Hough transformation, image histogram calculations, etc. The high-level image processing deals with the methods and algorithms in which the output of low-level algorithms is used as input parameters for further processing for designing and building computer vision-based applications [22].

In the pre-processing stage information, the position of lane markings is extracted from a frame and passed on to the lane detection or following step. The road grayscale image is preprocessed to remove interferences degradation in edge. There are several operations which can be applied to the image before feature extraction to reduce noise and enhance features of interest region.

Divide RGB image in its bands and find histogram to each band we use image in blue band that represent road area, as shown in figure4. in order to minimize the processing time, choose the lower part of image that represent the road area as shown in figure5.

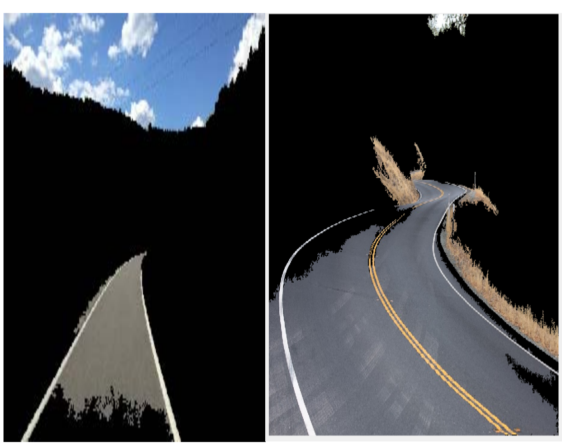

Figure 4: Blue band of image

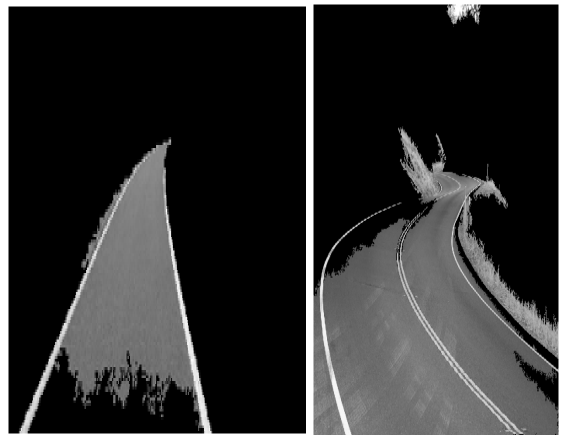

Figure5: Grayscale to blue band

3.1.3 Threshold by using otsu method

To create a binary image from a gray-level image we must perform a threshold operation. This is done by specifying a threshold value and will set all values above the specified gray level to “1” and everything below or equal to the specified value to “0.”

Although the actual values for “0” and “1” can be anything, typically 255 is used for “1” and 0 is used for “0” value. The “1” value will appear white, and the “0” value will appear black.

Otsu’s thresholding chooses the threshold to minimize the intraclass variance of the thresholded black and white pixels.

3.1.4 Enhancement image

To remove pixels which do not belong to the region of interest. We used function (**bwareaopen**) in MATLAB, that are removes all connected components (objects) that have fewer than **P** pixels from the binary image **BW**, producing another binary image, **BW2**. The default connectivity is 8 for two dimensions, as show in figure 6. Then apply morphology operation to thinning lane mark in road, show in figure 7.

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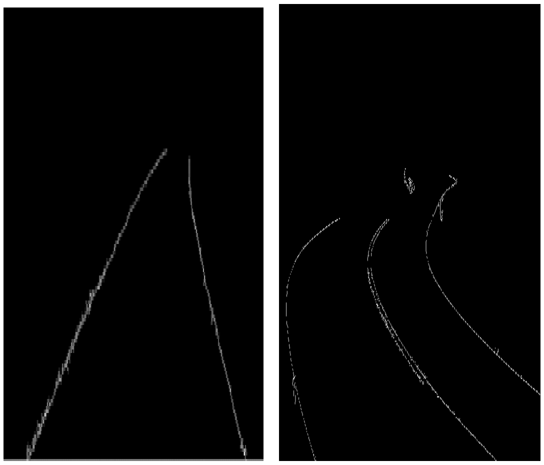

Figure6: Threshold and Remove pixel out road

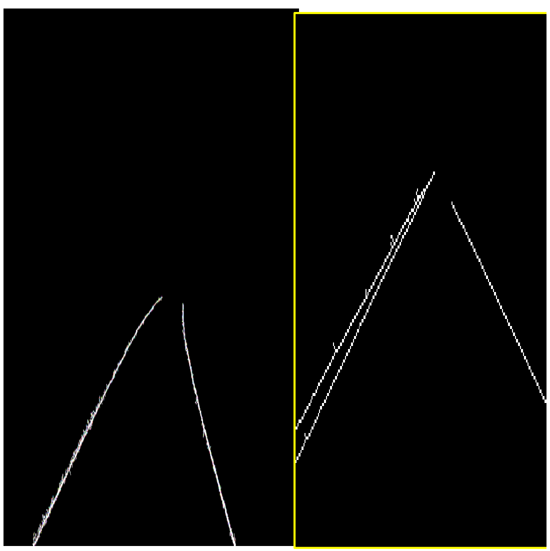

Figure7: Thinning to line in road

3.2 Lane Following Algorithm

The tracking of moving objects is one of a very important application of the computer vision. This section will show how the lane tracking in the road that helps auto-driving to determine direction of the road. The main goal of the work in this section is to robustly follow the lane road. The following flowchart describe the algorithm steps in figure 8.

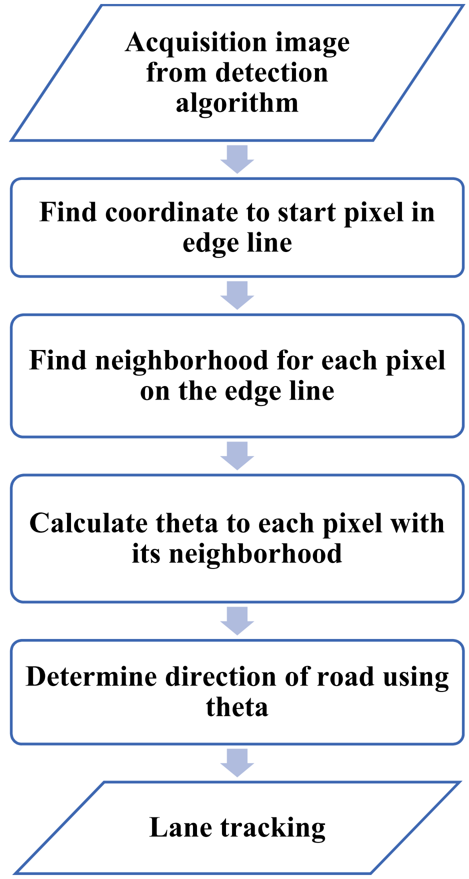

Figure 8: Block diagram of lane tracking algorithm

3.2.1 Input image

Acquisition image from previous detection algorithm, is used as input image of this algorithm. show in Figure 9.

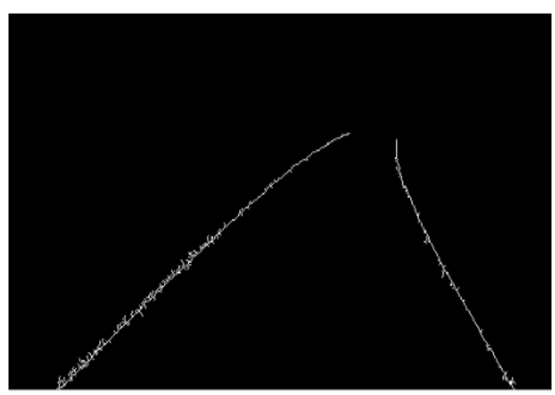

Figure 9:. image of lane detection

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3.2.2 Find coordinate to start pixel

This step to find coordinate of starting pixel in image by take window 3x3 and apply on image, as show in Figure 10.

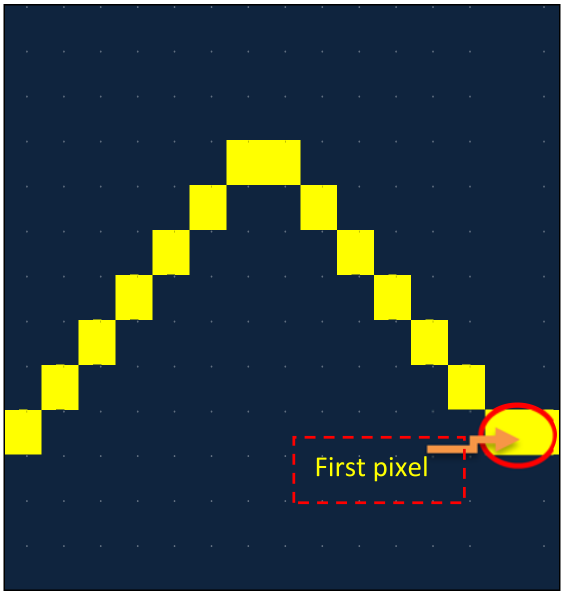

Fig.10. Find coordinate to start pixel

3.2.3 Find neighborhood

Neighborhood is the 4-connected and 8-connected sets, N4 and N8. This step to find neighborhood for each pixel on the line in 8 directions.as show in Figure 11.

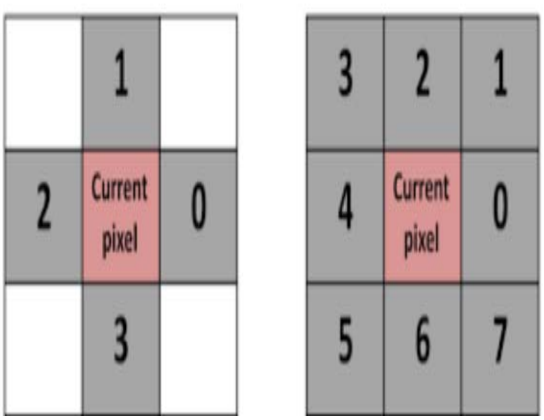

Figure 11: Neighborhood of pixel

3.2.4 Calculate theta to each pixel

Lane boundaries are marked by different types of lane marks. Where in our research se vector of theta that represent neighborhood pixel. The vector has sequence of values for theta. The value of theta may take one from the following values for each step (0,45,90,135,180) to determine the direction of the road image which is used in the next step.as show in Figure 12.

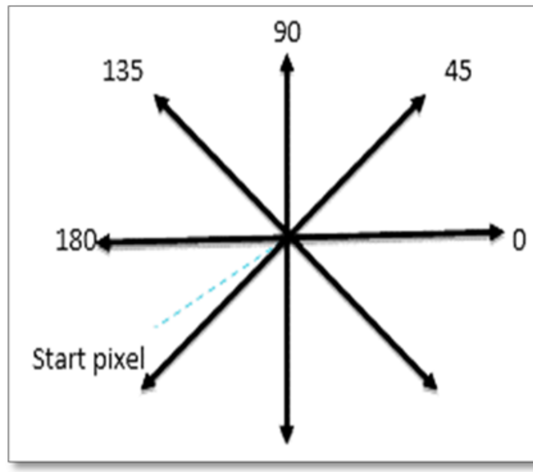

Figure 12: determine theta

3.3 Feature extraction

In this stage, the features are extracted from road image we have two features) parameters) the first feature is (delta) where delta is distance between left line and right line, Where the distance was calculated using the Euclidean distance if p = (p1, p2) and q = (q1, q2) then the distance is given by

$$d(p,q) = \sqrt{(q_1 - p_1)^2 + (q_2 - p_2)^2}.$$

The second feature is theta where theta is collected into $Theta_{road}$, and $Theta_{road}$ has a different value of theta for each pixel in two lines to the left and right. The value of theta is 0.45,90,135,180. Each pixel calculates its theta, and then a vector is based on these values (0.45,90,135,180) for the left line and also for the right line and then subtracting theta in the left line from Theta for the right-pixel line by pixel is a vector for the theta output of both lines. After that, we collect the resulting values to have a single value through which we determine the direction.

delta= L_{left} - L_{right}
Theta=SUM($Theta_{road}$)
$Theta_{road}$=$theta_{left}$-$theta_{right}$

if (delta>=-17 AND delta<=17) AND(theta>=-17 AND theta<=17) then **FORWARD**
if (theta<=-15 AND theta>=-60) OR (delta<-15 AND delta >=-40) then **FORWARD RIGHT**
if (theta<=-59 OR delta<-39) then **RIGHT**
if (theta>=15 AND theta<=60) OR (delta>15 AND delta<=40) then **FORWARDLEFT**
if (theta >=59 OR delta>39) then **LEFT**

4. COMPARISON OF VARIOUS LANE DETECTION AND TRACKING ALGORITHMS

In this section, Lane detection and following algorithms are discussed. Presents a detailed analysis of various lane detection and lane tracking algorithms. also investigates the best lane detection and following algorithms that can be selected for a specific road condition.

The method that offer it Y. U. Yim and S.-Y. Oh in 2003. Used in pre-processing sobel operator. And detection lane use hough transform and three feature vectors. Either in tracking use temporal predictor is used to predict current lane vector. Where Works fine for rainy and shady road.

Either method that offer it S. Sehestedt, et al. in 2007. Used in pre-processing Inverse perspective mapping. And in detection lane use weak model-based vector. Either in tracking use clustered particle filter. Where result is robust in difficult lighting conditions.

The method that offer it M. Aly in 2008. Used in preprocessing Inverse perspective mapping, selective oriented gaussian filters. And in detection lane use hough transform and RANSAC spline fitting. Where result is comparable results to Algorithms using both detection and tracking.

The method that offer it A. Borkar et al. in 2009. Used in preprocessing adaptive thresholding. And in lane detection use low resolution hough transform and matched filter. Where result is Robust in night time.

the method that offer It Y.-C. Leng And C.-L. Chen in 2010. used in preprocessing sobel operator. and in lane detection use heugh transform. where result is successful detection in worn-out road surface, signs, graphs, warning lines and image shaking.

The method that offerG. Liu et al. in 2011. used in preprocessing Color, position and gradient Descriptors and Sobel operator. and in lane detection use Statistical transform. either in tracking use Partitioned particle filter Where result is Computationally expensive.

The method that offer H.Jung et al. in 2013. used in preprocessing Steerable filter. and in lane detection use Haar like features. where result is Robust in illumination changes.

The method that offer it V. S.,Bottazzi et al. in 2014 . used in preprocessing Histogram. and in lane detection use Segmentation. either in tracking use Lucas-Kanade tracking. Where result is Robust in illumination changes.

the method that offer it Kumar S. in 2016. used in preprocessing binary mask image and applying range threshold. and in lane detection applying contrast analysis at pixel level intensity values. A set of points, available in an image frame, based lane feature models are used for detecting lanes on color image frame captured from video.

Our proposed method was used in preprocessing divide RGB image in its bands and find histogram to each band we use image in blue band that represent road area. Either in lane detection use threshold Otsu’s method and Enhancement image by using function (**bwareaopen)** in MATLAB. and in following lane we use Find neighborhood for each pixel on the edge line, calculate theta to each pixel with its neighborhood and Determine direction of road using theta. Where result is robust and efficient method for tracking road that used in driving car in special condition.

5. EXPERIMENTAL RESULTS

This paper explains a lane detection with lane tracking system based on image processing and computer vision methods. The algorithms are implemented in real roads which are take image and video sequences from web on internet “https://www.shutterstock.com/search.**”,** and video record from small car (4DW) in our city. By using

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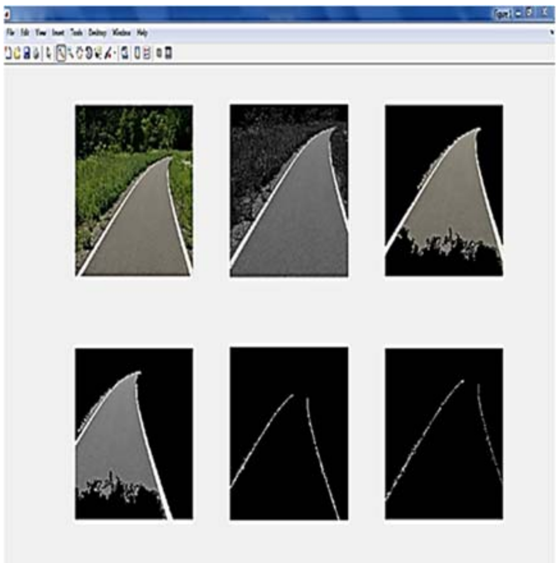
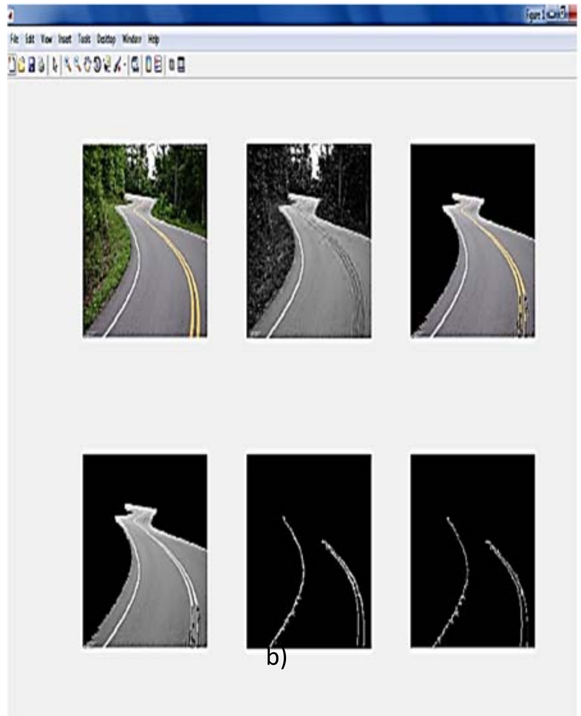
windows 7 operating system. Many of the basic image processing functions such as preprocessing to image, threshold, morphology operation and extract boundary to road using MATLAB environment ,Where using image to road and video input to MATLAB we read image RGB and extract bands to image and find histogram to each bands we use only one band is blue band that represent road area, and the convert image to gray and resize to reduce data , and take threshold by using Otsu's Method ,and then removes from a binary image all connected components (objects) that have fewer than P pixel, where result logic image (0,1) ,where one represent line pixel in image, as show in Figure13 is the final detection result



a)



b)

Figure 13: a) Apply lane detection algorithm on straight road, b) Apply lane detection algorithm on curve road

The results obtained from the Line Detection algorithm (road markers) are used to determine the direction of the road. Where the beginning of the path line is found and then find the limits of each pixel on the line representing the edges of the road, then calculate the angle of each pixel representing the direction of the road. Three features were extracted to determine the direction of the road which represents the length of the first line, the length of the second line and the sum of the differences the corners of the lines. The possibilities were either that the road was straight meant for the front or the road round either right or left, as show in figure 14.

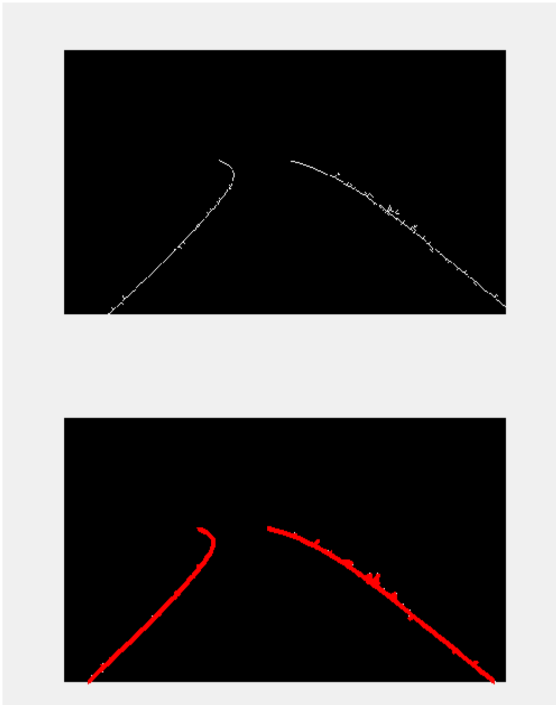


Figure14: Tracking line road

6. CONCLUSION

Lane detection and tracking are important because is an integral part of autonomous vehicle control system and used for a driver assist system and an auto driving system. In this paper, we proposed and implemented an efficient and robust algorithm for detecting and tracking lanes in road. The aim of research is to control robot driving by using image processing technique. Where we introduced two algorithms for self - driving techniques using image processing. The first algorithm is to detect the road lines to easier the process of following the road. used the use threshold Otsu's method and applied to the Blue Band image then the enhancement of image to remove noise and to remove pixels which do not belong to the region of interest by using the function (**bwareaopen**) in the MATLAB. This has found the road lines. This algorithm We applied them on different road. Then apply the tracking algorithm to know the road. Which helps the car in self – driving.

This algorithm is at first finding its first pixel that has Values one then find neighborhood for each pixel on the line to Calculate theta to each pixel with its neighborhood and Determine direction of road using theta.

finally applying the algorithms. we obtained a system capable of recognizing the path and direction of the road whether straight or round and other. The system was applied to real pictures of streets using video from a website https://www.shutterstock.com/search.

For future works, use Artificial intelligence techniques such as fuzzy logic, neural network and genetic algorithm .and using other image process technique as global threshold, canny algorithm in edge detection or Hough transform etc….

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