Automated Driving System of Lane Detection Using Image Processing Techniques

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***Abstract* - This research aims to develop automated driving system of lane detection using image processing techniques in order to receive the data of the surrounding environment and forward to the processor to make to the decision and command the car to move in the right direction and proper speed. Video recording of lane separating line has been made by using camera module. The results of lane detection system using images processing technique found that the system can be operated by taking images from the camera on the self-driving car and processed by the Raspberry Pi board using image processing from the car camera to detect and track the road. Experimental results of environments of the system show the effectiveness of designed program which detects the lane precisely as 90 percent when driving during the human risk caused by driving and to help the disabled to be able to travel independently, so the research offers the methods in using the automation to control the cars instead of human control.**

***Keywords* - Self-Driving Car, Lane Detection, Hough Transform**

I. INTRODUCTION

Recently, the traffic around the world has increased which impact the demand for safe driving of the population at a higher level as well as the demand for reducing the road accidents [1]. Due to the increase of the driving population, the drivers should drive with caution in order to prevent the potential accident. In driving vehicles, the most important and dangerous is the traffic lane changing, as there are more than 250,000 accidents per year in United State caused by the lane changing and the accidents also happen in every 2 minutes [2]. The more important thing is road accident and death severely impacting the individual, community, and nation as the cost in curing a large number of injuries puts a heavy burden on the health care system, also requires the limited hospital beds and resources. This results in loss of productivity and hinders the country's prosperity which crucially affects the society and the economy. The number of accidents also indicates that it is the health and development crisis that expected to be more severe if not resolved [3].

It is mentioned that the human capacity to control vehicle may have various limited factors and it might due to the condition of the driver who is not ready such as exhausted from not enough rest, high alcohol level or various organ deficiencies. Moreover, there are limitations from road conditions while driving, which cause bad vision, driving on an unfamiliar road or the limitations from driving on the risk environment such as violent situation area or hazardous toxic area. This research aims to decrease the human risk caused by driving and to help the disabled to be able to travel independently, so the research offers the methods in using the automation to control the cars instead of human control [4].

The Automated Driving System is something that manufacturers have developed for a long time, however, the important problem of the development is the practical use on the road. The Automated Driving System in the cars is extremely different from the Automated Driving System in the planes, but the manufacturers are still trying to develop the system. Nowadays, the cars are Semi – autopilot or half automated which the cars are moving automatically with the drivers are taking care and responsibility for their own safety. The Semi-autopilot used 4 keys technologies to build the cars, namely; Computer Vision, Deep Learning, Robotic and Navigation. The general working system of the Self-driving car is receiving data through a camera or sound waves and then processing with Deep Learning, then uses to that data from Deep Learning (ex. Reduce speed sign) turn to the command to drive the car [5].

From all the above information, the researcher has main concept and goal to develop the Automated Driving System that detects the road with Image Processing Techniques in order to receive the data of the surrounding environment and forward to the processor to make to the decision and command the car to move in the right direction and proper speed.

II. LITERATURE REVIEWS

Marmoiton, Collange, and Dérutin [6] used the images with the monocular vision of the car camera, and the Kalman filter to estimate the relative trajectories of the vehicles which marked at both right and left tail lights and on the roof. The application program of the system can control the speed of the automated driving cars. In the test, the system can estimate the relative vehicle speed with a 10% error due to the different conditions of driving.

Ponsa and López [7] performed the analytical theory about the use of images with the monocular vision attached to the vehicle in order to track and estimate the 3D dynamics of other vehicles. Their research showed the vehicle detection accuracy and it's possible that the system can identify the movement of the vehicle precisely, however, the system has not been tested with the actual image data.

Wedel el al. [8] presented an algorithm for detecting vehicles and other objects in view of the camera. The first step is to trace the area of interesting images to create a hypothesis for depth estimation. Then test the hypothesis if the change of the tracked area corresponds to the size of the obstacle set by the hypothesis. The research team may use this algorithm to set the hypothesis and track the scope of the vehicle in the images.

Viloa and Jones [9] it is the algorithm widely used in car searching. Most of the algorithms developed from this algorithm, such as Stojmenoiv M., [10] who developed the algorithm to work faster using small training to erase the parts that are not likely related to the cars, which make the data processing a lot faster.

Wang, Teoh and Shen [11] presented the method called B-Snake to detect the driving lane and the principle is that the parallel road which is sent as the perspective will be projected into a B - Snake model which is the B-spline functions with 3 or 4 control points. Then the Optometric estimation Canny / Hough (CHEVP) method can be used to estimate the starting value of B-Snake model that used for real-time driving lane detection. After that, the Gradient Vector Flow (GVF) is used to find the external force field that will minimize the mean square error between the image's edge and the B-Snake model. Then set the parameter of the B-Snake driving lane model repeatedly throughout the operation.

III. SYSTEM MODELING AND DESIGN

A. The Automated Driving System Development [5, 12]

The vehicle with the Automated Driving System in this research is adapted from the small self-driving car. The size and structure of the car were designed and formed by the small 3D Modal. In this self-driving car modal has a motor and battery to move the car and the driving system can be driven forward only in fig. 1.

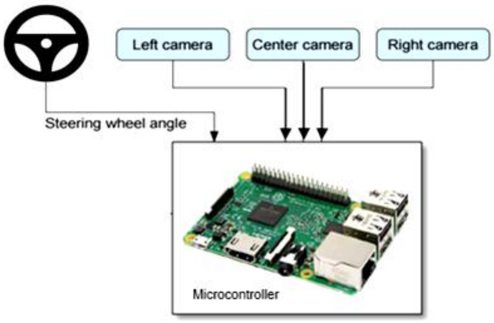

Fig. 1 The High Level View of the Dataset Data Collecting System [5]

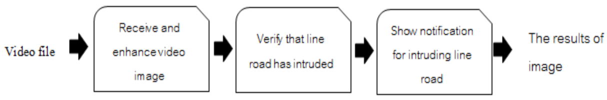

Fig. 2 The Feature of the Self-Driving Car Lane Line Detection System

From the fig. 2, shows the structure analysis of the lane line detection system comprising the key components that are car camera and controller processing board set for image capture. The system starts by recording the data image of the self-driving car camera and sends the data to the controller board set to do the frame grabber process and record the data image in. avi. Then the image signal analysis program will process the recorded data image [13]. This research aims to make the controller board set to monitor the image of the road line whether it gets crossed or not and it will alarm when the line is crossed.

B. Algorithm Design for Development [14]

For the algorithm design for development and the software design for system development by programming the operating system as follows:

- **Receiving VDO File**

In developing this system can receive the Video file in format .avi in the Streaming form and it is the first step of the motion capture algorithm. The image will be as clear as the capability of the camera that used to record without further setup and the image receiving detail can be described.

- **Frame Separating Process**

The operation of this process is the system will analyze the recorded video file and deport to the video frame separating process by reading the video file data which stored in the Stack array. Then the system will set the variable to separate the minor frame in the Array image variation. After all the frames are separated, the system will store them in the Frame buffer which shown in the storage module for analyzing in the next step.

- **Quality Development**

In this step, the system will bring the frame from the frame separating process in the storage module to be analyzed in order to determine the area of the detector or the monitor area in the image. This system is the road part image that starts by bringing the frame of RGB color in 3 stack array that store data of the red, green and blue image stacked sequentially into intensity process, as shown in function hColorConv1 = vision. ColorSpaceConverter (...'Conversion', 'RGB to intensity') for the quick processing in the next step. After this process, the image will be Y'CbCr.

- **The Edge Detection**

Processing the 2-D filter using the image filter system object to detect the image edge in the imported video. Moreover, the using of edge detection technique to find the edge of the image which helps with the more accurate detection.

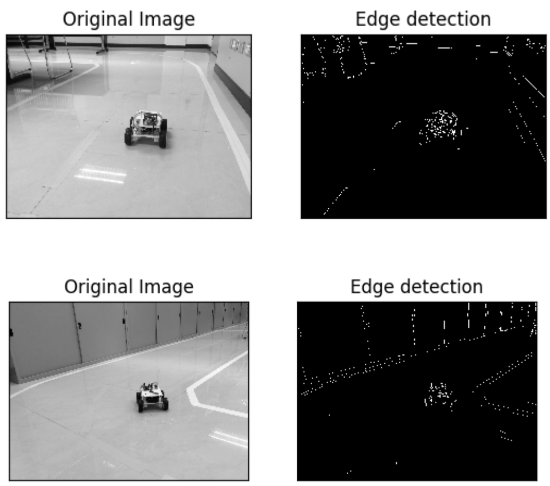

Fig. 3 The Result of the Edge Detection

- **Threshold Configuration**

To convert the intensity of the input image into a binary image by setting the Auto threshold which is the fundamental setting of the system with the code as follow:

hAutothreshold = vision. Autothresholder

- **Calculate the Hough Transform**

The system will segment the image to find the lane line using Hough line transform technique in finding the straight line, curve line, and circle in the image. Fit straight line with CHT using a polar equation that is:

When x, y is the coordinate of the image point of x, y level.

ρ is the distance perpendicular from the straight line to the point in the level x, y.

θ is the angle from the x-axis to the perpendicular.

- **Finding the Peaks**

After calculating with the Hough transform to find the peaks of the Hough transform using Local Maxima Finder object to find the maximum value in the matrix of input image data, use syntax that consisting of the matrix input I, LocalMaximaFinder object, H.

- **Finding a Cartesian Coordinate System of Lane Line**

Creating the Hough Lines System objects to find the Cartesian coordinates of the lane line. The basic division of the line in Hough transform can be divided into 2 functions in order to explain the meaning of parameter and find the line as follows:

lines = houghlines(BW, θ, ρ, peaks)

Whereas BW relates to bins in Hough transform. Theta(θ) and rho(ρ) are the vectors from Houghpeaks function or the matrix from the Houghpeaks function that comprise with connected rows and columns of the Hough transform. After that, use the parameter and/or pair of values as follows:

lines = houghlines(…, param1, val1, param2, val2)

This function specifies the distance between two lines in the same Hough transform bin. If the distance is less than the specified value, the houghlines will merge them as a single line.

IV. RESULTS

In the lane line detection system using image processing technique, the researcher performed the test by setting up the video camera for tracking and recording the movement of the self-driving car in order to detect the lane line. The video file reader object was created to read the input video, separate video into an image frame, convert an RGB image into Y'CbCr image, create image filter and image edge detection, configure the threshold to get the binary image then use Hough transform technique for lane line detection. The researcher designed the algorithm and the algorithm efficiency test results for lane are as follow:

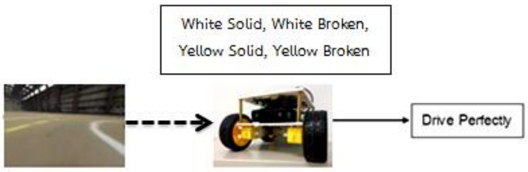

Fig. 4 Shows the Camera Used to Record the Steering Control of the Self-Driving Car

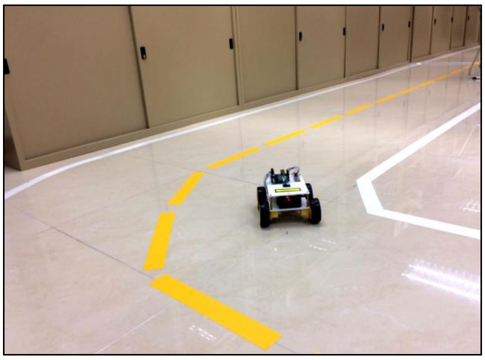

Fig. 5 Shows the Self-Driving Car Test Drive in the Laboratory

From fig. 6, the system algorithm was designed, started with receiving the video files using the video camera with 160 x 120 pixels and processing speed 60 frames/minute on the notebook computer, then ran the system using the controller board processing. After that tested it on the roads with different color and line styles, so that the system can detect all types of them. Next divided the road, according to colors namely; yellow and white lane line, also divided by the line styles namely straight line and dash line. This test shows the line detection by showing the colors and texts on the detected lane line which are white, yellow and black, also the text color shows the actual color of the lane line. The algorithm design can be divided into 2 types as follows:

Then evaluated the performance of the built road algorithm 20 times. Tested the system by considering the appropriate position in the installation of a self-driving car camera. The test was divided into 4 times, details as follow:

(A) Yellow Dash Line and Lane Changing
(B) Yellow Dash Line / Yellow Straight Line

Fig. 6 Shows the Lane Line Detection System Using an Image Processing Technique

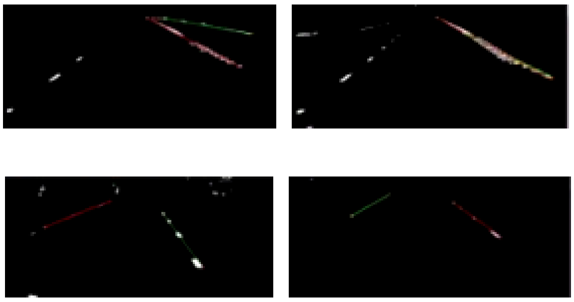

Fig. 7 Lane Detection Results by Hough Transform

The fig. 7, the self-driving car test drive using the image processing technique to the specific extent. Each video files created by the connecting the images, each image in connection is called a frame. The colors were used to code so the system can show the detected lane line on the computer screen while moving which the yellow line shows left lane detection, white line shows the right lane detection, the black line shows the detection of the other road besides the pair lane and blue polygon shows the tracking lane line by covering the area with the lane line detected. Then evaluated the performance of the algorithm 20 times and tested the system by considering the appropriate position in the installation of a self-driving car camera.

V. CONCLUSION

The development of a self-driving car with the lane line detection system using images processing technique found that the system can be operated by taking images from the camera on the self-driving car and processed by the Raspberry Pi board using image processing from the car camera to detect and track the road. From the algorithm tests for 20 times found that the real-time lane line detection system can work well. The system is 90 percent accurate in an environment where there are no objects or obstructions, the road is clearly seen and the light not too bright, so the system can detect the color code on the lane line as well as can great track of traffic lane. The researcher has guidelines for further improvement by developing the system so it can be used in the self-driving car which helps driving on the road more safety and reduce the accident caused by the negligence of the driver.

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(Arranged in the order of citation in the same fashion as the case of Footnotes.)

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