DEVELOPMENT OF A ROAD LINE DETECTION ALGORITHM FOR MONITORING DRIVING PATTERN

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This Report Is Submitted In Partial Fulfilment of the Requirements for the Award of Bachelor of Electronic Engineering (Computer Engineering) With Honours

Faculty of Electronic and Computer Engineering
University of Technical Malaysia Melaka

June 2016

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN

PROJEK SARJANA MUDA II

Tajuk Projek : DEVELOPMENT OF A ROAD LINE DETECTION ALGORITHM FOR MONITORING DRIVING PATTERN

Sesi Pengajian : 1 5 / 1 6

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Special dedication to my family, supervisor Dr Masrullizam Bin Mat Ibrahim and friends in FKEKK for their supports and help.

ACKNOWLEDGEMENT

I would like to express my grateful to Allah S.W.T for blessing me with a good health, knowledge and strength to finish my thesis writing and final year project successfully.

My special thanks to my supervisor, Dr Masrullizam Bin Mat Ibrahim for conducting me during this final year project studies. A lot of guidance and knowledge provided by him, helped me during my final year project studies. I would like to thanks to all lecturers who are involved for giving their opinions, information and suggestions in my project.

I would like to thanks to my parents for their support especially morality support throughout my studies. They have been my inspiration since I started my degree studies in University of Technical Malaysia Melaka (UTeM). Besides, a very special dedication I rewarded to all master students who helped me a lot in completing this project. This thesis is a part of their contribution.

Lastly, I would like to thanks to UTeM for giving me the very best facilities during my studies, and my dearest friends who helped me a lot to complete this thesis writing.

ABSTRACT

Lately, the road accidents contribute a very high accident rate which involve in death. The main cause because of human error such as distraction and careless behaviour while driving is the biggest factor of road accidents. Road line detection system is one of the systems of the Automated Car Driver Assisted system. The Road line detection is aimed to give warning to the drivers when the vehicle starts to veering off from the actual lane towards lane boundary without any intention of the driver to change from the initial lane path. This system is aimed to reduce the number of road accident that are frequently happened because of the driver behaviour, distraction and drowsiness. This Road line detection system can also be advantageous in many real world applications such as security control freeway, driving training, autonomous navigation and the visually impaired assistant. The Road line detection system is based on visual sensor using camera that is usually placed behind the windshield of the vehicle, laser sensor which is attached in front of the vehicle and infrared sensor which is attached either behind the windshield or beneath the vehicle. While driving, it is unknown whether the driver driving with normal behaviour or not. Hence, this project is aiming on the lane detecting and tracking by using vision sensor. This main purpose is to study the technique used to detect the road road line detection and tracking by using vision sensor (camera). In order to achieve the main objective, the other objectives must be achieved are to develop the best algorithm of the road road line detection and lane tracking and to read the driving pattern using the developed algorithm. Overall, this system is able to enhance lane boundary information to drivers.

ABSTRAK

Pada masa kini, kemalangan jalan raya menyumbang kepada kadar kemalangan yang mengakibatkan kematian. Punca utama adalah kerana keadaan pemandu seperti gangguan dan kecuaian ketika memandu merupakan faktor kemalangan yang paling besar. Sistem Pengesanan Jalan adalah salah satu sistem Bantuan Pemanduan Kereta Berautonomi. Matlamat Sistem Pengesanan Jalan ini adalah untuk memberi amaran kepada pemandu apabila kenderaan mula bergerak keluar dari jalan tanpa niat untuk menukar laluan. Sistem ini bertujuan untuk mengurangkan kadar kemalangan jalan raya yang disebabkan sikap pemandu, sebarang gangguan dan keletihan pemandu ketika memandu. Sistem ini boleh diaplikasikan kepada situasi sebenar seperti kawalan keselamatan lebuh raya, latihan pemanduan, navigasi autonomi dan pembantu kepada pengguna cacat penglihatan. Malah, Sistem Pengesanan Jalan ini berdasarkan sensor visual pada kebiasanya dipasang di belakang cermin depan kenderaan, sensor lesor yang dipasang pada bahagian hadapan kenderaan dan penderia inframerah yang dipasang sama ada di belakang cermin depan atau di bawah kenderaan. Semasa memandu kenderaan, ia tidak diketahui sama ada pemandu memandu dengan kelakuan normal ataupun tidak normal. Maka, projek ini tertumpu kepada pengesanan dan penjejakan jalan menggunakan sensor visual. Tujuan utama adalah untuk mempelajari teknik-teknik yang boleh digunakan dalam pengesanan dan penjejakan jalan menggunakan sensor visual (kamera). Untuk mencapai objektif utama, objektif lain mestilah dicapai bagi mendapatkan algoritma dalam sistem pengesanan dan penjejakan jalan ini untuk menganalisa bentuk pemanduan. Kesimpulannya, sistem ini boleh memberi informasi mengenai kedudukan kereta di atas jalan raya kepada para pemandu.

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CHAPTER 1

INTRODUCTION

1.1 Project Introduction

Research shows that accident happens are caused by human behaviours that is because of driver‟s lacking skill. To ensure the safety and security of automobiles and passengers, apparently, some car system technologies have been developed such as forward collision prevention and lane keeping assist. The technologies may help preventing accidents, thus, reducing accident rates.

Traffic accidents have become one of the most serious problems. The reason is that most accidents occur due to slackness of the driver. Careless and slack driving can push other drivers and passengers at risk on the roads. More and more misfortunes could be escaped if such risky driving condition is detected early and warned especially to the drivers. Mostly, cameras and speed sensors are being used for observing and detecting drivers who surpassed the permitted speed limit on roads and motorways.

Basically, this project, the road line detection project is designed to help prevent a sleepy or distracted driver from accidentally drifting out of his or her lane. Most importantly, this project is to alert drivers. The analysed driving pattern can show the condition of the driver, either in good driving condition or in dangerous driving condition. This is one of the way to monitor the driving condition.

A camera is used to capture images along the road parallel with cars. It uses camera to detect lane markings and triggers a warning if the car try to penetrate and

out of the line. Besides, the system will also trigger even when the car approaches near to the line. This can also be used for a road detection in urban traffic.

An algorithm of a road line detection algorithm is analysed using MATLAB Software. Full coding of MATLAB need to be programmed in order to give the best result. The algorithm produced in MATLAB software is expected to be able to detect road line successfully. It is then able to show output based on Graphical User Interface (GUI).

1.2 Objectives of this project

The main goal of this project is to use the best method of the road line detection system. Specifically, the main objectives of this project are:

- To develop road line detection algorithm.
- To analyse and evaluate performance of the developed algorithm.
- To read the driving pattern using developed algorithm.

1.3 Problem Statement

While driving, it is unknown whether the driver is driving in the correct behaviour or not. Human error such as distraction while driving is the biggest factor of road accidents. Mainly, this project is a mechanism to alert drivers to help preventing a sleepy or distracted driver from accidentally drifting out of his or her lane. This may results in reducing numbers of accident caused by human error. Therefore, a road line detection is focusing on detecting and tracking with the use of camera vision sensor.

1.4 Scope of Project

The scope of this project is to detect the road line. At first, a camera is used to record road line. The camera recording is during the day time in an offline mode.

A full algorithm based on a specific method is programmed using MATLAB software. The algorithm is used to detect all white road line. After that, the driving pattern is read based on how the vehicle move towards the line.

1.5 Project Limitation

This project has a limitation of the study. In this project, only about a kilometre of recorded road lane will be used for testing. Only MATLAB software will be used to analyse the algorithm.

Besides, the camera recording is during an offline mode. This means that the algorithm is programmed and analysed only for recorded image.

1.6 Report Structure

This thesis is the combination of five chapters that contains the introduction, literature review, methodology, result and discussion and the last chapter is the conclusion and recommendation of this project.

Chapter 1 covers the introduction to the project. In this chapter, we will explain the background and objectives of the project. The concept behind this project and an overall overview of the project also will also be discussed within this chapter.

Chapter 2 tells about the literature review of the road line detection upon previous research done. Based on the research, all methods that have been done can be referred well. Chapter 3 will explain about the project methodology. This chapter will show the steps and flows for problem solving technique in such a specific method. The method used will also be discussed.

Chapters 4 describes the outcome results from this project and this may justify the project performance so that it meets the objectives of the research. Then, the behaviour of drivers can be analysed well too. Finally, Chapter 5 concludes the whole research and proposes the future progress of the project.

CHAPTER 2

LITERATURE REVIEW

This chapter will explain and discuss about the literature or research which is related to the road line detection including the method used that has been studied from different resources to perform this project.

2.1 Road Line Detection Overview

Road line detection is very important to drivers. Road line detection is a well-researched area of computer vision with application in autonomous vehicles and driver support systems as one of safety features.

There are some of the most remarkable improvements in technologies and they can aid a safer driving includes Adaptive Cruise Control, Anti-Lock Braking System (ABS), Automatic Parking and Blind Spot Monitoring [3]. For example, adaptive cruise control systems help to sense vehicles forward and regulate the speed to retain a safe following distance while blind spot monitor are the sensors around vehicles that give warning when nearby car is detected.

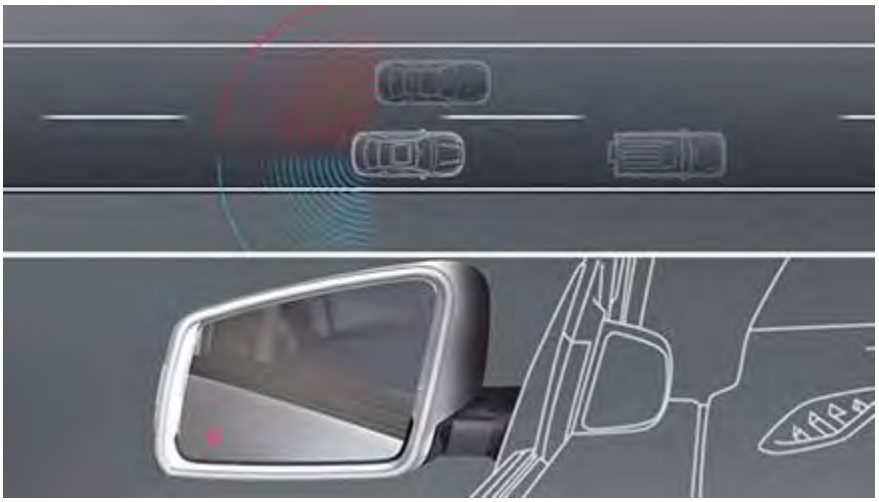

Figure 2.1: Blind Spot Monitoring using Sensors

Moreover, there are various sensing techniques can be used for movement detection and surveillance. This includes image processing and sensors. Figure 2.1 showed an example of sensing technique. Blind Spot Sensor automatically notifies any upcoming objects or vehicles in a blind area [3].

The obstacles on the real road lane line roads are often because of few degradation factors, such as shading of white paint, low condition on crack roads, and so, in the finding process, to attain a high performance and reliability is very problematic. With that, the algorithm of detecting this road line detection must be in full optimization. Mostly, the road lanes seems as well-defined, straight-line structures especially in highways, or as curves. The linear HT (Hough transform), a popular line detection algorithm, is widely used for road line detection [14]. The HT is a parametric representation of points in the edge map. It consists of two steps, "voting" and "peak detection" [15] [16].

As a video was documented along the roadways, the white line will be observed and analysed carefully. However, it can be very challenging to determine road line markings on various types of road. These difficulties arise from shadows, occlusion by other vehicles, changes in the road surfaces itself, and different types of paint used in line markings. A road line detection system must be able to pick out any type of markings from cluttered roadways and analyse them to produce a reliable estimate of the vehicle position.

With that, there are many methods that have been produced and proposed by researchers in order to increase the performance road line detection system. These

methods are believed to be the most effective methods to be approachable in the road line detection system.

2.1.1 Research Study

The study research based on road line detection system has been widely explored by researchers, the researchs are taking into consider of different techniques and methods to be perfomed. Mostly, the research field explored are for enhancing the analysis of image and video processing.

2.1.1.1. Linear Fuzzy Space Mathematics

Linear Fuzzy method is a mathematical model of inexact point objects to determine the maximal space between inexact point objects. The best way to describe a road is to identify lane marks.

Figure 2.2 showed the fuzzy filter „„line like““ which extracts number of points holding just two single connected fuzzy points (extreme points) and a limited dual linked fuzzy points, fuzzy points that are fuzzy equivalent with not more than two other fuzzy points from the set, where the sum of the distances of all fuzzy coincident points from the set is sufficiently close to the distance between extreme points [17].

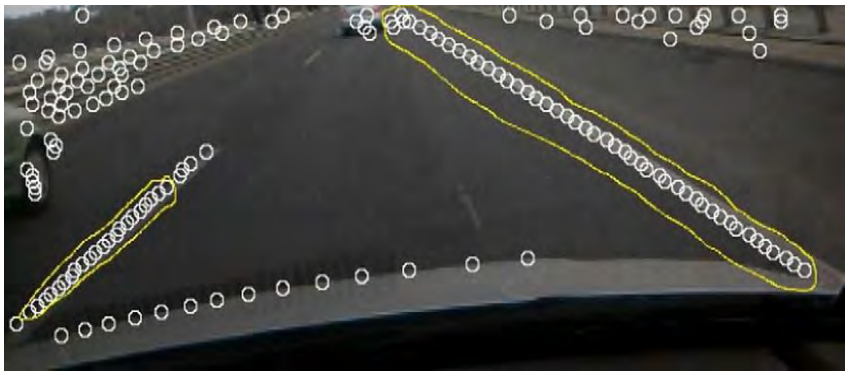

Figure 2.2: Two primary ‘‘line like’’ fuzzy linked sets of fuzzy points.

2.1.1.2. Lane Feature Extraction Approach And The Gaussian Sum Particle Filter (GSPF)

This method is based on zooming into vanishing point of the lanes. So, the lane markings or boundaries can only move on the same straight lines they are on. Objects other than the lanes in the frame do not share this property and can be ignored during the model parameter estimation. Three types of tracking algorithms are compared, that are the original Sequential Importance Resampling (SIR) particle filter, the Gaussian Particle Filter (GPF) and the Gaussian Sum Particles Filter (GSPF).

Besides, this method is able to recover the feature extraction and subsequently improves road line detection and tracking performance. It applies the global lane shape data and is capable to extract feature points that are probable belong to the lanes as well as refining the feature map. A good feature map allows a higher detection rate and more accurate detection results.

When applying the SIR particle filter, a problem of lying in the parameter range stage occurs. Even if the later probability density of the parameters is offered, a set of parameters to symbolise the original lanes is very difficult to be picked. In difficult surroundings, if the mean is chosen, the final outcomes can be swayed by non-zero mean noise and become imprecise. While comparing with the SIR particle filter, the GPF and the GSPF do not need resampling, which are co-operative for parallel implementations with fewer processing power.

Figure 2.3: Vanishing points using GSPF

The lane boundaries in each image segment are treated as piecewise straight lines. Thus, the correct vanishing point positions, as in Figure 2.3, is used for dissimilar image sections are able to be found so that the zooming process for different image sections can also be divided. The proposed feature extraction method produces feature maps with the least noise which permits the act of all three tracking algorithms to be enriched dramatically [18].

2.1.1.3. Robust Road line detection and Low Illumination Conditions Using Local Gradient Features

This method is using processing grayscale images of local gradient structures, characteristic spectrum of lanes, and linear prediction. All points on the nearby right and left lane are documented via the local gradient descriptors. A simple linear prediction model is positioned to estimate the path of lane markers.

This method starts by extracting the single frames from video and processing every frame to identify and track the road lane markers. The vertical gradient is chosen to eliminate effect of silhouettes along the road which are frequently horizontal shape as shown in Figure 2.5. To differentiate between computed lane markings and predicted markings, blue and red box-shaped are used.

Moreover, this method does not need threshold value to transform the gradient image into binary image and so not affected by illumination circumstances and shadows. The vertical gradient I every image is gained by 2-Dimensional discrete convolution of an image I (m, n) with h (m, n) [19].

$$G(m,n) = I(m,n) * h(m,n)$$

where h (m, n) is a mask given by

$$h(m,n) = \begin{bmatrix} 1 & 1 & 1 \\ 0 & 0 & 0 \\ -1 & -1 & -1 \end{bmatrix}$$

Figure 2.4: Method to Calculate Vertical Gradient in Feature Extraction

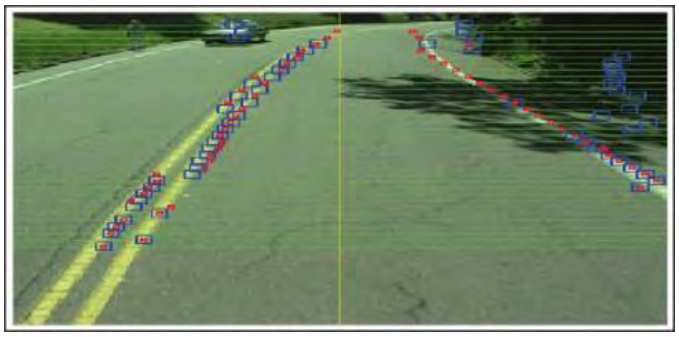

Figure 2.5: Computed lane markings (blue box), and predicted markings (red dots) plot on the vertical gradient image

2.1.1.4. H-Maxima And Improved Hough Transform

This method is using local gradient features, characteristic spectrum of lanes, and linear prediction. All points on the adjacent right and left lane are acknowledged using the local gradient descriptors. A simple linear prediction model is organised to foresee the direction of lane markers.

Basically, this method describes the area of interest from input image to cut searching space, that is the image is divided into near and far field of view. For near field of view, Hough transform has been used to detect lane markers after the process of noise filtering. This method has been urbanised via image processing programming language platform and is verified on video data.

The h-maxima transformation calculation can be defined by the method below:

$$\mathrm{HMAX}_h(g)=R_P^{\lambda}(g-t)$$

Where g expresses an intensity image;

the h-maxima transform H is used for suppressing all maxima in the intensity image;

t means threshold.

R represents the reconstruction.

R_P^λ is the morphological reconstruction by g.

Improved Hough is implemented within ROI limits, cut image pixels that link Hough transform and by correct range of angle θ, which is between its maximum and minimum values.

2.2 Summary of the Literature Review

After the literature review process regarding the project algorithms, there are few methods that are suitable to be used as references. The method that is chosen for this project is the detection of road lane in a video processing by Parajuli, A., Celenk, M., & Riley, H. B. [19] due to the better efficiency in offline mode algorithms and can track roads lane markers of various shape whether in curved or straight lines and trace exact lane marking points on each horizontal image line which is unaffected by shadows.

The practice of the pre-processing stage to filter the interference and noise in the footage recorded for better efficiency should made. Then, the pre-processing for road line detection should also be applied in a region of interest (ROI) and edge detection to ease the road line detection process.

CHAPTER 3

METHODOLOGY

In this chapter, the methodology step includes the collection of theories on the image pre-processing and classification of driving pattern based on line detection. It also includes about the MATLAB used for reading the driving pattern using developed algorithm. The information can be done from searching the related topic literatures, white papers, technical and proceeding papers, product data sheets, web pages and also through other projects. The methodology is referred as a guideline before the final result can be successfully obtained.

3.1 Project Planning

This project has been planned before it gets started in order to obtain the expected result. The project planning is represented in the Gantt chart. Table 3.1 shows the project planning since semester 1 to semester 2 in the year of 2015 and 2016.