UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF VEHICLE BLIND SPOT DETECTION SYSTEM USING FPGA

This report is submitted in accordance with the requirement of Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Computer Engineering Technology (Computer System) with Honours

by

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Computer Engineering Technology (Computer System) with Honours. The members of the supervisory is as follow:

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ABSTRAK

Pada masa kini, kemalangan jalan raya telah kerap berlaku tidak kira sama ada di lebuh raya atau jalan raya di kebanyakan negara. Setiap tahun kemalangan jalan raya semakin meningkat dan telah menjadi kritikal pada satu tahap. Antara faktor yang menyebabkan kemalangan jalan raya adalah titik buta pada kenderaan yang hendak memotong atau menukar haluan. Sikap pemandu yang tidak berhemah adalah salah satu faktor yang menjadi punca kemalangan jalan raya. Oleh yang demikian, projek ini akan mencipta satu algoritma dengan menggunakan sensor untuk mengesan jarak antara objek atau kenderaan yang berada di titik buta. Algoritma ini menpunyai dua bahagian iaitu isyarat sebelah kanan dan isyarat sebelah kiri dan di kawal oleh sensor yang berasingan tempat. Sensor ini ditempatkan di bahagian titik buta kenderaan dan akan aktif apabila isyrat kanan atau kiri di gunakan. Apabila sensor aktif, ia akan mengesan objek atau kenderaan di bahagian titik buta dan mengeluarkan isyarat pada pemandu tentang jarak antara objek selamat atau tidak. Komponen yang telah digunakan untuk projek ini adalah FPGA board, ultrasonic sensor, dan LED. Bahasa pengaturcaraan yang digunakan untuk projeck ini adalah Altera Quartus II. Projet ini telah berjaya dilaksanakan dan kesemua objektif telah dicapai.

ABSTRACT

Nowadays, road accident often occur regardless of whether on highways or normal roads in most countries. Every year road accident was increased and become critical at one of stage. There are several factor that cause road accident such as blind spot on vehicle that are trying to bypass a car or changing lane. This problem occur because of human error that does not follows regulation while driving. Therefore, this project has been develop to overcome this issue. This project will create an algorithm that capable to give an indicator or signal to the driver by using sensor to detect the distance between object and vehicle at the blind spot of a car. This algorithm has two section which are for left signal and right signal that are controlled by separate sensor. The sensor will be place on each side of blind spot area of a vehicle. Once the sensor are active, it will detect the distance between an object that inside the blind spot area and will alert driver whether the distance are safe to change lanes or not. The component that has been used to run this project are FPGA board, ultrasonic sensor and LED. The programming language that has been used in this project is Verilog and the software are Altera Quartus II. This project was successfully implemented and all the objective has been achieved.

DEDICATIONS

Alhamdulillah..

Thank Allah because of His grace, I have been able to prepare this project successfully. Appreciation to my beloved parents, En Abdul Wahab Bin Syafiee and Pn. Habibah Binti Awang @ Hussien. I acknowledge my sincere indebtedness and gratitude to them for their love, dream and sacrifice throughout my life. I am really thankful for their sacrifice, patience, giving spirit and strength to me in a life filled with these allegations.

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As the end of this speech, I would like to take this opportunity to thank my friends that have been through thick and thin throughout the completion of this project. This project report might be impossible to complete without all of your help. Last but not least, thank you to everyone that directly and indirectly involved in helping me finishing this Finale Year Project report. Thank you.

TABLE OF CONTENTS

LIST OF TABLE

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

In this chapter, the introduction is the main topics that involve background, problems statement, objectives and scope of the project. The background of the study describes the most important subtopics such as about blind spot detecting system.

1.1 Background

Blind spot by definition is an area that could not be seen, either due to view outside of the vision, or due to some physical obstacle. Frequently, it used to describe the area around a car that cannot be seen with the rear-view or side mirrors. For an example, a car has a blind spot on the right and left side, so the driver needs to always remember to tilt the head to check an incoming vehicle before making any action.

Most of the common theory, the brain actually fills in the missing information using visual sight in the environment. Even though if one of the eyes is close, the blind spot is virtually impossible to detect. The cause of this was the brain is adept at providing the missing visual information. Thus, a small gap probably cannot be noticed in the visual field. Here are some of the example:

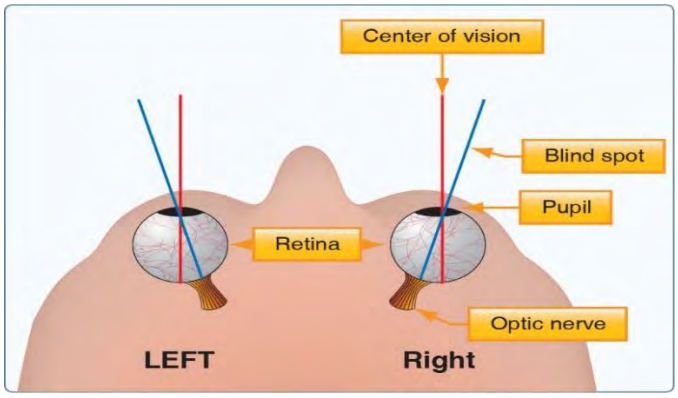

Figure 1.1: Human eye blind spot (Lin and Li 2010).

Figure 1.1 shows that human eye blind spot, the area where the optic nerve connected to the retina in the black of each eye is known as the optic disk. The eye is the completely blind spot when there is a total absence of cones and rod in that area. The effect is by referring to as the blind spot that human has in each eye. Under some circumstance (both eyes are used together), there is no problem because an object cannot be in the blind spot of both eyes at the similar time. Besides that, the vision of one eye can be blocked by an object, a visual can be the blind spot while another eye remains undetected.

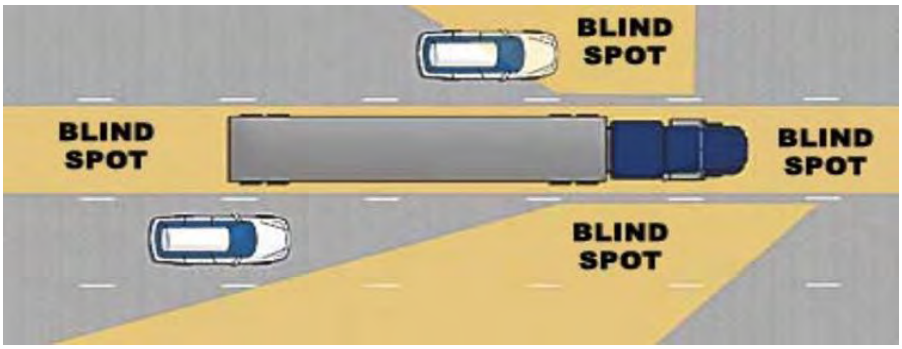

Figure 1.2: Vehicle blind spot (Shashkov P., Khomutov G., Yerokhin A. 2012).

Figure 1.2 shows that blind spot of vehicle, the position of cars on the road and the driver view from the rear mirror and side mirror was shown. The black spot is the area that the driver can see the vehicle. One of the cars was in sight of the lorry driver and the other one is inside the blind spot area. In prediction, if the lorry suddenly changes lane to the left, the lorry will hit the left vehicle and an accident will happen cause of the lorry driver does not have the vision on the left side.

1.2 Problem Statement

Human eyes are aided to reacts with light and pressure which it helps to deliver a three dimensional, moving image, standard coloured in daylight. Unfortunately, the vision of human eye has its own limit of sight. There is a certain angle of an area that eyes cannot be seen without moving the head to left or right. This type of vision problem is called blind spot area. Assume as a driver in a vehicle, vehicle blind spot area which its need side mirror and rear mirror to see an approaching vehicle from behind and left or right side of the vehicle. Therefore, by using the rear mirror and side mirror is not enough for a driver which its need to tilt their head in order to see approaching vehicle.

Besides that, changing into other lanes without a care about other road users can be very dangerous. The presence of vehicles in the blind spot area while shifting lanes can cause accidents which also may lead to injuries or death of the driver or the passengers. This is also may due to the drivers usually assumes that there is no vehicle in that area or they think the incoming vehicle may apply brakes to avoid a collision. This negative assumption is one of the main cause of accidents.

Thus, the side mirrors help the driver to know the situation in the blind spot area. However, the side mirror is not able to allow the driver to monitor the blind spot area as it is. Therefore, it is still not enough to ensure the safety of the driver especially during changing and merging into another lane.

In this research, the main design parameter to be focused is the area covered by the sensor used. The performance of the sensor is also determined by the position of the sensor.

1.3 Objectives

i. To study the method of blind spot detection system and creating algorithm used in FPGA system.
ii. To develop and implement the algorithm of the vehicle blind spot detection system in FPGA.
iii. To analyze the functionality and reliability of the proposed project.

1.4 Scope of Work

The scopes of this current project are consisting of four work scope. The first work scope is developing an algorithm for sensor and detection system by using Verilog hardware description language (HDL). The algorithm will control the system by using FPGA DE0 board. The board consists programmable IC which allow the development of the digital system.

The second work scope is the software Altera Quartus II Design Software is used to develop the algorithm. The simulation of the system algorithm done by using ModelSim which for observation. Then, to analyze the system, SignalTap II is used to verify the program and system algorithm give the same result of the simulation in ModelSim.

The third work scope is the area of this experiment will be in the laboratory. The proposed project does not use a real vehicle. Thus, the proposed project can be tested in the laboratory.

The last scope is about two ultrasonic sensor HC-SR04 will be placed at a different position which is on the left side and right side. The sensor is to detect the approaching obstacle between the left side and the right side area. It also compares the distance value to give warning alert by using LED.

From the result obtained, an analysis will be made so that it will meet the specifications and the main objectives of the project. If there has an errors, the source of error will be identified and corrected. The project will also go through a few adjustment and improvement so that it will give the best result.

CHAPTER 2

LITERATURE REVIEW

The literature review is a search and evaluation in developing this project which helps to identify the excellent method to accomplish the objective of the project. The main key to literature review is to ensure the topic has been understood carefully. Besides that, it also can identify possibilities from the research similar work done among the previous study in order to improve future use. All the resource has a very useful information that will guide to develop this project. Each review sources are selected according to the similarity of project's scope.

2.1 Blind Spot

The blind spot is an area could not be seen as a driver in the vehicle where by using rear mirror the driver needs to tilt their head slightly in order to check incoming vehicle from behind before making an action such as changing lane or intercept front vehicle. An accident may happen when a vehicle approaching behind another vehicle whereby the driver unable to see the vehicle and decided to change the lane. Figure 2.1 shows that the position of cars on the road and the driver view from the rear mirror and side mirror was shown. The black spot is the area that the driver can see the vehicle. If the grey vehicle suddenly changes lane before getting in the black spot, an accident may happen between the two vehicles.

Moreover, frequently road accident are happens in blind side area particularly in highway because of overwhelming, surpassing or changing the lane action. Meanwhile, a few drivers are focus on side mirror and loss focus on the front road and may lead to an accident that can cause death. The result of the careless driving will bring disaster to innocent people.

Therefore, design and implementation of vehicle blind spot detection system by using FPGA is developed and testing in breadboard as the prototype to overcome the blind spot problem. Hence, this project will reduce accident risk along with accident statistic and make all drivers can use this technology on their vehicle.

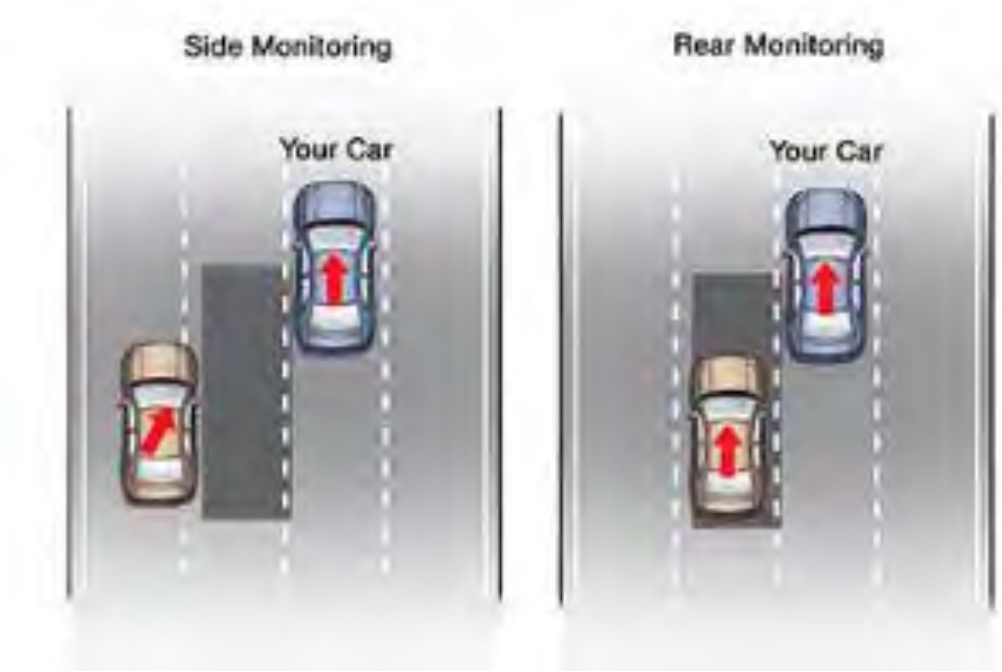

Figure 2.1: Example of Blind Spot (Barriga 2007).

2.2 Blind Spot Detection System

According to Lin and Li (2010), the blind spot detection helps to prevent the possibility by collecting blind spot information. Older system had frequently widened the range of side mirror or installed two cameras on both sides on a vehicle to gather blind spot information. As a result, the driver likewise still concentrate on the road and decide to change lane when the road is safe.

The Blind Spot Detection System is an intelligent application design on the vehicle to prevent distraction related accident. The system work when the driver wanted to change lane, the system will warn the driver whereby the road is safe to change or not. The blind spot detection system uses high technologies to estimate the distance of an approaching vehicle. The example of high technologies is the ultrasonic radar. It has the ability to detect distance by using ultrasonic distance detection technology. Nevertheless, radars usually have a blind spot and smaller view. The range of blind spots links with the number of several installed radars. In contrast, blind spot detection system can help to overcome the problem of the blind spot. Below are some lists of previous work blind spot detection system that has been implemented to overcome the blind spot problem.

1. Vector Blind Spot Detection.
2. Vision-Based Blind Spot Detection Using Optical Flow.
3. Vehicle Detection Using Normalized Color and Edge Map.
4. Blind Spot Detection with Automatic Steering.
5. Semi-Truck Blind Spot Detection System.
6. Wireless Vehicular Blind-Spot Monitoring System
7. Haptic Blind Spot Alert System

2.3 Previous Works

2.3.1 Vector Blind Spot Detection

The research of Clara *et al*. (2012) Inventor and CEO of the Vector Blind Spot Detection System have invented an infrared sensor as the input of the system that can be detachable at the rear mirror along with the infrared transmitter is linearly modulated. It has the ability to enabling the blind spot detector to determine the proximity of the detected object. In normal behavior, the proximity can detect an obstacle by transmitted signal greater than a fixed lower threshold and less than proximity level will active the LED indicator on the system housing.

According, the principle object of the invention to provide blind spot detector System that has an automatic built-in test capability that continuously monitors the calibration of the detector system. The system function to detect the imprecise distance to an obstacle and offer improved element and arrangement for the purpose which is affordable, reliable and effective to achieve the goals.

2.3.2 Vision-Based Blind Spot Detection Using Optical Flow

According to Otero, Gra, & Vilares (2007),Vision-based blind spot detection using optical flow is an intelligent application that uses a camera to be attached in the side mirror of a car to give detection where the blind spot area is located. The detection system use pattern recognition that will bring the information by using computer vision technique by referring the double stage data clustering and optical flow technique to detect a vehicle. The optical flow technique which consists the main sensor that providing the vision to detect a vehicle.

This technique will share the information to clustering technique for pre detection, considered to potential vehicle overtaking of another vehicle. Hence, the system will alert the driver with alarm signal indicating that a vehicle has entered the blind spot zone. Figure 2.2 is the flow diagram of the blind spot detection algorithm.

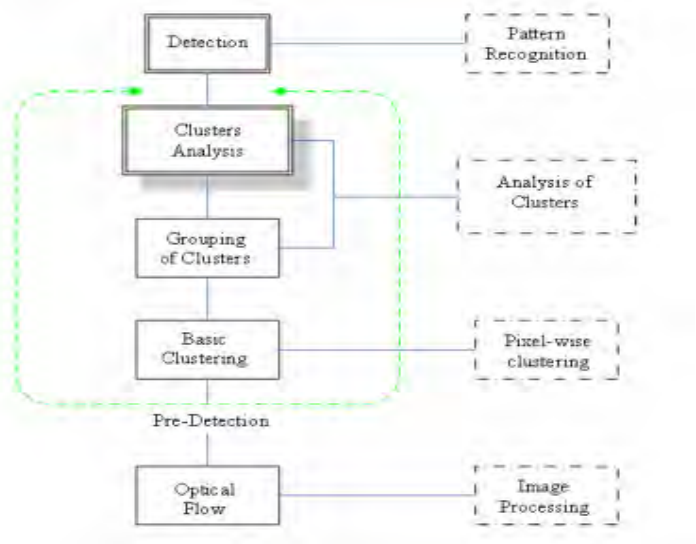

Figure 2.2: The Flow diagram previous project of the blind spot detection algorithm (Otero *et al.* 2007).

2.3.3 Vehicle Detection Using Normalized Color and Edge Map

According to Tsai *et al.* (2007), vehicle detection using normalized and edge map is a new color transformation model that has the ability to locate significant vehicle color from an image for quickly find possible vehicle around the area. This technology has the great capabilities to categorize vehicle pixel from contextual even there is enlightenment condition. Each of possible vehicle user can be detected through the pixel of the system. It has two special feature that is used to constructing a multi-channel classifier to verify a vehicle user which are edge maps and coefficients of a wavelet transform. Denoting the classier, this technology can perform actual scanning to detect all anticipated vehicles from motionless pictures. This type of scanning color feature is used to filter out finest background pixel and this scan are very fast to process.