UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN AND IMPLEMENTATION OF VEHICLE PARALLEL FRONT SENSING SYSTEM USING FPGA FOR PARKING ASSISTANCE AND POSSIBLE COLLISION ALERT

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

by

MUHAMMAD ADLI HAZIQ BIN ROZAINI

B01510094

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APPROVAL

This report is submitted to the Faculty of Electrical and Electronic 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 Systems). The member of the supervisory is as follow:

Signature	:	……
Name of Supervisor I	:	Encik Aiman Zakwan Bin Jidin
Date	:	……

Signature	:	……
Name of Supervisor II	:	Encik Noor Mohd Ariff Bin Brahin
Date	:	……

ABSTRAK

Pada masa kini, kemalangan jalan raya kerap terjadi yang menyebabkan kecederaan dan kematian. Setiap tahun kadar kemalangan jalan raya semakin meningkat. Terdapat beberapa faktor yang menyebabkan kemalangan jalan raya antaranya brek secara tiba-tiba dan memandu terlalu rapat dengan kenderaan hadapan. Sikap pemandu yang mementingkan diri dan tidak berhati-hati merupakan faktor utama berlakunya kemalangan jalan raya. Oleh yang demikian, projek ini akan mencipta satu algoritma yang mampu untuk memberi amran atau isyarat kepada pemandu dengan menggunakan sensor untuk mengesan jarak antara sensor dengan objek atau kenderaan yang berada di hadapan. Algoritma ini mempunyai 2 mod iaitu mod memandu dan mod meletakkan kenderaan. Mod memandu berfungsi dengan mengesan kadar perubahan jarak antara sensor dengan kenderaan hadapan dan juga mengesan jarak selamat antara dua kenderaan. Manakala mod meletakkan kenderaan berfungsi mengesan jarak selamat antara sensor dan kenderaan atau objek yang berada di hadapan untuk mencegah atau mengurangkan kerosakan yang disebabkan oleh pelanggaran. Komponen yang telah digunakan untuk menjalankan projek ini adalah FPGA, buzzer, LED dan sensor ultrasonic yang digunakan sebagai pengesan jarak. Bahasa pengaturcaraan yang digunakan dalam projek ini adalah Verilog manakala perisian yang digunakan untuk projek ini adalah Altera Quartus II. Projek ini telah berjaya dilaksanakan dan kesemua objektif telah dicapai.

ABSTRACT

Nowadays, road accidents often occur that cause injuries and deaths. Every year the rate of road accidents increases. There are several factors that cause road accidents such as sudden braking and driving too close to the front of the vehicle. The attitude of selfish and careless drivers is a major factor in the occurrence of road accidents. Therefore, this project proposed the development of an algorithm capable of giving an indicator or signal to the driver using a sensor to detect the distance between the sensor with the object or the vehicle in front. This algorithm has 2 modes namely driving mode and parking mode. Driving mode works by detecting the rate of change of distance between the sensor and the front of the vehicle and also detects the safe distance between the two vehicles. While in parking mods it work to detect the safe distance between the sensor and the vehicle or object that is in front to prevent or reduce the damage caused by the collision. Components that have been used to run this project are FPGA board, buzzers, LEDs and ultrasonic sensors used as detector distances. The programming language used in this project is Verilog while the software used for this project is Altera Quartus II. This project has been successfully implemented and all objectives have been achieved.

DEDICATION

To my beloved parents and all my family members who always encourage and support me during my project.

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TABLE OF CONTENT

TABLE OF CONTENT……..…….....…ix

LIST OF FIGURES……...…xi

LIST OF TABLES……...xiii

CHAPTER 1: INTRODUCTION….……..1

1.0 Introduction 1

1.1 Project Background 2

1.2 Problem Statement 3

1.3 Objectives 3

1.4 Work Scope 4

1.5 Summary 5

CHAPTER 2: LITERATURE REVIEW…….……..6

2.0 Introduction 6

2.1 Anti-collision 6

2.2. Anti-collision detection system 7

2.3 Previous Works 8

2.3.1 Using FPGAs in Automotive Radar Sensors 8

2.3.2 Development of an Anti-collision Model for Vehicles 9

2.3.3 Collision Avoidance System in Cars 10

2.3.4 Vehicles Anti-collision System 11

2.3.5 Design and Development of Vehicle Anti-collision System using Electromagnet and Ultrasonic Sensors 12

2.3.6 Comparison between Previous Project and Proposed Project 13

2.4 Sensor 15

2.4.1 Infrared Detectors 15

2.4.2 Microwave/ Millimeter wave radar 16

2.4.3 Ultrasonic 17

2.5 Overview of FPGA 18

2.5.1 Application of FPGA 21

2.5.2 Comparison between FPGA and microcontroller 23

2.5.3 Altera FPGA DE0 Board 26
2.6 Conclusion 28

CHAPTER 3: METHODOLOGY...……...…..29

3.0 Introduction 29
3.1 Project Overview 29
3.2 Project Flowchart 31
3.3 Project Overview 32
3.3.1 Process flowchart 33
3.3.2 State machine of ultrasonic sensor controller 34
3.3.3 State machine of Anti-collision system 36
3.4 List of components 37
3.5 Implementation Process 37

CHAPTER 4: RESULT AND DISCUSSION……...…40

4.0 Introduction……...……..…….40
4.1 Hardware Implementation……..……....…….……...40
4.2 Algorithm Implementation Setup……42
4.3 Hardware Implementation Analysis……44
4.4 Simulation Result…….……47
4.5 Hardware Validation……49
4.6 Limitation…….53
4.7 Conclusion……54

CHAPTER 4: CONCLUSION……...……..…55

5.0 Introduction……...……..…….55
5.1 Conclusion……..……....…….……...55
5.2 Recommendation…….…….56
5.3 Commercial Potential……...57

REFERENCES…….58
APPENDICES…….…….60

LIST OF FIGURES

Figure 2.1: Example of anti-collision system (slideshare, 2018). 7
Figure 2.2: Block Diagram and Photograph of the UMRR Radar Sensor (Hanak and Mende n.d.). 9
Figure 2.3: Example of such cars in metropolitan areas (Zungeru n.d.). 9
Figure 2 4: Schematics for the msp-sensor PCB (Agarwal et al. n.d.) 10
Figure 2 5: Example of laser detector (Kumar et al. 2014). 11
Figure 2. 6: Performance principle of Blinder Laser detector (Kumar et al. 2014) ... 12
Figure 2.7: Power supply 13
Figure 2.8: Image of Infrared (IR) sensor (Hasan 2017). 16
Figure 2.9: Picture of Millimeter Wave Radar 17
Figure 2.10: Image of ultrasonic sensor. 18
Figure 2.11: Safety concept with test pattern and comparator (Chakraborty and Eberspacher, 2012). 25
Figure 2. 12: Cyclone III FPGA DE0 Board 27

Figure 3.1: Project flowchart 31
Figure 3.2: Block diagram for Anti-collision system 32
Figure 3.3: Hardware flowchart. 33
Figure 3.4: State machine of ultrasonic sensor controller. 35
Figure 3.5: State machine of Anti-collision system. 36

Figure 4.1: Hardware implementation 41
Figure 4.2: DEO board user manual to setting the input and output port 41
Figure 4.3: Generated RTL design of System Algorithm 43
Figure 4.4: Generated State Machine of Sensor Module 43
Figure 4.5: Generated State Machine of Comparator Module. 44
Figure 4.6: Flow Summary 45
Figure 4.7: Generated Time Setup summary in TimeQuest Timing Analyzer window 46

Figure 4.8: Generated Time Hold summary in TimeQuest Timing Analyzer window 46
Figure 4.9: Generated Fmax summary in TimeQuest Analyzer window 46
Figure 4.10: Simulation result for difference value 47
Figure 4.11: Simulation result for value 15500 and above 48
Figure 4.12: Simulation result for value 15500 and below 48
Figure 4.13: Green LED lighted up which means safe distance. 50
Figure 4.14: Logic Analyzer show the safe_trig is HIGH while warn_trig is LOW that show it in safe distance. 50
Figure 4.15: Red LED lighted up show that the distance is close..... 51
Figure 4.16: Logic Analyzer show the safe_trig is LOW while the warn_trig is HIGH that show it in close distance..... 51
Figure 4.17: Buzzer for level 1 that produce fast volume. 52
Figure 4.18: Buzzer for level 2 that produce moderate volume. 52
Figure 4.19: Buzzer for level 3 that produce slow volume. 53

LIST OF TABLES

Table 2.1: Comparison between previous project and purposed project 14
Table 2.2: Comparison between PLD, FPGA and ASIC 19
Table 2 3: Major market segments for FPGA 22
Table 2.4: Comparison between FPGA and microcontroller applied in wireless system(Subhas et, al, 2013). 26
Table 2.5: Comparison Cyclone II and Cyclone III 26

Table 3.1: Shows the list of component that have been used in this project..... 37

Table 4.1: Input and Output Port 42

CHAPTER 1

INTRODUCTION

1.0 Introduction

Transportation nowadays has become more and more convenient and safe; however, there are still lot of people dying because of road accident. One of the factors that caused road accidents are suddenly braking or emergency brake and driving too closely with vehicle ahead. Majority of road accidents are cause by carelessness of driver, especially when they drive at midnight, the strong desire to reach to the destination in a short time always make them not alert to the surrounding vehicle. Therefore, a collision avoidance alert system is required to alert driver to avoid any crashes or minimize the impact of collision and can save life. A range detector can be used for these purpose. A range detector is a detector that will detect the range between two vehicles on the road. It can be used to detect the safe distance between two vehicles. Therefore, this study was going to design an algorithm that was able to alert driver by detecting the range from the detector to the vehicle ahead. This algorithm contained 2 modes. First, driving mode, it would detect the rate of change of range between the detector and the vehicle ahead and also detect the safe distance between two vehicles. Second, parking mode, the detector detects the safe distance between the detector and the obstacle ahead. Once the vehicle was not in the safe condition, the system would activate a signal and buzzer to alert the driver to reduce speed or take possible action. This will help the driver to prevent or reduced damage from collisions.

1.1 Project Background

Based on statistic that has been produced by Kementerian Pengangkutan Malaysia, from year 2011 until 2016, total number of death caused by an accident was increased from 6877 to 7152 was recorded but only year 2014 decrease from 6915 to 6674 (MALAYSIA 2018). From this statistic, it can be seen that road accidents were large number of deaths and injuries.

The number of road accident was increasing year by year. According to Osman (2017), Pengarah Jabatan Siasatan Penguatkuasan Trafik (JSPT) Bukit Aman, Senior Asisten Komisioner Sharul Othman Mansor said most of the frequent mistake that driver make is driving fast, change lane without giving signal, racing, not aware about traffic light and using mobile phone. Mostly road accidents happened because of human's behavior, careless and selfish. After all these years, it has been found that that there were 93% of vehicle collisions were caused by human factor based on British and American crash data. From the article written by Olivia Olarte (2011), Bob Joop Goos, chairman of the International Organization for Road Accident Prevention pointed that road accident is mainly caused by human factor where there were 90% of road accidents were caused by human factor. Jose Miguel, chairman of the Portuguese Society for Road Accidents Prevention, claimed that the quality of road transport system or a break system of a car and how the driver applies the car break system corresponding to the environmental demand is the condition of occurring road accident.

Therefore, it is very important to make people to be conscious that the behavior of driver in driving is the main factor that causing accidents. In order to reduce this problem, the traffic safety program should be focus on people by telling them the consequences of road accidents and the way that all of us can do to prevent road accidents. Besides that, an alert system can be used to alert driver when driver is in dangerous. Due to the behavior of the driver, they rather choose to ignore any risk that may cause accident. With an alert system installed in a car, it can be used to alert driver so that he or she notice that they are not in the safe area.

There are many campaigns and programs that has been done but yet, the number of accidents occur still increasing People not interested to attends programs like that because it seen like wasting time. So the other ways to attract people attention, build something new, build a smart anti-collision avoidance system inside the car to alert the driver.

1.2 Problem Statement

In this modern era, car continues to become safer and convenience, however, they are still a lot of accidents happen. Traffic accidents occur for several reasons. Most of the traffic accidents are caused by driver's careless, especially when vehicle ahead brake suddenly and driver driving too close to the vehicle in front, this cause the driver unable to brake in time and accident occurred.

Many accidents occur due to the driver's failure to recognize danger. Many people unable to estimate the safe distance between own vehicle and the vehicle ahead on the road so that when the vehicle in front make sudden braking, the driver still hit the vehicle ahead although they had applied the brakes. Drivers with stronger desire to arrive at their destination as soon as possible are more likely to take risk. Sometimes, when driver driving too long for the journey will cause them cannot pay well attention on driving and leave unnoticed when the vehicle ahead changes their speed.

Therefore, an alert system is required to alert the driver with warning when the system determines there is a possibility of collision and allow the driver to keep a safe distance with the vehicle in front.

1.3 Objectives

1. To study the methods to detect the rate of distance change between vehicles.

2. To develop and implement the algorithm for vehicle anti-collision and safe distance alert system, as well as the parking assistance in FPGA.

3. To analyze the functionality and reliability of the alert system in the aspect of distance detection.

1.4 Work Scope

The aim of this project was to design an algorithm to detect the range between the detector and the vehicle or object ahead on the road by using FPGA to prevent or minimize the risk of road accidents. An ultrasonic sensor was used for testing the functionality of the system. The ultrasonic sensor was connected with a FPGA which was generally configured by using hardware description language. This project was focusing only on the algorithm implementation and testing by using ultrasonic sensor. This project has been done in the lab to check either it is worked or not. The test was done in the following situation:

In driving mode:

1. If vehicle ahead make sudden braking, the system should alert the driver.

2. If two vehicles are driving too close to each other and their gap is less than the safe distance, the system should alert the driver.

In parking mode:

1. If the vehicle is not in the safe distance with vehicle ahead during parking, the system shall alert the driver as well. Due to the speed of vehicle in driving and in parking are different, the safe distance in driving mode and in parking mode are also different.

1.5 Summary

In this chapter it briefly introduces of this project. The idea to develop this project because nowadays road accidents account a large number of deaths and injuries. Therefore, a FPGA based collision avoidance system is required to alert driver if there are possibilities of collision. The component in building the system included FPGA and the language used to configure FPGA could be either Verilog or VHDL. This project would focus only on the algorithm implementation and testing by using ultrasonic sensor.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter will search and identify similar project that has been done by previous researcher in order to improve for future use. In this chapter also will discuss about the application of field programmable gate array (FPGA). The comparison between FPGA and other microcontroller as well as the advantages and disadvantages of FPGA. Besides that, this chapter will also discuss about two hardware description languages which are Verilog and VHDL, these two languages have their own applications and advantages as well as disadvantages.

2.1 Anti-collision

Anti-collision means to prevent something from a collision happen. Anti-collision can alert the drive that the distance between his vehicle and car ahead so close. So, the driver can take early action to avoid or reduce the impact of collision. This will help to reduce the number of accident.

Most frequently accident happen because of driver attitude and selfish on the road especially youth. Sometime people suddenly brake their vehicle and vehicle at behind cannot stop their vehicle because of careless the driver. Another situation, driver do not give any signal during changing lane. This situation also one of a factor that accident happen.

Therefore, implement of anti-collision detection system by using FPGA will be develop. Hence, this project will reduce accident risk and make all drivers can use this technology on their vehicle. From Figure 2.1, it shows concept of anti-collision. It detects distance of vehicle ahead.

Figure 2.1: Example of anti-collision system (slideshare, 2018).

2.2. Anti-collision detection system

The anti-collision system helps to prevent the possibility of crashing happen on the road. The older system using several sensors to implement this system such as infrared, motion sensor, radar sensor and many more.

The anti-collision system is an intelligent system that design on vehicle to prevent from accident. This system work when driver drive too close to car ahead, the system will warn the drive either the driver reduce speed or stop the car. The high technologies that has been use in this system is radar sensors. The design targets of the radar sensor platform were mainly performance and flexibility, the intention was to cover a certain range of automotive applications, with the focus on high dynamic scenarios. Below are some of lists of previous work on anti-collision detection system that has been implemented to overcome from accident occur.

1. Using FPGAs in Automotive Radar Sensors.
2. Development of an Anti-collision Model for Vehicles.
3. Collision Avoidance System in Cars.
4. Vehicles Anti-collision System.
5. Design and Development of vehicle anti-collision system using Electromagnet and Ultrasonic sensors.

2.3 Previous Works

2.3.1 Using FPGAs in Automotive Radar Sensors

The research of (Hanak and Mende n.d.), this system was using Universal Medium Range Radar (UMRR) Radar Sensor Technology. This component performance, first, it can direct and simultaneous measurement of range, velocity and angle. Second, it can measurement in short of time. Third, it is good at minimum range, medium and maximum range typically about 50m to 70m. Fourth, it conformity with ETSI and FCC frequency regulations. Fifth, One-Box-Design with integrated detection, tracking and communication software and last, it is stand alone or network (sensor fusion) operation.

The sensor consists of two unit components: RF frontend module and DSP module. This is depicted in the block diagram in Figure below, a photograph is given on the right. The size of the device is only (including processor) 94x78x31mm (WxHxD).

The RF module contains a VCO, transmit and receive amplifiers, mixers, and is made all planar of discrete components. There are also means provided for the waveform generation as well as for the control of in-band emissions and waveform linearity. A mono-pulse principle patch antenna type (one transmitter, two receive antennae) is applied.

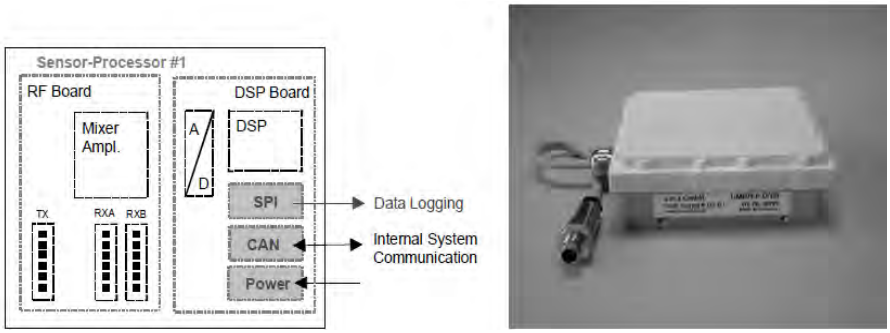

Figure 2.2: Block Diagram and Photograph of the UMRR Radar Sensor (Hanak and Mende n.d.).

2.3.2 Development of an Anti-collision Model for Vehicles

For this research, Zungeru (n.d.) said that Infrared Anti-Collision Device are expected to be made of relatively inexpensive components for easy purchase and incorporation. The researcher aims at the design of a prototype showing how this system could function. The main purpose is to find a way to implement a minimum spacing for cars in traffic in an affordable way, alongside to achieve safety for passengers of a moving car. The anti-collision device, when wired into the circuitry of a vehicle would help in the reduction of road mishaps. Though not every kind of collision can be helped by this, and it must be stated here that no allusion is being made that technology is the best to take the line of action.

Figure 2.3: Example of such cars in metropolitan areas (Zungeru n.d.).

2.3.3 Collision Avoidance System in Cars

The researcher Agarwal *et al.* (n.d.), in their article, for the first model, they used Microcontroller, Ultrasonic transducers, Universal Shift Register and Darlington Arrays. The ceramic ultrasonic transducer is to transmit and receive the ultrasonic sound waves. The MSP430 Microcontroller drives the transmitter transducer with a 12-cycle burst of 40-kHz square-wave signal derived from the crystal oscillator, and the receiver transducer receives the echo.

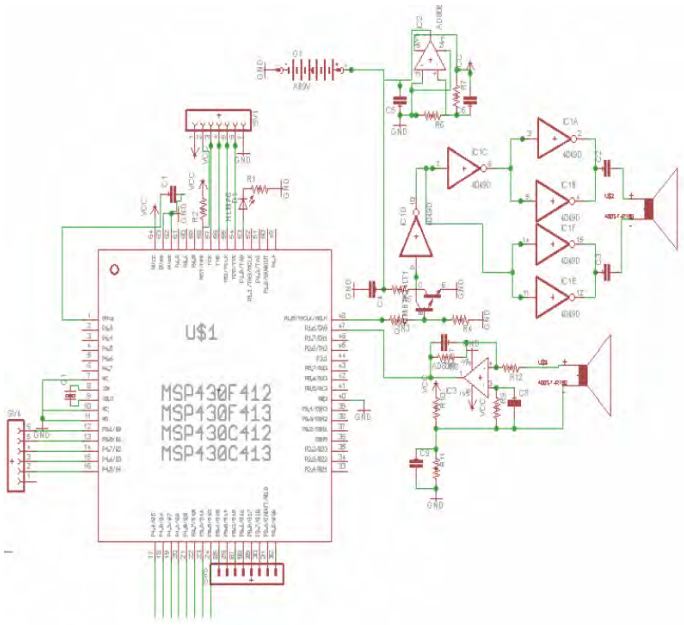

Figure 2.4: Schematics for the msp-sensor PCB (Agarwal *et al.* n.d.)

While for the second model, they use ATMEGA 32 instead of using msp430 and use a simpler version of the circuit with same guidelines as first model. The main component that having use is ATMEGA 32 microcontroller, A3982 motor drivers, Ultrasonic transducer and stepper motors.

2.3.4 Vehicles Anti-collision System

Kumar et al. (2014) states BLINDER (Laser detector) it can detect infrared light of laser beam. During bright day, there are more infrared light is scattered about which jammer/detector circuitry needs to content with. At night due to absence of sun only presence of infrared light makes it easier. Therefore, laser detector system can work best in full daylight or at night.

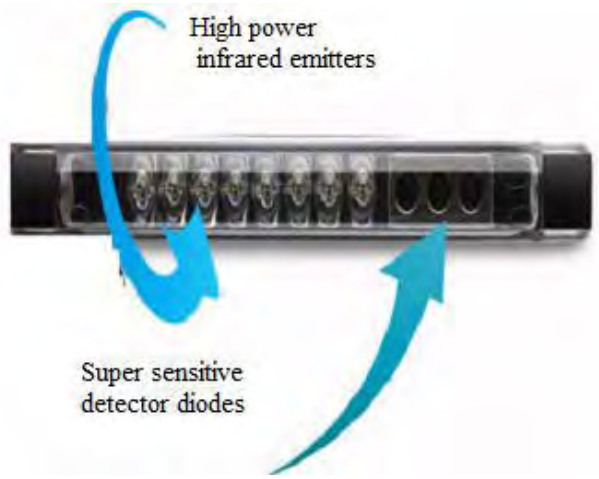

Figure 2.5: Example of laser detector (Kumar *et al.* 2014).

The BLINDER system detect different objects with unequal effectiveness depending on the color of the object. If the object in bright color, it reflects much better compare if the object in dark color. This system cannot detect and alert on glass or transparent materials. Besides, laser will not respond to any incoming laser pulse in parking mode.

The BLINDER laser system contains transponder units and CPU module. The transponder units should be mounted such that transmitting and receiving infrared laser beam will not pass through any interfering objects. It is essential that view of the road for all transponders are clear and unobstructed, pointing straight ahead, mounted horizontal and parallel to the road surface and driving direction.