UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN AND FABRICATION OF AUTOMOBILE BLIND SPOT DETECTION SYSTEM USING ARDUINO

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

by

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfilment of the requirements for the degree of Bachelor of Mechanical Engineering Technology (Automotive Technology) with Honours. The member of the supervisory is as follow:

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Muhammad Nur Bin Othman

(Project Supervisor)

ABSTRAK

Salah satu punca kemalangan ketika bertukar haluan di jalanraya adalah kerana kawasan titik buta. Kawasan titik buta adalah kawasan di sekitar kenderaan dimana pemandu gagal untuk mengenalpasti sebarang kenderaan atau objek. Terdapat pelbagai jenis sistem untuk mengatasi masalah ini. Namun, sistem sebegini hanya boleh didapati dalam kenderaan berteknologi tinggi and tiada dalam kenderaan berteknologi rendah. Maklamat projek ini adalah untuk membina sebuah sistem untuk mengatasi masalah titik buta. Sistem ini dikenali sebagai Sistem Pengesanan Titik Buta (BSD) dan sistem ini menggunakan Arduino sebagai alat pengawalan mikro dan sistem ini adalah sistem tanpa wayar. Sistem ini dapat mengenalpasti sebarang kenderaan yang sedang bergerak atau tidak bergerak. Terdapat tiga jenis modul dalam sistem ini. Pertama, dua daripada modul ini adalah modul pengesanan dan modul ini akan diletakkan pada sisi kenderaan. Kedua, modul utama akan diletakkan pada papan pemuka kereta. Modul pengesanan akan mengesan kenderaan dan menghantar input kepada modul utama. Modul utama akan memproses infomasi ini dan menyalakan lampu amaran yang akan dipasang tiang-A kenderaan. Sebuah prototaip akan dibina dan digunakan dalam tiga eksperimen. Pertama ialah untuk mencari lokasi yang terbaik untuk meletakkan sistem ini pada sisi kenderaan. Kedua ialah ketika kenderaan tidak bergerak. Ketiga ialah ketika ia sedang bergerak pada tiga kelajuan yang berbeza. Selain itu, masa reaksi bagi alat pengesan 'ultrasound' juga akan dikira. Kajian juga akan dijalankan bagi mendapatkan pandangan masyarakat mengenai sistem BSD. Keseluruhan eksperimen menunjukkan hasil yang positif apabila lampu menyala ketika objek berada dalam kawasan titik buta. Masa reaksi alat pengesan juga telah dikira and hasil kiraan menunjukkan bahawa masa meningkat apabila jarak antara objek dan alat pengesan meningkat.

ABSTRACT

One of the major causes of lane change accidents is the blind spot region. This region is around the vehicle where the driver is unable to observe and fails to identify any vehicles or objects. There are many detection systems that be used to overcome this problem but it is only available in high end vehicles and not in low end vehicles. The goal of this project is to build a system that would overcome this problem. This system is known as the Blind Spot Detection (BSD) and it utilizes the usage of Arduino as the microcontrollers and it is a wireless system. This system will detect any moving vehicles, or any obstacles that is in the blind spot region. There are three modules in this system, two of them are the detection module which will be place the side of the vehicles at each side. The other module is the centre module which be place at the dashboard of the vehicle. The detection module that will detect any vehicle and transmits data to the centre module. It will process the data and light the warning indicators which be placed at the A-pillars of the vehicle. The prototype will be tested. Firstly, to determine the best position to place the detection module. Secondly, to test the maximum length of ultrasonic ranging. Third, to test the prototype when the vehicle is stationary with another vehicle is moving in the blind spot region. Fourth, to test the prototype when the vehicle is moving at three different speeds. Finally, the time of flight for the ultrasonic sensor will be calculated. Besides that, a survey will be conducted regarding the general public's opinion about the blind spot region and BSD system. The overall results obtained from the experiments were positive with BSD system detecting objects in the blind spot region and the BSD alerts the driver by turning on the LED lights. The time of flight increase as the distance between the sensor and object increases.

DEDICATION

I would love to dedicate this thesis to my father who has been working as security guard even after retiring just so I could be able to complete my studies and make my dreams happen.

ACKNOWLEDGEMENT

As the letter A is the first of all letters, so the eternal God is the first in this world. Praise to God for His blessings and divine guidance that this project was successfully completed.

To my dear parents, I would be forever in debt with your unconditional love, support, care. Thank you for everything.

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LIST OF ABBREVIATIONS

BSD	-	Blind Spot Detection System
SA	-	Situation Awareness
BLIS	-	Blind Spot Information System
BSM	-	Blind Spot Monitoring
PWM	-	Pulse Width Modulation
USB	-	Universal Serial Bus
UART	-	Universal Asynchronous Receiver/Transmitter
ToF	-	Time of Flight
d	-	Distance measurement
k	-	Constant of sensor geometry
Vs	-	Velocity of sound in the air
LED	-	Light emitting diode

CHAPTER 1
INTRODUCTION

1.0 Project Background

In these recent years, the number of vehicles on the road has been increasing. With that much of vehicles on the road, the probability of accidents due to driver's mistake is very high. One of the main causes of accidents is due to the blind spot region. The blind spot region is a region that is cannot be viewed by the driver on the side mirrors. Drivers have to look sideways to see if there are any vehicles or object on the sides of the car. Due to this inability, drivers face difficulties and in some cases there are severe accidents. Figure 1.1 illustrates the region known as the blind spot region.

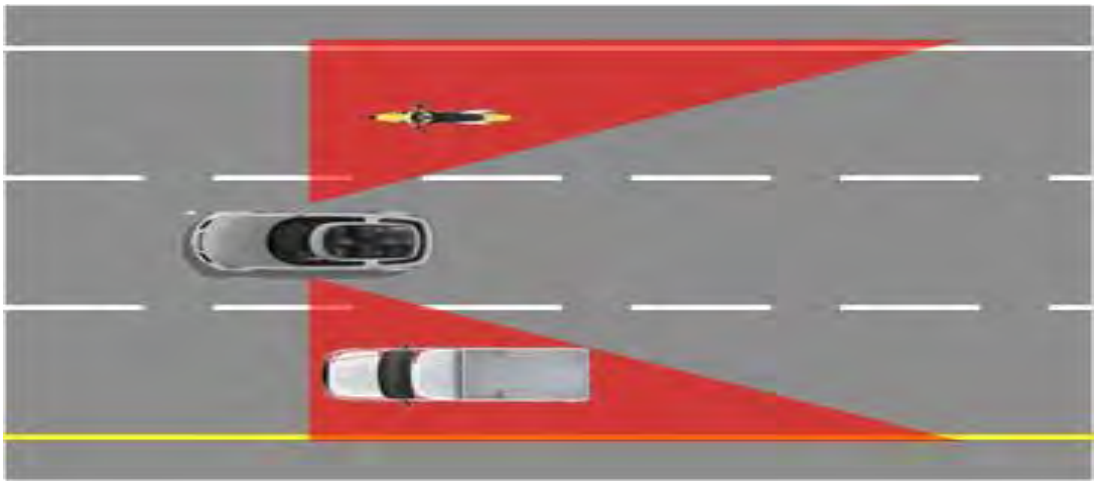

Figure 1.1: Blind Spot Region

There have been many technologies developed over the course of the years by vehicle manufacturers worldwide. According to the websites of manufacturers such as Volvo, BMW, Mercedes Benz, and Audi, these manufacturers have developed similar technologies known to assist drivers and overcome the blind spot region problem. It is generally known as the Blind Spot Detection System (BSD). The core base of this system is that it utilizes the usage of sensors like ultrasonic, radar and laser. The sensors will be attached to the side of the vehicle and it will detect if there's any vehicles in the blind spot region. Then, it will engage the Light-Emitting Diode (LED) lights attached to the side of the A-Pillars on the car.

1.1 Problem Statement

Having a blind spot region is extremely dangerous to the driver and the surrounding vehicles. Blind spot region is the lack of visibility for the driver during lane switching. This contributes to plenty of accidents during lane change and some even ends up in fatality. Even though, the technology to overcome the blind spot has been developed and widely used, it is only available in high end luxury cars such Volvo, BMW and many more. Majority of the cars that can be found on the Malaysians roads are low end vehicles. With these cars dominating the Malaysian roads, there is no doubt that the safety of road users is stake due to blind spot region. The reason why BSD system is not implemented in low end vehicles is mainly because of its cost. So it is important to develop a BSD system with high level of accuracy but at the same time it should also be low in cost so that owners of low end vehicles can enjoy the same features and safety.

1.2 Project Objective

The objective of this project is to:

1. To design and develop a wireless BSD system using Arduino prototype for low end vehicles.
2. To determine the best position to place the prototype on the side of the vehicle.
3. To test the prototype on three different moving speeds and stationary.

1.3 Project Scope

The scope of this project is to:

1. Determine the blind spot region angle and size
2. To choose an appropriate sensor and microcontrollers
3. Utilize the usage of Arduino and wireless system
4. Utilize ultrasonic sensors in detecting vehicle in blind spot region

1.4 Thesis Outline

Chapter 1:

It consists of introduction where the general idea of the project will be explained. Besides that the problem statement of the project will be discussed. Followed by the project objective and project scope which will be explained.

Chapter 2:

This chapter contains the literature review that is related to this project. The information provided is gathered from journals, articles, reference books, thesis and many more. The project also will be explained more in depth and elaborately down to even what type of sensors should be used.

Chapter 3:

This chapter contains the method that was used and the necessary explanation as to why such methodology was used for the overall project.

Chapter 4:

This chapter is about the survey analysis and how the software and hardware implementation works. The prototype that will be developed will be tested.

Chapter 5:

In this chapter, the results and analysis of the project will be discussed. The performance of the project will be explained.

Chapter 6:

This chapter contains discussion and conclusion. Problems face during project, recommendations and future improvements will be discussed on this chapter. Lastly, conclusion will be discussed.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

In this chapter, the key components such as concepts and fundamental theories that are related with this project will be discussed. To get a better understanding about this, project, a lot of previously written journals, articles, thesis and books was studied. By doing so, necessary knowledge and technical skills was gained to complete this project.

2.1 Blind Spot

The region around the vehicle which the driver will be unable to observe is known as the blind spot region. The drivers' visibility is limited to the maximum distance of which they will be able to see and identify any moving or stationary object. As in the blind spot region, the visibility of the driver is limited. There are several different location of blind spot region around a vehicle. These regions are the A-pillar, the side view mirror and the rear view mirror blind spots. However the most common blind spot region is the side view mirror blind spot region.

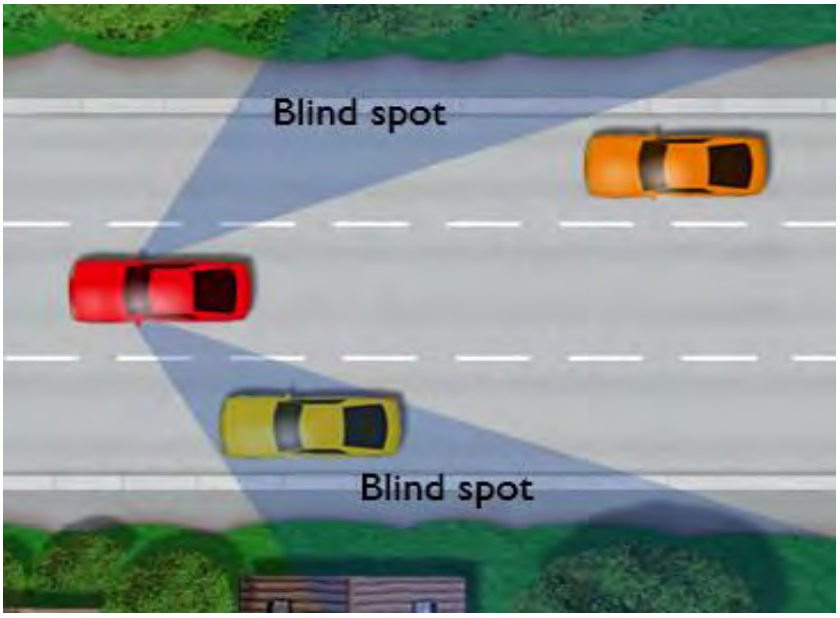

Figure 2.1: Side mirror view blind spot region

It is extremely crucial for the driver to have a good visibility as to the need to prevent an accident from occurring. For example, when a driver is changing lanes, he or she may look in to the side mirror and when they were about to change lanes, a vehicle appears out of nowhere from their sides. Therefore it is important for the driver to have a Situation Awareness (SA) when changing lanes. There are three levels of SA according to Endsley (1995):

1. Perception of elements in the environment

A driver must perceive the surrounding situations such vehicles in other lane, warning lights, road condition and obstacles. Besides that, the driver must be aware of their vehicle.

2. Comprehension of current situation

Drivers must be more than aware of the situation. They should be able to have an understanding about the elements and form a holistic picture of the environment.

3. Projection of future status

The driver must have the ability to predict future collisions in order to act effectively and avoid any collisions.

These three levels must be taken before decision making and performance of action.

2.1.1 Effects of Blind Spots and Accidents

One of the effect is that the drivers would be required to check the blind spot region by turning their heads. But it is important note that taking their eyes off the road would reduce their reaction time to manoeuvre the vehicle or stop it if there is any vehicle makes a sudden change of path. In one study by Summala *et al*. (1998) drivers who were visually distracted had longer brake reaction times in response to front vehicle braking. Another similar study by Barr and Najm (2001) also estimates is the driver spends 2 seconds to turn their head while traveling at 70 mph, their vehicle has travelled for about 205ft unattended. In those 2 seconds, the risk of them facing or causing an accident has increased significantly.

Blind spots are extremely hazardous to a driver when they are changing lanes. In the United States of America alone, lane changes are one of the major cause of accidents with 500,000 lane changes accidents annually NHTSA (1992). There are about 9 percent of police reports regarding to lane change and merge crashes NHTSA (2007). Besides that there about 2.2 percent of fatalities due to lane changes and merge crashes. According to the study by Endsley (1993), approximately 75% of the accidents occur due to driver's failure in Situation Awareness during lane changes.

2.2 Blind Spot Detection System

Throughout the years, many car manufacturers, independent researches and university students have studies regarding to overcome the blind spot problem. Many came up with different types of Blind Spot Detection System but the basic principle of the system remains the same, which is to identify the object in the blind spot region and alert the driver.

In 2007, Volvo a renowned car manufacturer has developed a system called as the Blind Spot Information System (BLIS). The system was first installed on the Volvo S80 sedan car. The system was equipped with two lenses mounted on the door to detect any vehicles in the blind spot region. The system has a range of 9.5 meters towards the rear and 3 meters to the sides (Volvo, 2013). Volvo's parent company, Ford has adapted the same system into its own car.

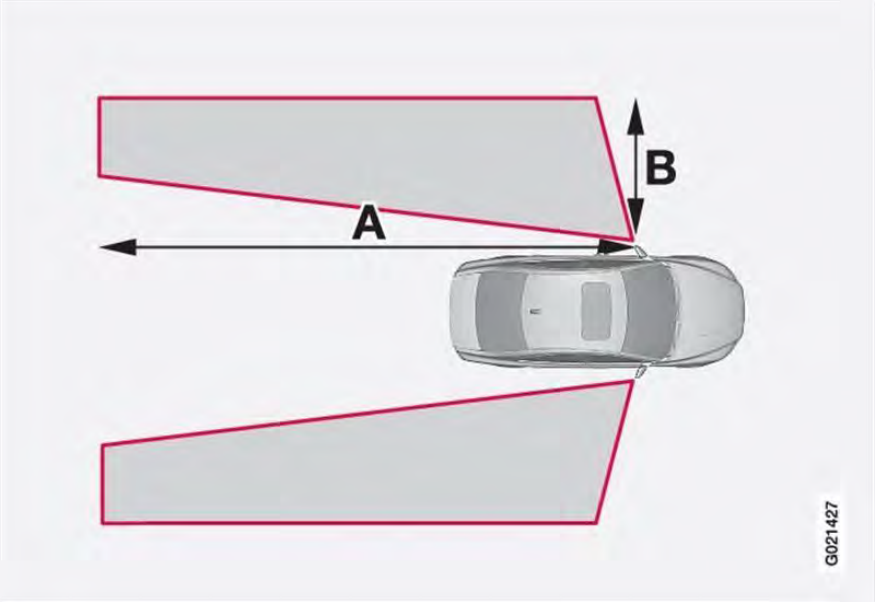

Figure 2.2: Areas monitored by BLIS, Distance A = approx. 31 ft. (9.5 meters), Distance B = approx. 10 ft. (3 meters)

Figure 2.3: Volvo's BLIS system

Another renowned company that implements the blind spot detection system is Mazda. Its system is known as the Blind Spot Monitoring (BSM) system. There two radar sensors that are mounted on the rear sides of the vehicle. If there is a vehicle at the speed of approx. 32km/h, the system will turn on the warning lights to notify the driver (Mazda, 2014). Its detecting distance is 8 meters behind the vehicle. Besides that, if the driver changes lane without noticing the warning lights, the system will give a beep sound to alert the driver.

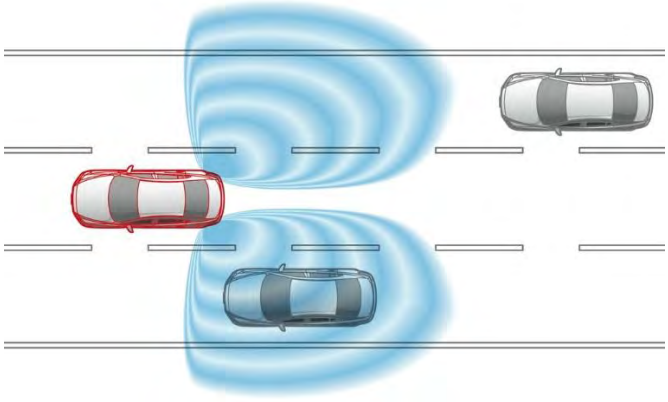

Figure 2.4: Mazda's Blind Spot Monitoring System