UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF SMART VEHICLE BLIND SPOT DETECTION SYSTEM

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

By

ZAINALFIRDAUS BIN ADNAN

B071510459

960801-04-5187

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Disahkan oleh penyelia:

.....

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APPROVAL

This report is submitted to the Faculty of Mechanical and Manufacturing Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfillment of the requirements for the degree of Bachelor of Mechanical Engineering Technology (Automotive) with Honours. The member of the supervisory is as follow:

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ABSTRAK

Penyelidikan ini bertujuan untuk merangka konsep baru bagi sistem pengesan titik buta, yang membawa matlamat yang sama seperti sistem lain yang telah dicipta untuk menghilangkan titik buta untuk pemandu sesebuah kenderaan. Sistem pintar yang diwujudkan mengambil kira kekurangan sistem sedia ada terutama untuk aspek kebolehsuaian serta kos. Kriteria sistem baru ini adalah reka bentuk yang ringkas, kemampuan yang tinggi dan kos yang rendah, supaya sistem ini dapat dipasang pada semua jenis pengangkutan ringan dan berat di Malaysia. Untuk menghasilkan produk pada kos yang rendah, komponen yang digunakan dalam sistem perlu dilihat secara teliti. Arduino UNO dan sensor ultrasonik HC-SR04 telah dipilih untuk sistem baru ini kerana kedua-dua komponen tersebut boleh didapati pada harga yang berpatutan. Selain itu, sensor ultrasonik telah terbukti berkesan dalam projek sistem pengesan titik buta sebelum ini. Untuk memastikan peranti itu serasi kepada mana-mana kenderaan, reka bentuk dibuat secara padat yang mana menggabungkan unit kawalan dan dua unit sensor di badan utama yang dipasang pada cermin sisi, manakala isyarat amaran dipisahkan dalam badan kedua untuk diletakkan dalam ruang penumpang. Sudut bagi dua sensor adalah sangat penting kerana keduanya bertanggungjawab untuk memantau kawasan titik buta dengan betul. Pada akhir projek ini, satu prototaip sistem baru telah dihasilkan untuk diuji dalam keadaan sebenar. Terdapat beberapa ujian yang disedia dengan keadaan yang berbeza untuk menguji keupayaan peranti. Berdasarkan keputusan yang dikumpul, kriteria sistem yang baru dibina telah dikenalpasti memenuhi objektif penyelidikan. Kekuatan dan kelemahan juga dinyatakan bagi peningkatan selanjutnya.

ABSTRACT

This research aims to design a new concept of the blind spot detection system, which carries a similar goal as another developed system to eliminate the blind spot of the driver. The new smart system developed simply targeted to improve the previous concepts to compromise user compatibility as well as cost-effectiveness. The criteria of the new system are compact, reliable and low-cost so that the system affordable for the car owners. In order to produce a low-cost blind spot detection system, the selection of components used in the system play an important role in the present work. The Arduino UNO and HC-SR04 ultrasonic sensor have been chosen for the new system as both components are affordable in price. Besides that, the ultrasonic sensor has been proven as effective in the previous blind spot detection system project. To make sure the device is compatible to any vehicle, the design is made up compact which combines the control unit and two sensors in the main body is mounted to the side mirror, while the warning signal is separated in the second body to be placed in the passenger compartment. The angle of two sensors is very crucial as they carry the responsibility to monitor the blind spot correctly. At the end of this project, a prototype of the new system has been produced to be tested in the real situation. There are several tests set up with the different condition to observe the ability of the device. Based on the result collected, the criteria of the new-built system have answered the objectives of present work. The strength and weakness the present system were also discussed to for further improve the developed product.

DEDICATION

This work is dedicated to my beloved parents, Adnan Othman and Saleha Zainal, my family, and friends whose supports and prayers have been endless during a long period of my studies. Thank you very much for providing me with the best education.

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S	-	Distance
t	-	Time
V	-	Speed
θ	-	Angle
T	-	Temperature

LIST OF ABBREVIATIONS

2D	Two-dimension
2D FTT	Two-Dimensional Fourier Transform
3D	Three-dimension
AC	Alternating Current
BLIS	Blind Spot Information System
CPU	Central Processing Unit
CCD	Charged Coupled Device
CW	Continuous-wave
DBSCAN	Density-Based Spatial Clustering of Applications with Noise
DC	Direct Current
ECU	Electronic Control Unit
FM	Frequency Modulation
GND	Ground
GPS	Global Positioning System
GPU	Graphics Processing Unit
IR	Infrared
INS	Inertial Navigation System
LED	Light-emitting diode
LiDAR	Light Detection and Ranging
OEM	Original Equipment Manufacturer

PIC	Peripheral Interface Controller
RAM	Random-Access Memory
RANSAC	Random Sample Consensus
RH	Relative Humidity
SVIS	Sensor-based Vehicle Information System
TMC	Traffic Management Center
TMS	Traffic Management System
USB	Universal Serial Bus
VBDS	Vehicle Blind Spot Detection System
VBSS	Vehicle Blind Spot System
VCC	Voltage at the Common Collector
veDYNA	Vehicle Dynamics Simulation Environment Applications
Wi-Fi	Wireless Fidelity

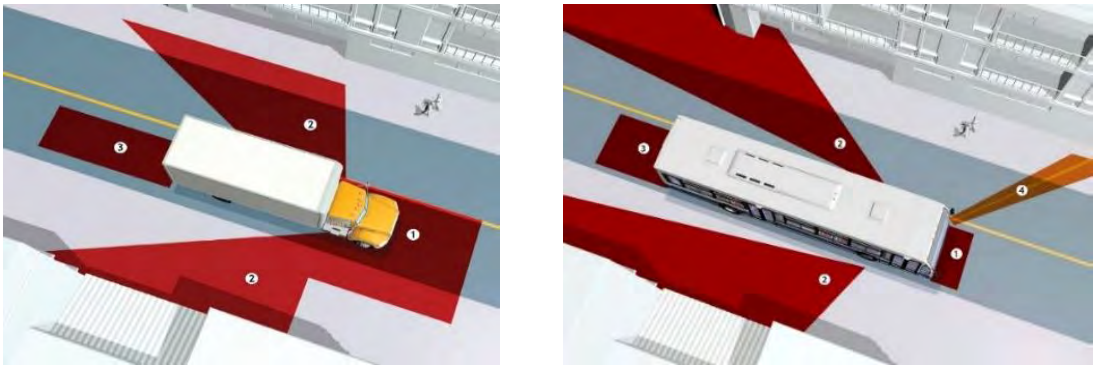
CHAPTER 1

INTRODUCTION

1.1 Overview

Throughout the driving course, it is crucial for the driver to get information regarding the behaviour of the other vehicles on the road to avoid road accidents and traffic jam (Padmanabhan and Chellamuthu, 2013). However, there is a certain area that cannot be seen directly by the driver or even through the side mirrors, which can be described as the rear quarter area on both sides of the vehicle. This is called blind spot phenomenon (Hassan and Zainal Ariffin, 2013).

The blind spot is crucial because when the other vehicle enters the blind spot while driving, the driver cannot see the presence of the vehicle and make the wrong decision to change lanes while the other vehicle is in the blind spot area. This is the main cause of the accident, especially for the motorcyclist (Md Isa, 2016). However, there are some factors that vary the blind spot occurrences such as the height of drivers and the size of the vehicle. Large vehicles tend to have a wider blind spot around the vehicle as shown in **Figure 1-1(a)** truck and **Figure 1-1(b)** for the bus**.**



(a) **(b)**

Figure 1.1: Blind spot area on **(a)** Truck and **(b)** Bus (SAAQ, 2018).

More than 457000 accidents occur every year in the United States while an estimated 975 lives and 2100 injuries in Europe as a result of failing to detect any vehicle on the hazard zone or blind spot area, proving it as the main cause of vehicle and pedestrian impact occurred (Md Isa, 2016). This shows that the demand for a safety equipment such as a blind spot detector on a vehicle is at a crucial state. A device such as Vehicle Blind Spot System (VBSS) is an example of which assist the driver in detecting the presence of another vehicle on the designated blind spot area (Hassan and Zainal Ariffin, 2013). Nowadays, car manufacturing companies have developed this technology with various ways on their cars, in relevant of the safety factors, such as Blind Spot Information System (BLIS) for Volvo, Audi Side Assist for Audi, Blind Spot Monitoring used by Mitsubishi and Toyota as well while Blind Spot Warning system used in Mazda vehicles. Unfortunately, in Malaysia, it is estimated that only 3% of the vehicle sales are equipped with this technology (Md Isa, 2016). This shows the necessity for Malaysian vehicle manufacturer to include this technology in our local products.

1.2 Research Background

Blind spot on the vehicle issue had stolen many car manufacturer company's attentions over the past three decades, started by Volvo in 1979 with a development of fit wide-angle door mirror as cited in Hanlon (2004). Then the advanced blind spot system launched by Volvo again in 2005, namely Blind Spot Information System (BLIS). The technology developed in this system is a vision-based detection by using the camera to recognize the vehicle presence in the blind spot (Hanlon, 2004).

In BMW ZZ2 concept car, a wide-angle camera is equipped at the rear part of the car, which allows a 120° view to enhancing the driver's visual on the vehicle approaching the blind spot. With the blind spot detector presence, however, there is a real challenge that must be faced to overcome the vehicle's blind spot phenomenon. In raining or snowing condition, the camera cannot recognize the approaching vehicles. This shows the weakness of the detector which requires for further development in the area of vehicle blind spot detection system.

Most of the car manufacturers' target is to develop a sensor that can work in various condition and weather. Therefore, Audi provides a lane change assist system known as Audi Side Assist, which use radar technology to monitor the traffic behind the vehicle at a roughly 70 meters range (Audi Technology Portal, 2016). However, this system consumed at a really high cost and the radar may have a problem in detecting an object that too close to the sensor. This is because the reflected pulse arrived much earlier than the time required by duplexer to connect receiver part with the antenna so, the reflected pulse is not received by the radar (Lidar and Radar Information, 2017).

The ultrasonic sensor which been used by Hassan and Zainal Ariffin (2013) has overcome this problem like a sensor that can function well in various condition. Despite the low cost, the ultrasonic sensor is also an active system which is similar to the use of the radar sensor. Unlike passive sensor such as a camera, the use of the active system can cause interference with the other vehicle with the same system (Sotelo and Barriga, 2008).

1.3 Aim and Objectives

1.3.1 Aim

The aim of this research is to provide the best way of solving the blind spot crash that involves road users and pedestrian when the drivers fail to detect any hazard coming at the blind spot. The developed system must assist the driver's awareness of the behaviour of other vehicles around the car effectively in various situation.

There are four major parameter aspects involve in the present the detection system. The first aspect is to look into the type of detecting the device followed by exploring how the new device reacts to the blind spot problem. The third aspect is to further investigate the effectiveness of the device's performance in various situation and finally the system capabilities to assist the driver in a hazard situation.

1.3.2 Objectives

The objectives of the present research are as follows:

i. To design and develop a smart and low-cost Vehicle Blind Spot Detection System (VBDS) to overcome the vehicle's blind spot phenomenon.

ii. To conduct an experimental study of the developed product to investigate the system's performance in various condition.

1.4 Scope of Study

A VBDS experimental is conducted to test system under static and dynamic condition during the day as well as night condition. However, the presence VBDS does not cover the effects of four weather season due to the Malaysia weather condition. In short, this system is completely available to be used in Malaysia.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

The new development of vehicle blind spot detection system increases the road safety not only to the car but also for motorcycles and pedestrian (Md Isa. 2016). For the system development, the blind spot is determined first in order to set the detector correctly. The detector will monitor and sense any potential hazard presence on the designated spot immediately thus warns the driver through the indicator until the hazard zone is clear. The warning can be visual or audible. Many car manufacturers use a similar approach in monitoring blind spot, by locating sensors at both rear parts of the vehicle. A smart and simple blind spot detector has to be developed to offer an advanced technology of vehicle blind spot detection, which also can work in different condition. The overall literature review for the present work is shown in **Figure 2.1**.