SIMULATION OF AUTONOMOUS DRIVING IN FOLLOWING HIGHWAY LANE

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DECLARATION

I declare that this thesis entitled "Simulation Of Autonomous Driving In Following Highway Lane" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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Name : IZZ FITRI HAIKAL BIN HAIRIZAL

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APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Mechanical Engineering Technology (Automotive) with Honours.

Signature	:	
Supervisor Name	:	Nur Rashid Bin Mat Nuri
Date	:	28/1/22

DEDICATION

To my beloved mom and dad, Puan Yuslaini binti Yusof and Encik Hairizal, my younger sister and younger brother who encouraged me to make a great thesis based on my topic. I had spent about one year to finish this thesis report.

To my bestfriends, Nur Syahmi and As-Shakirin and also friends from my class as well as from different courses and programmes, who always support and have my back whenever I felt down to earth. Thank you for the inspiration and kind words.

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ABSTRACT

An autonomous vehicles are the future smart car that created to be driverless, efficient, and also crash avoiding ideal urban car of the future. Many studies have been made to realize the dream of an autonomous driving with many test of system. Solving the defect during the test run for the autonomous driving simulation will be difficult challenges. As many as the challenges appeared, the first challenge would be to design and customize the system and how the system is needed to be put on the appropriate location. Visible technologies that help an autonomous driving to be more effective are important components of Intelligent Transportation Systems. Many researcher, technologist, engineers, and commercial systems have been proposed in the literature. The derivation about the equation for the vehicle dynamics will help to give more exposure about how the vehicle can turns when reaching the curved road in theory as well as in calculation research. In this paper, the system for an autonomous will be discussed especially about how the system will help driver to reduce accident happened by avoiding collision and impact from possible angle to the vehicle. The lane detection and tracking and lane departure warning both have its own function. Other than that, this paper will also discuss how an autonomous driving vehicle system more advanced system such as lane keeping assist system performs in road lane. This study's objective is to develop lane keeping assist (LKA) system to observe the behavior of the vehicle in highway lane. MATLAB Simulink software will be the platform for developing the system. Many block diagram from the library are used to develop the LKA system in the software such as lane keeping controller which link to the vehicle block diagram to synchronize the lane detection with the movement of the vehicle. The lane also developed in the software for curve road type. Furthermore, that simulation can be observed more clearly with highway speed of 100 km/h. The results present about the difference between the performance of the vehicle without enable the system and with enable the system according to safe lateral distance values. Safe lateral distance that is set from the controller in MATLAB Simulink software is 0.5 m until 2.0 m with interval of 0.5 m. The behavior of the vehicle includes the lateral deviation, relative yaw angle, and steering angle. These three behaviors show how the vehicle perform in highway lane and the comparison for each value of safe lateral distance.

ABSTRAK

Kenderaan berautonomi adalah kereta pintar masa hadapan yang diciptakan untuk dijadikan sebagai kenderaan yang tidak memerlukan pemandu, effisien, dan kenderaan yang dapat mengelakkan rempuhan. Pelbagai penyelidikan telah dilaksanakan bagi merealisasikan impian pemanduan berautonomi dengan pelbagai cubaan sistem. Penyelesaian terhadap kecacatan yang berlaku semasa ujian simulasi pemanduan autonomi menjadi cabaran yang sukar. Dalam pelbagai cabaran yang mendatang, cabaran pertama adalah merancang dan menyesuaikan sistem dan bagaimana sistem perlu ditempatkan di lokasi kenderaan yang sesuai. Teknologi berupa penglihatan pada kenderaan berautonomi yang membantu pemanduan autonomi menjadi lebih berkesan adalah komponen penting Sistem Cerdas Transportasi. Ramai penyelidik, teknologi, jurutera dan sistem komersial telah dicadangkan di dalam kajian perpustakaan. Terbitan tentang persamaan untuk dinamik kenderaan akan membantu untuk mendapatkan lebih banyak pencerahan tentang bagaimana sistem ini dapat membantu pemandu untuk membelok apabila sampai pada selekoh jalan berdasarkan kajian teori dan juga dalam penyelidikan pengiraan. Dalam tulisan ini, sistem untuk autonomi akan dibincangkan terutama mengenai bagaimana sistem akan membantu pemandu untuk mengurangkan kemalangan yang berlaku dengan mengelakkan perlanggaran dan impak dari sudut yang bermungkinan akan berlakunya hentaman. Objektif kajian ini adalah untuk mencipta system lane keeping assist (LKA) bagi permerhatian terhadap tingkah laku kenderaan di lebuh raya. Perisian MATLAB Simulink akan menjadi platfom untuk mencipta sistem. Pelbagai blok gambar digunakan bagi menghasilkan sistem LKA seperti blok gambar lane keeping yang menghubung dengan blok gambar kenderaan bagi menyatukan pengesanan lorong. Selanjutnya, simulasi yang dilakukan dapat diperhatikan dengan lebih jelas dengan kelajuan lebuh raya 100 km/j. Hasil simulasi akan menunjukkan perbezaan antara prestasi kenderaan tanpa mengaktifkan sistem dan system setelah diaktifkan berdasarkan nilai ‘safe lateral distance’. ‘Safe lateral distance’ tersebut menggunakan nilai 0.5 m sehingga 2.0 m dengan selanga nilai 0.5 m. Tingkah laku kenderaan merangkumi ‘lateral deviation’, ‘relative yaw angle’, dan sudut stereng. Ketiga-tiga tingkah laku ini akan dibincangkan untuk menyelesaikan bagaimana sistem akan dilakukan di lebuhraya dan perbandingan antara semua nilai ‘safe lateral distance’.

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LIST OF SYMBOLS AND ABBREVIATIONS

v_x	-	Vehicle speed
β	-	Sideslip angle
r	-	Yaw rate
f_ω	-	Lateral wind force
C_r	-	Center of gravity of rear tire
C_f	-	Center of gravity of front tire
m	-	Mass of vehicle
y_L	-	Lateral deviation error
ψ_L	-	Heading error
r	-	Radius
ρ_r	-	Road curvature
R_r	-	Curvature radius
T_d	-	Driver torque
T_a	-	Assistance torque
T_s	-	Self aligning torque
$\dot{x}_v$	-	Vehicle state
w	-	Disturbance vector
u_v	-	Control input
η_t	-	Torque efficiency
LKA	-	Lane Keeping Assist
LDW	-	Lane Departure Warning
LDT	-	Lane Departure and Tracking

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CHAPTER 1

INTRODUCTION

1.1 Background

Autonomous driving is a method where people can drive their vehicle without controlling the vehicle such as step on the accelerator pedal, brake pedal, and control the steering of the car. The system was set up in the vehicle to give command to the vehicle so that the vehicle will detect surrounding and follow the command that was set up by the driver. Plus, autonomous vehicles are vehicles that are able to detect their surrounding and environment and to move without any intervention of a human driver. It also are known as driverless, self-driving, unmanned or robotic vehicle.

Vehicle automation was first proposed in 1918 (Pendleton et al., 2017), and General Motors demonstrated the first autonomous vehicle concept in 1939. (Shladover, 2018). In the 1950s, General Motors and the Radio Corporation of America Sarnoff Laboratory collaborated on the first steps of research and development (R&D) (Shladover, 2018). Several other R&D programmes were active in the United States, Europe, and Japan from 1964 to 2003, under the individual and joint initiatives of various government institutes and academia to develop automated bus and truck platoons, supersmart vehicle systems, and video image processing for driving scene recognition (Shladover, 2018).

The Defense Advanced Research Projects Agency's (DARPA) Grand Challenges Program in the United States expanded AV research in 2004. In 2005 and 2007, AVs capable of traversing desert terrain were developed as a result of the challenges. Via DARPA's Urban Challenge Program, researchers were also able to position AVs on city roads (Pendleton et al., 2017). R&D has progressed at a rapid pace in both academia and industry since then (Shladover, 2018).

There are variety of system for autonomous driving to be used as a system to detect surrounding of the location so that the autonomous driving can be more effective. For example, the implementation of Lane Keeping Assist (LKA) system for the autonomous driving. LKA system is a pro-active system that is able to alerts the driver, either with an audio/visual prompt or haptic feedback through the steering wheel, and also able to intervene and manipulates the steering to prevent the driver from the case of understeer or oversteer when driving.

1.2 Problem Statement

Statistics of accident are increasing years by years. There are many types of causes that related to this problem. One of type causes is human factor such as driver's careless and fatigue when driving their vehicle. It shows that the driver can not focus when driving the car and causes accident by changing lane without the driver knowing. The cause inattention when driving also can affect other driver safety. Next, driver tend to oversteer and understeer when they are not focusing on the road which also can cause accident. Oversteer or understeer were also caused by inattention driver. This is because when they are not aware of the lane to control the steering wheel, accident could happened. This is why many researchers, technologists, and engineers were proposing system that could help driver as well as passenger to autonomously control the vehicle whenever required. By developing an autonomous driving system, the results of how the autonomous driving can be obtained to help reduce the accident to occur in highway. The autonomous driving alone will not enough to help to avoid a car accident. So, verifying an assist system for the autonomous driving by using MATLAB Simulink Software can help to investigate the safe lateral distance especially in highway road. Using Simulink also can investigate how the vehicle will perform in respective highway lane with the most accurate calculation of distance and speed. Simulink also will help to reduce the time used to test the safe distance between the car and the highway lane.

1.3 Research Objective

The objectives of the project are:

a) To model an autonomous driving block diagram using Lane Keeping Assist system in MATLAB Simulink software.

b) To investigate the effectiveness of safe lateral distance between vehicle and highway marking lane.

c) To verify the behavior of the vehicle by following the highway lane.

1.4 Scope of Study

Based on the objectives, the scopes of study are highlighted as follows:

a) Lane keeping assist (LKA) system is developed in the MATLAB Simulink Software.

b) The safe lateral distance will be set from 0.5m until 2.0m with an interval of 0.5m.

c) The velocity of the vehicle is set based on highway speed of 100 km/h.

1.5 Research Flowchart

Figure 1.1 below present the flow of process for this reseach. Process flow for research acts as a map with a brainstorming idea to get a researcher from the beginning of inquiry to the end of a conclusive understanding.

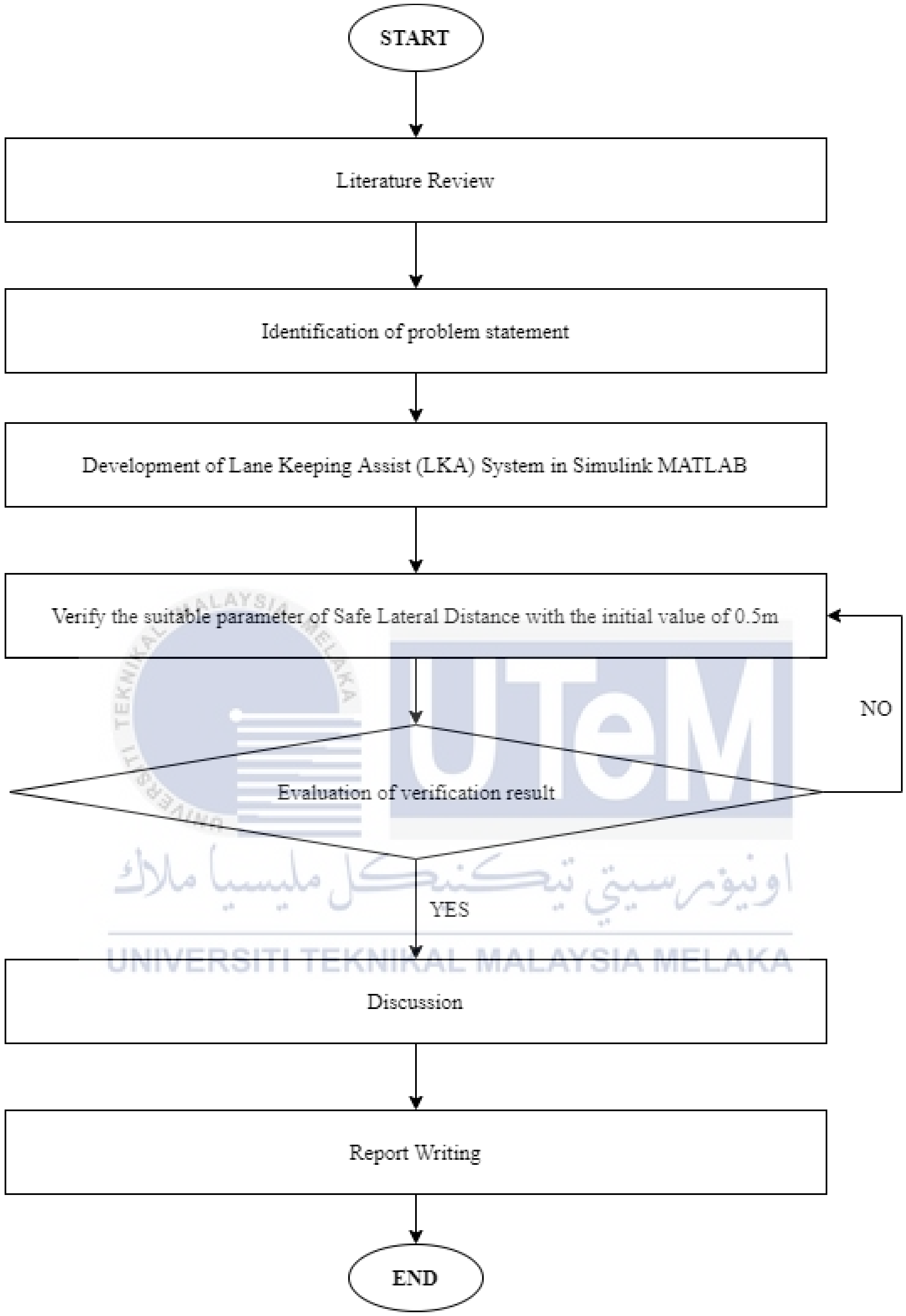

Figure 1.1 Process Flowchart

1.6 Summary

An autonomous driving have been developed since 1980 and further study in 1984 and 1987 for Mercedes-Benz project. The study then spread to a new technology for accomplishment of fully autonomous vehicle. Chapter 2 will continue on how the system is reviewed based on previous study for further planning. Then, Chapter 3 presents the method about how the system is developed using the idea planned while Chapter 4 shows the simulation result test from MATLAB Simulink software with details of discussion. Lastly, Chapter 5 contains conclusion for the whole project.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

To make the explanation simple, literature review is a research about any topic in every particular where it is being described, evaluated, and summarized. It also shows at how the knowledge has developed in the field with the point what was already done, what is generally known, what emerges, and how the topic is currently is being considered. The literary review is to identifies the research gap to understand and explain how the gap is addressed in a specific research project. This section will be describing about type of vehicle, system used for the autonomous driving to work effectively and also the explanation of road lane especially in highway lane.