SUPERVISOR DECLARATION

"I, hereby declare that I have read this thesis and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of

Bachelor of Mechanical Engineering (Automotive). "

Signature: _____

Supervisor: _____

Date: _____

AUTOMATIC THROTTLE BODY CONTROL USING PID CONTROLLER

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This report was submitted in accordance with the partial requirements for the honor of Bachelor of Mechanical Engineering (Automotive)

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DECLARATION

"I, hereby declare that the work in this report is my own except for summaries and quotations which have been duly acknowledge."

Signature: _____

Author: _____

Date: _____

Specially dedicated to

Beloved father and mother.

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All praises to **Allah the Almighty** that by His blessings I have been able to successfully finished my Projek Sarjana Muda II (PSM II), which the course requirement that in Universiti Teknikal Malaysia Melaka (UTeM).

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ABSTRACT

Projek Sarjana Muda that will be conducted is about the development of vehicle speed control by using MATLAB Simulink software and the performance evaluation of the controller. This development is conducted to develop the adaptive cruise control system (ACC) which needed the throttle body actuator to control the vehicle speed in order to maintain the safe distance between drive vehicle and target vehicle. The focus of the project is on the development of the throttle body actuator and the performance evaluation of the controller. The control structure of the throttle body actuator will be developed in this project as the subsystem for adaptive cruise control system. After the validation of the control structure of vehicle longitudinal model and throttle body actuator succeeds, the throttle body actuator will be tuned to get good results. This report consist the introduction, literature review to develop this project, research methodology on how to develop vehicle longitudinal model and control structure of throttle body actuator, results and discussion. There are some equations involved in order to complete the control structure and will be displayed in this report. At the end of this project, the objectives will be achieved and the suggestions or improvements will be made if critically needed. Finally, conclusions will be made based on tasks performed during this project.

ABSTRAK

Projek Sarjana Muda yang akan dijalankan adalah berkenaan dengan pembangunan kawalan kelajuan kenderaan dengan menggunakan perisian MATLAB Simulink dan penilaian prestasi pengawal. Perkembangan ini dijalankan untuk membangunkan sistem ‘adaptive cruise control’ (ACC) yang memerlukan penggerak pendikit untuk mengawal kelajuan kenderaan bagi mengekalkan jarak yang selamat antara kenderaan yang memandu dan kenderaan sasaran. Fokus projek ini menekankan kepada pembangunan penggerak pendikit dan penilaian terhadap prestasi pengawal yang dibina. Struktur kawalan penggerak pendikit akan dibangunkan dalam projek ini sebagai subsistem untuk system ‘adaptive cruise control’. Selepas pengesahan struktur kawalan model longitudinal kenderaan dan penggerak badan pendikit berjaya dilaksanakan, prestasi penggerak pendikit akan dinilai pada akhir PSM 2 dalam 2 semester melalui eksperimen di makmal Autotronic di UTeM. Laporan ini mengandungi pengenalan, sastera, kajian semula untuk membangunkan projek ini dan juga penyelidikan methodology tentang bagaimana untuk membangunkan struktur kawalan dan eksperimen yang berkaitan. Terdapat beberapa persamaan matematik yang digunakan dalam usaha menyiapkan struktur kawalan dan akan dipaparkan dalam laporan ini. Di akhir projek ini, dijangka objektif akan tercapai dan cadangan atau penambahbaikan akan dilaksanakan sekiranya projek ini perlu kepadanya. Akhir sekali, kesimpulan akan dibuat berdasarkan kerja-kerja yang telah dilaksanakan sepanjang projek ini dijalankan.

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°	-	Degree of angle
T_{Max}	-	Maximum available engine torque at given rpm for a typical V8 engine
R	-	Engine speed in unit RPM
η_g	-	Gear ratio
η_f	-	Final gear ratio
ω_i	-	Final wheel velocity
μ_e	-	Rate of change of energy transfer coefficient
τ_{es}	-	Equivalent lag
F_{zr}	-	Rear wheels normal force
F_{zf}	-	Front wheels normal force
F_d	-	Drag forces
F_a	-	Aerodynamic resistance forces
F_r	-	Rolling resistance forces
ρ	-	Air density equal to 1.23 kgm/3
C_r	-	Rolling resistance coefficient
C_d	-	Aerodynamic drag coefficient
A	-	Frontal area of the vehicle
λi	-	Wheel slip ratio
μ_i	-	Pacejka model

τ_{e_i}	-	Torque delivered by the engine to each wheel
τ_{b_i}	-	Torque applied to each wheel due to the brakes
τ_{r_i}	-	Reaction torque on each wheel due to tyre tractive force
p_{b_i}	-	Pressure applied to the brake disc
ω_i	-	Wheel angular speed
τ_{b_i}	-	Braking torque
S	-	Number of steps per revolution
$\Delta\phi$	-	Number of rotor pole
T_{Mj}	-	Motor torque
k_m	-	Motor constant
$\phi(t)$	-	Actual motor position
ϕ_{0j}	-	Location of the coil j in the stator
$I_j(t)$	-	Current in the coil as function of time
emf_j	-	Electromotive force induced in the phase j
L	-	Inductance of the coils
J	-	Inertia of the rotor and load
D	-	Viscous damping constant
T_A	-	Load acceleration
ϕ_{i+1}	-	Commanded rotor position
P_j	-	Required pulses for each phase

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

The purpose of this chapter is to provide with an introduction to the research conducted for this project. In this section, the overview of controller, the overview of current development of controlling vehicle will be included. The main objective, scope of the project, and the problem statement also will be included in this section.

1.2 OVERVIEW OF CURRENT DEVELOPMENT OF CONTROLLING SYSTEM IN VEHICLE

Nowadays, the developments of automotive technologies are quite competitive as the cars produced by many vehicle manufacturers all over the world are increasing. There many types or categories of technologies in automotive developments such as hybrid vehicle, antilock brake system (ABS), electronic brake force distribution (EBD), active force steering system (AFS), adaptive cruise control (ACC) and many more.

Talking about the technologies of adaptive cruise control (ACC), this technology development is still at the early stage as there are still many problems occur, doubtful and not at the best expectation. However, this technology is very challenging and good to be studied by the engineers and still can be improve by apply some modifications on the system.

The controlling system like adaptive cruise control (ACC) is very useful to the drivers or road users because it help user to drive safely. The controlling mechanism in ACC help users to cruise their vehicle automatically by set at desired speed and at the same time, the controllers ensure the safety distance so that the car will not collide the vehicle in front which at same lane.

Overall this technology is very intelligent, smart in reduce the drivers burden, reducing drives fatigue, improving comfort by allowing positioning changes more safely, make long journey more comfortable and of course increase the fuel efficiency. However, there are still disadvantage in this technology like not recommended to drive the vehicle with ACC system (ON mode) in the bad weather like heavy snow because the vehicle still might slip and the accident may occur.

1.3 OBJECTIVES

The main objective of the project is to develop vehicle speed control to control the throttle plate angle at the desired speed which is set in adaptive cruise controller. Before developing the vehicle speed control or more details develop the throttle body actuator in control structure form, it is important to study first the about the vehicle longitudinal model. Before go through to the main objective, it is needed to understand the behaviour of the vehicle in longitudinal motion.

Thus, the first objective is to develop the vehicle longitudinal model using Matlab Simulink software. The next objective would be the development of the vehicle speed control system also using Matlab Simulink software. The development of the basic control structure of the throttle body actuator will be guide by the previous studies and researches in order to control the throttle plate angle at the desired speed.

The validation for control structure, vehicle longitudinal model and vehicle speed control will be validating by using CARSIM v8 software. The options that contain in this software will help to validate the control structure built either the development are successful or not.

1.4 SCOPES

In order to complete the entire task in this project, the scopes of the project will be focused on control structure development by using Matlab Simulink and CARSIM v9 software. Thissoftware basically will help to identify the throttle opening angle at the desired speed set by the adaptive cruise control system. Next the project will focused more on the evaluation and comparison of performance between the developed controller and the actual controller of throttle body.

1.5 PROBLEM STATEMENT

Although the Conventional Cruise can automatically control the vehicle velocity by set the desired speed at the controller, the conventional cruise control do not have the automatic braking system to reduce the vehicle speed. This mean that the system must rely on brake pedal which is must apply manually or push the CANCEL manually button from controller in order to switch off the cruise control system.

In conventional cruise control, generally the vehicle needs to rely on manual controller, air friction and drag force to reduce the vehicle speed. In this project, the vehicle speed controller need to be developed in adaptive cruise control system to replace the conventional cruise control system. The ideal vehicle speed control that can be develop in the adaptive cruise control is electronic throttle control (ETC) based on drive-by-wire or throttle-by-wire system.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The purpose of this chapter is to provide the previous studies and researches that strongly related to the project. The previous studies and researches found will be the references to this project. The literature review is very important in preparing the needed parameters to develop control structure of vehicle longitudinal and control structure of vehicle speed control.

Besides, the previous experiments about experimental validation of throttle body actuator is very useful as a guidance when conduct the experiment in the lab. The expected result for this project should be at least more or less the same to the previous results that heavily relate to the project.