PROJEK SARJANA MUDA

DEVELOPMENT OF MANUAL TRANSMISSION POWERTRAIN DYNAMIC MODEL FOR DRIVE SIMULATOR.

NAME : MOHAMAD NIZAM BIN SHAMSUDDIN

MATRIC NUMBER : B040710082

COURSE : BACHELOR OF MECHANICAL ENGINEERING (AUTOMOTIVE)

SUPERVISOR : EN. MOCHAMAD SAFARUDIN

SECOND SUPERVISOR : EN. FAIZUL AKMAR B. ABD KADIR

DEVELOPMENT OF MANUAL TRANSMISSION POWERTRAIN DYNAMIC MODEL FOR DRIVE SIMULATOR

MOHAMAD NIZAM BIN SHAMSUDDIN

This report is submitted in partial fulfillment of the requirement for the

Bachelor of Mechanical Engineering (Automotive)

Faculty of Mechanical Engineering

Universiti Teknikal Malaysia Melaka (UteM)

7th APRIL 2010

I admit that have read this report and in my opinion, this report is enough in terms of scope and quality to bestowal Bachelor of Mechanical Engineering (Automotive)

Signature : …….

Supervisor I : …….

Date : …….

I declare that this report is my own work except for any summary or quotation from every single source is explained.

Signature : ……

Author : MOHAMAD NIZAM BIN SHAMSUDDIN

Date : 7 APRIL 2010

For my beloved father, mother and family

ACKNOWLEDGEMENT

In general, I hereby would like to express my appreciation to those involved either directly or indirectly in accomplishing my PSM 2. This project would not have been possible without the support of many people. Mr. Mochamad Safarudin, my supervisor, deserves a special mention because he has given me all the support and encouragement throughout this project. And finally, thanks goes to my parents and numerous friends who have endured this long process with me and always offer valuable support and love all this while. I hope all the support and knowledge given enable me to gain more significant experience and precious understanding on engineering field in the future.

ABSTRACT

The purpose of this project is to build a manual transmission powertrain dynamics model to be used in drive simulator simulation and validation. With the estimation of parameters that will be given to the model, the drive simulator will look like such as the real driving situation. This project will be used the Simulink software to build the manual transmission powertrain dynamics model. The powertrain in manual transmission vehicle for rear wheel drive (RWD) consist of engine, clutch, transmission or gearbox, propeller shaft, differential gear, drive shaft and wheel. So the result of this project will be the torque and speed at each powertrain component. For give more efficient to the project result, the experiment also will be provided to compare between experimental and project result. With the experimental result the design of manual transmission powertrain dynamic model will be fixed and the final results of this project do not have a lot difference compare to real situation. With the possible result, the design of manual transmission powertrain dynamic model finally will be used for drive simulator.

ABSTRAK

Tujuan projek ini adalah untuk membina atau mereka sebuah model dinamik penghantaran kuasa bagi transmisi manual yang akan digunakan dalam simulasi pemanduan. Dengan memberikan anggaran parameter-parameter kepada model, simulasi pemanduan akan kelihatan seperti pemanduan sebenar. Projek ini akan menggunakan perisian Simulink untuk membina model dinamik penghantaran kuasa bagi kotak gear manual. Penghantaran kuasa bagi kotak gear manual bagi pemanduan tayar belakang (RWD) adalah merangkumi enjin, klac, kotak gear atau transmisi, `propeller shaft` , `differential gear`, `drive shaft` dan tayar. Jadi keputusan untuk projek ini adalah merangkumi kuasa, tork dan kelajuan bagi setiap komponen penghantaran kuasa. Untuk memberikan keputusan projek yang lebih efisien, eksperimen juga akan dijalankan dan keputusan antara projek dan eksperimen akan dibandingkan. Dengan berpandukan keputusan daripada eksperimen, model dinamik penghantaran kuasa bagi transmisi manual akan dibaiki atau diubah supaya keputusan terakhir projek ini tidak mempunyai perbezaan yang ketara dengan pemanduan yang sebenar. Dengan keputusan atau hasil yang munasabah, rekaan model dinamik penghantaran kuasa bagi transmisi manual akhirnya dapat digunakan untuk simulasi pemanduan.

CONTENT

CHAPTER	SUBJECT		PAGE
		2.1.1.4 Rotary Engine	7
	2.1.2	Internal Combustion	8
	2.1.3	Basic Engine Parts	9
		2.1.3.1 Spark Plug	9
		2.1.3.2 Valves	9
		2.1.3.3 Piston	9
		2.1.3.4 Piston Rings	9
		2.1.3.5 Connecting Rod	10
		2.1.3.6 Crankshaft	10
		2.1.3.7 Sump	10
2.2	Clutch		10
	2.2.1	Introduction	10
	2.2.2	Clutch Slip	12
2.3	Transmission		12
	2.3.1	Introduction	12
	2.3.2	Manual Transmission	14
	2.3.2	Simple Transmission	15
	2.3.4	First Gear	17
	2.3.5	Real Gear	18
	2.3.6	Reverse Gear	20
	2.3.7	Synchronizers	20
2.4	Differential		21
2.5	Driveshaft		24
	2.5.1	Front Engine Rear Wheel Drive	24
	2.5.2	Front Engine Front Wheel Drive	25
	2.5.3	Four Wheel Drive And All Wheel Drive	25
2.6	Wheel		26
2.7	Longitudinal Vehicle Dynamics		26
	2.7.1	Aerodynamic Drag Force	28

LIST OF TABLE

LIST OF FIGURE

LIST OF SYMBOL

Pe	= Engine power (Watt)
Pm	= Maximum power of engine (Watt)
Wm	= Engine speed at Maximum power (Rad/sec)
We	= Engine speed (Rad/sec)
Pw	= Power at wheel (Watt)
η overall	= Overall efficiency
ηc	= Clutch efficiency
ηg	= Gearbox efficiency
ηd	= Differential gear efficiency
Ng	= Gearbox ratio
Nd	= Differential gear ratio
Tw	= Wheel torque (N.m)
Tp	= Propeller torque (N.m)
Te	= Engine torque (N.m)
Tp	= Propeller torque (N.m)
Fx	= Traction force (N)
Ww	= Wheel speed (rad/sec)
Vx	= Velocity in x direction (m/s)
Rw	= Wheel radius (m)
Tin	= Input (engine torque)
ρ	= Mass density of air (kg/m^3)
C_d	= Aerodynamic drag coefficient
A_F	= Frontal area of vehicle (m^2)

V_x = Longitudinal vehicle velocity (m/s)

V_{wind} = Wind velocity (m/s)

F_{xf} = The longitudinal tire force at the front tires (N)

F_{xr} = The longitudinal tire force at the rear tires (N)

F_{aero} = The equivalent longitudinal aerodynamic drag force (N)

R_{xf} = The force due to rolling resistance at the front tires (N)

R_{xr} = The force due to rolling resistance at the rear tires (N)

m = The mass of the vehicle (kg)

g = The acceleration due to gravity (m/s²)

θ =The angle of inclination of the road on which the vehicle is traveling (degree)

$C_{\sigma f}$ and $C_{\sigma r}$ = Longitudinal tire stiffness (N)

σ_x = Slip ratio.

f = Rolling resistance coefficient

Fzf = Front wheel vertical load (N)

Fzr = Rear wheel vertical load (N)

LIST OF APPENDIX

CHAPTER I

INTRODUCTION

1.1 Project Introduction

A manual transmission power train consists of engine and driveline. The main parts of the driveline are clutch, transmission, shafts and wheels. The driveline is a fundamental part of a vehicle and its dynamics has been modeled in different ways depending on the purpose. In order to analyze and develop of manual transmission power train dynamic (forces generated and the responses of the power train), a model should be developed. From the manual transmission power train dynamic model, a mathematical model will be developed. Then, with the development of power train mathematical model, a simulation can be developed using software like Mat Lab and Simulink. Finally the simulation will be using for the drive simulator.

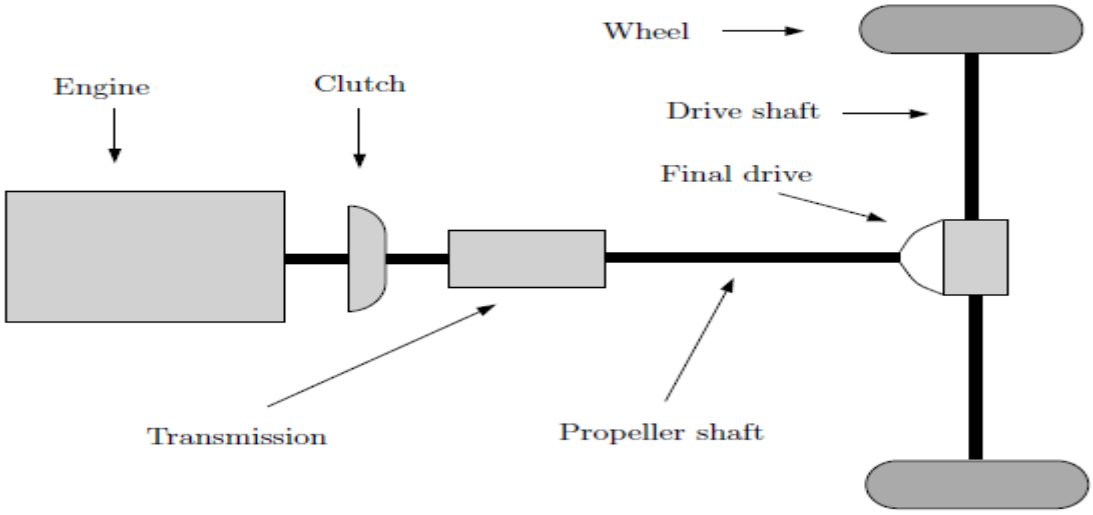

Figure 1.1: Rear Wheel Drive (RWD) Manual Transmission Powertrain

Simulation has become common practice in automotive developments because it speeds up the development cycle and decreases costs. The increasing demand for driving comfort has put some emphasis on the dynamics of the power train. In this context dynamic simulations can be of aid in several aspects:

- Possible sources of unwanted behaviour of the system can be detected in early stages of the design process. This allows the designer to correct the design at an early stage and minimizes the need for expensive prototypes. It also makes the design process faster.
- Known problems can be analyzed and possible solutions can be tested in the simulation models. This leads to better solutions, faster treatment and minimizes the need for testing.
- Dynamic simulations lead to a better understanding of the behaviour of the system. This knowledge can then be used in future designs to avoid possible problems.

However the main point of this project is to develop the manual transmission powertrain dynamics model for drive simulation and not a prototype or design. So this project only covers about the identification of the powertrain, development of the powertrain dynamics model and the parameter estimation.

1.2 Project Objective

To built a manual transmission powertrain dynamics model to be used in drive simulator simulation and validation.

1.3 Problem Statement

To give the passions to the one who are driving the drive simulator, the simulation must be look like the real one. In order to give the perfect simulation, the drive simulator of manual transmission powertrain dynamics model is designed. With the dynamics identification and parameter estimation given to the model, the result must be very interesting.

1.4 Scope

- Powertrain dynamics identification.
- Develop powertrain dynamics model.
- Parameters estimation.

CHAPTER II

LITERATURE REVIEW

In a vehicle, the term powertrain refers to the group of components that generate power and deliver it to the road surface. This includes the engine, transmission, driveshafts, differentials, and the final drive.

2.1 Engine

An engine is a mechanical device that produces some form of output from a given input. The purpose of an engine is to produce mechanical power from a fuel source. Originally an engine was a mechanical device that converted force into motion. The purpose of a gasoline car engine is to convert gasoline into motion so that your car can move. Currently the easiest way to create motion from gasoline is to burn the gasoline inside an engine. Therefore, a car engine is an internal combustion engine (combustion takes place internally).

The core of the engine is the cylinder, with the piston moving up and down inside the cylinder. Most cars have more than one cylinder (four, six and eight cylinders are common). In a multi-cylinder engine, the cylinders usually are arranged in one of three ways. That are inline, V or flat (also known as horizontally opposed or boxer), as shown in the following figures.