EVALUATION OF A PERODUA KANCIL ENGINE MOUNTING SYSTEM

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MAY 2011

"I hereby declare that I have read this thesis and in my opinion this report is sufficient in terms of scope and quality for award of degree of Bachelor of Mechanical Engineering (Automotive)."

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"I hereby declare that the work in this report is my own work except for summaries and quotations that I have mentioned its sources."

Signature: ……………………….

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To my beloved parents,

Mr. Ishak Bin Mohd and Mrs. Maison Binti Mohd Rafie

My siblings

And also

To all my trusted friends

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Alhamdullillah...

Grateful to Almighty for with His divine grace, I have successfully completed this Projek Sarjana Muda 1 with great success. By the end of my project, I have produced a report which is compulsory for all students.

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ABSTRACT

This project presents an Evaluation of Perodua Kancil Engine Mounting System. The engine vibration may occur due to road irregularities, at low frequency, and also reciprocating mechanism of the piston in the engine, at high frequency. Mathematical model of an engine mounting for passive and active engine mounting (AEM) system are developed and simulated in MATLAB Simulink based on force analyses of system parts. The developments of the equation of motion have been made for 3 degree of freedom (DOF). However, a single DOF must be done first in order to understand the 3 DOF for engine mounting system. A number of controllers in AEM system have been proposed. In this project, active engine mounting are equipped with proportional integral derivative controller (PID). The comparison simulation result between passive, active and skyhook engine mounting have been made. The result indicated that the active engine mount can achieve better vibration isolation performance than passive and skyhook engine mount.

ABSTRAK

Projek ini mengenai penilaian Sistem Pemegang Enjin Perodua Kancil. Getaran enjin boleh berlaku kerana permukaan jalan yang tidak rata, pada frekuensi rendah, dan juga mekanisme piston pada enjin, pada frekuensi tinggi. Model Matematik untuk sistem pemegang enjin pasif dan sistem pemegang enjin aktif diterbitkan dan disimulasikan dalam MATLAB Simulink berdasarkan analisis pada daya yang bertindak dalam sistem pemegang enjin. Persamaan pergerakan sistem pemegang enjin berdasarkan 3 darjah kebebasan. Namun, satu darjah kebebasan harus dilakukan terlebih dahulu untuk memahami 3 darjah kebebasan dalam sistem pemegang enjin. Kawalan dalam sistem pemegang enjin mempunyai banyak pilihan. Dalam projek ini, pemegang enjin aktif dilengkapi dengan ‘proportional integral derivative’ (PID). Perbandingan keputusan simulasi antara pemegang enjin pasif, pemegang enjin ‘skyhook’ dan pemegang enjin aktif telah dibuat. Keputusan kajian menunjukkan bahawa pemegang enjin aktif dapat mencapai prestasi penyerap getaran yang lebih baik dari pemegang enjin pasif dan pemegang enjin ‘skyhook’.

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LIST OF SYMBOLS

P(t)	=	Excitation force
M_e	=	Engine mass
M_u	=	Unbalance mass
r	=	Radius of the rotation
ω	=	Speed of rotation
F_s	=	Spring force
F_d	=	Damper force
k_s	=	Spring constant
C_s	=	Damping constant
Z_s	=	Engine unit displacement
Z_u	=	Chassis unit displacement
$\dot{Z}_s$	=	Engine unit velocity
$\dot{Z}_u$	=	Chassis unit velocity
$\ddot{Z}_s$	=	Engine unit acceleration
F_v	=	Vertical force

F_{sf}	=	Front spring force
F_{srr}	=	Rear spring force
F_{sr}	=	Right spring force
F_{sl}	=	Left spring force
F_{df}	=	Front damper force
F_{drr}	=	Rear damper force
F_{dr}	=	Right damper force
F_{dl}	=	Left damper force
F_{cf}	=	Front skyhook force
F_{crr}	=	Rear skyhook force
F_{cr}	=	Right skyhook force
F_{cl}	=	Left skyhook force
P	=	Track width
L	=	Wheelbase length
k_{sf}	=	Front spring constant
k_{srr}	=	Rear spring constant
k_{sr}	=	Right spring constant
k_{sl}	=	Left spring constant
C_{sf}	=	Front damping constant
C_{srr}	=	Rear damping constant
C_{sr}	=	Right damping constant
C_{sl}	=	Left damping constant
Z_{sf}	=	Front engine unit displacement

Z_{srr}	=	Rear engine unit displacement
Z_{sr}	=	Right engine unit displacement
Z_{sl}	=	Left engine unit displacement
Z_{uf}	=	Front chassis unit displacement
Z_{urr}	=	Rear chassis unit displacement
Z_{ur}	=	Right chassis unit displacement
Z_{ul}	=	Left chassis unit displacement
$\dot{Z}_{sf}$	=	Front engine unit velocity
$\dot{Z}_{srr}$	=	Rear engine unit velocity
$\dot{Z}_{sr}$	=	Right engine unit velocity
$\dot{Z}_{sl}$	=	Left engine unit velocity
$\dot{Z}_{uf}$	=	Front chassis unit velocity
$\dot{Z}_{urr}$	=	Rear chassis unit velocity
$\dot{Z}_{ur}$	=	Right chassis unit velocity
$\dot{Z}_{ul}$	=	Left chassis unit velocity
M_p	=	Pitching moment
M_r	=	Rolling moment
I_p	=	Inertia in pitching
I_r	=	Inertia in rolling
θ	=	Pitching angle
$\ddot{\theta}$	=	Pitch acceleration

α	=	Roll angle
$\dot{\alpha}$	=	Roll rate
$\ddot{\alpha}$	=	Roll acceleration
F_a	=	Actuator force

LIST OF ABBREVIATION

AEM	=	Active Engine Mounting
ACV	=	Active Vibration Control
DOF	=	Degree of freedom
EMS	=	Engine Mounting System
FF	=	Feedforward
PID	=	Proportional Integral Derivative

LIST OF APPENDICES

CHAPTER I

INTRODUCTION

This chapter will provide information about the background, problem statement, objective, project scope, project Gantt chart, project outline and project flow chart of this project.

1.1 Background

Mounting are very important in a vehicle as an attachment point for a part or system to the chassis. It also acts as an isolator which keeping noise or vibration so they will not be felt by the driver and passenger. One of the mount systems in a vehicle was engine mount. An engine mount attached the engine to the chassis. The mounts are designed to allow a certain amount of rotation as well as absorbing much of the engine vibration. Each vehicle has different type and location of engine mounting. For Perodua

Kancil 850 EZ engine, it has four mounts which located at the front, right, left and rear. Generally conventional vehicle like Perodua Kancil use Passive Engine Mounting System (EMS).

1.2 Problem Statement

Worn engine mounts will bring much effect. The increasing of noise and vibration was the symptoms as well as increased pedal pressure or slower respons to driver input. It was because some linkage happens in controller linkage such as at throttle and transmission. In some cases, the throttle linkage can be jammed, resulting in unintended acceleration. A broken engine mounts inside a car with belt-driven, water pump mounted fan, may cause the engine to rotate forward and hit the radiator with the fan blades. Besides, problem with the engine mounts can lead to a chain reaction down the driveline. Broken engine mounts also will lead to misalignment of the driveshaft.

1.3 Objective

The main objectives of this project are to evaluate the performance of the active engine mounting system with the passive engine mounting system and skyhook engine mounting system and to develop a mathematical model for passive, active and skyhook engine mounting system.

1.4 Project Scope

MATLAB Simulink will be chosen as a simulating tool. Active engine mounting will use PID control as a controller unit. All dimensions for engine were taken from Perodua Kancil 850 EZ engine. The engine vibration will be assumed as sinusoidal disturbance.

1.5 Gantt Chart

Project Gantt chart PSM 1

No.	Task		Week													
			1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Choosing title		■													
2	1st meeting with Supervisor			■												
3	Gantt Chart			■	■											
4	Prepare Technical Report for Chapter 1 : Introduction	Background		■	■											
		Problem Statement		■	■											
		Objective		■	■											
		Projest Scope		■	■											
5	Study the Matlab Simulink software				■	■	■									
6	Review study of an engine mounting system					■	■	■								
7	1st PSM presentation							■								
8	Prepare Technical Report for Chapter 2 : Literature Review	Theory						■								
		Mathematical model							■	■						
		Engine mounting system							■	■						
9	Develop mathematical equation										■	■	■			
10	Prepare Technical Report for Chapter 3 and Chapter 4 (Methodology and Conclusion)												■	■	■	
11	2nd PSM presentation															■
12	Submission of technical report															■

Project Gantt chart PSM 2

No.	Task	Week															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.	Repair previous PSM1 report	■															
2.	Perform mathematical equation in MATLAB Simulink		■	■	■	■											
3.	Gathering data for model		■	■	■	■											
4.	Create simulation				■	■	■	■	■	■	■						
5.	Predict the performance of engine mounting system							■	■	■	■	■	■				
6.	Prepare Technical Report											■	■	■	■	■	■