INTELLIGENT ROBUST CONTROLLER FOR SEMI ACTIVE SUSPENSION SYSTEM

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I dedicate this thesis to my lovely family, who offered me unconditional love and support throughout the course of this thesis

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In the name of God

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ABSTRACT

A variety of semi-active suspension studies have been researched on decreasing the energy consumption and improving the system performance as fully active suspension systems because of the expense of fully active suspension systems for its actuators and execution equipments. However, the fully active suspension systems are much more powerful than semi active suspension. This project has proposed an intelligent robust controller for semi active suspension due to its applications on automotive industry using Magnetorheological (MR) damper. The entire model has been simulated in Matlab/SIMULINK environment and the results are gathered to compare the influences of the different controllers on ride comfort and handling performance. Four different controllers; PID, Fuzzy, Fuzzy PD+I and Fuzzy PID controller with parallel structure were implemented into the system also two different models of MR damper, polynomial and Adaptive-Network-based Inference System (ANFIS) model, were studied to simulate the shock absorber. The results illustrate that the Fuzzy PD+I controller and Fuzzy PID controller with parallel structure have successfully reduced the effects of road profile as a disturbance. The best results are owned by Fuzzy PID controller with parallel structure because of better ride comfort and handling performance.

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ABSTRAK

Pelbagai kajian penggantungan separa-aktif telah dikaji untuk mengurangkan penggunaan tenaga dan memperbaiki prestasi sistem sebagai sistem penggantungan sepenuhnya aktif kerana perbelanjaan sepenuhnya sistem gantungan aktif untuk penggerak dan peralatan pelaksanaan. Walau bagaimanapun, sistem penggantungan sepenuhnya aktif adalah lebih berkuasa daripada penggantungan aktif separuh. Projek ini telah dicadangkan pengawal pintar yang teguh bagi penggantungan separa aktif kerana penggunaannya ke atas industri automotif menggunakan Magnetorheological (MR) peredam. Seluruh model telah simulasi dalam persekitaran Matlab / SIMULINK dan keputusan berkumpul untuk membandingkan pengaruh pengawal berbeza pada keselesaan prestasi pemanduan dan pengendalian. Empat pengawal yang berbeza; PID, Kabur, Kabur PD + I dan pengawal PID Kabur dengan struktur selari telah dilaksanakan ke dalam sistem juga dua model yang berbeza MR peredam, polinomial dan Adaptif-Rangkaian-berasaskan Sistem Pentaabiran (ANFIS) model, telah dikaji untuk mensimulasikan penyerap hentakan. Keputusan ini menunjukkan bahawa PD Kabur + I pengawal dan pengawal PID Kabur dengan struktur selari telah berjaya mengurangkan kesan profil jalan sebagai gangguan. Hasil yang terbaik yang dimiliki oleh pengawal PID Kabur dengan struktur selari kerana selesa pemanduan yang lebih baik dan prestasi pengendalian.

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CHAPTER 1

INTRODUCTION

1.1 Background

A suspension has the three main elements; elastic element, damping element and set of mechanical elements. These elements act in different roles. The elastic element (generally coil spring) conveys the static load, and damping system (shock absorber) conveys the insignificant force at steady-state, while it has a critical function in suspension dynamics. The set of mechanical elements have the roles of joining the sprung mass to the unsprung mass. This project focused on the elastic and damping system.

Based on usage of energy in the suspension system, electronically controlled suspensions is categorized into two main parts namely; Active and semi-active suspension system. In the active suspension system, the energy is added to system, while in the semi-active suspension the system is modified without energy supplement. In this project the robust intelligent controllers are designed for semi-active suspension system.

Moreover, in this project several intelligent robust controllers are designed, analyzed and their performance for semi-active suspension system are compared.

1.2 Objectives

The aim of this project is to design and simulate an intelligent robust controller for semi-active suspension system using neuro-fuzzy algorithm.

1.3 Scopes

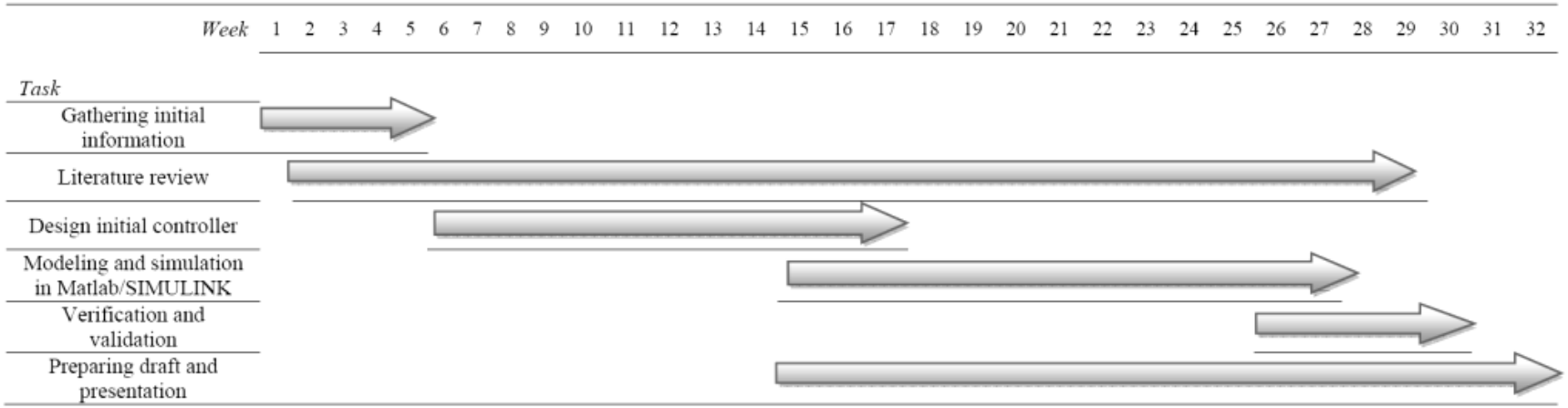
The scopes of the study are concentrated on:

- Review of the semi-active suspension, modeling techniques and intelligent robust controllers.
- Modeling of semi-active suspension system within Matlab/SIMULINK environment.
- Development and simulation intelligent robust controller for semi-active suspension system.
- Validation, verification, analysis and comparison of the intelligent controllers' performance for semi-active suspension system.

1.4 Thesis outline

The research began with obtaining the mathematical model of the semi-active suspension system. The process of implementation for this project is shown in next page:

Table 1.1: Project Outline



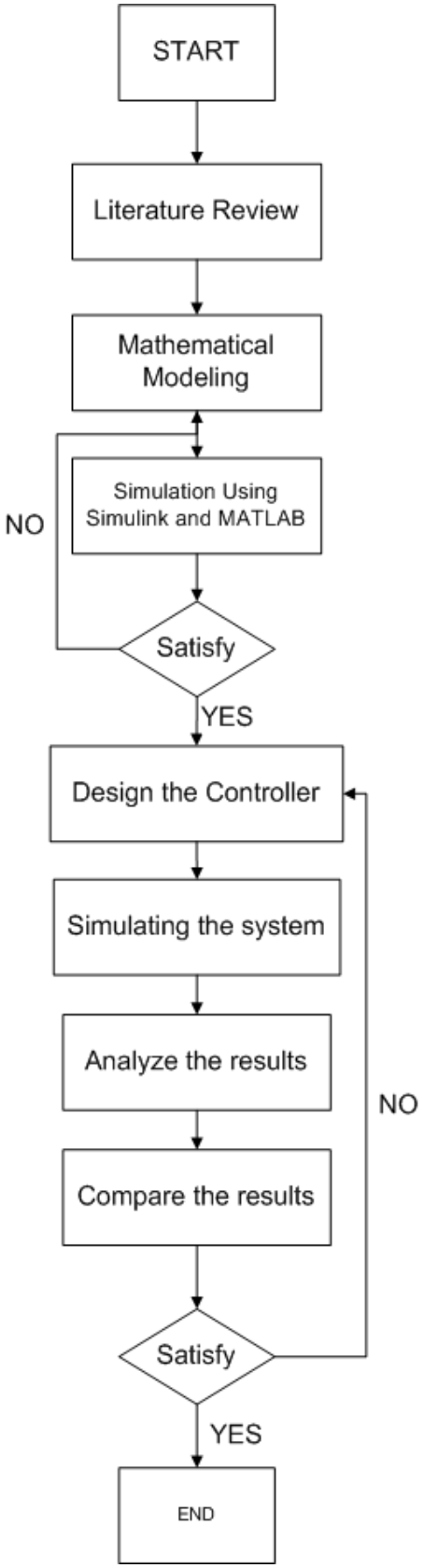


Figure 1.1 the process of implementation for this project

1.5 Research Methodology

In this research, a quarter-car model has been developed using simulation within Matlab/ SIMULINK environment, the dynamic of the suspension system is used as design and verification platform for the controller. The next step is to design and simulate the intelligent robust controller for the modeled semi-active suspension which the parameters of this controller are optimized by neuro-fuzzy algorithm. The final step is to evaluate the performance of the intelligent robust controller and validating, verifying and analysis for the modeled semi-active suspension system.

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