

Chapter 1

Introduction

Since the development of the vehicle suspension system, designers have been faced with the conflict of vehicle safety versus ride comfort. Originally, this trade-off was minimized by the single optimal adjustment of a passive damper. In more recent years, the development of computer-controlled suspension dampers and actuators has increased the investigation of the vehicle safety versus ride comfort trade-off, and has led to the development of numerous damper control policy designs. In this research, the vehicle safety versus ride comfort trade-off is studied. The study is based on the transient response of the vehicle model due to passive damping compared with the response due to several semiactive damping control schemes.

1.1 Objectives

The objective of this research is to compare the transient response characteristics of a roll-plane model, representing a class 8 truck, using passive dampers with the response characteristics of the model using semiactive damper control policies. The semiactive damper control policies to be examined include the previously acknowledge policies of on-off skyhook, continuous skyhook , and on-off groundhook control, along with an original fuzzy logic control design. The fuzzy logic controller will be designed and tuned to improve the passive damper response characteristics due to a road input into one tire. It will also be shown that the fuzzy logic controller, when tuned appropriately, is capable of improving both the on-off skyhook and on-off groundhook damper control responses to a road input. The robustness of the controller designs was not examined in this study.

1.2 Approach

The first step in accomplishing the objectives of this research was to create the vehicle model, along with the passive damping and semiactive damping control models. The vehicle model used for this research was a four-degree-of-freedom, roll-plane model, representing a class 8 truck. The model was then stimulated by forces to the vehicle body

or generated by a road input, with the stimulus input profile resembling a two-tenths of a second impulse. The results of the simulations were then compared for passive and semiactive damping. The semiactive damping control policies studied in the comparison include on-off skyhook, continuous skyhook, on-off groundhook, and an original fuzzy logic control design.

The response outputs of the roll-plane model simulation that are examined during the research include the vehicle body heave and roll displacements, the left tire heave displacement, and the vehicle body heave acceleration. The body heave displacement and acceleration are measures of the vehicle ride comfort, while the body roll and tire heave displacements are vehicle safety measurements. For each, the maximum peak-to-peak and RMS values of the response are used to examine the classic vehicle safety versus ride comfort trade-off.

1.3 Outline

The components of this research that were necessary for obtaining the objectives of Section 1.1 are given in the succeeding chapters. In Chapter 2, pertinent background material is given. This includes a discussion on the different types of vehicle suspension damping. In particular, the concepts of passive and semiactive damping are explained. The acknowledged semiactive damping control concepts used in the research study are discussed in detail as they pertain to a simple, two-degree-of-freedom model, and the basics of fuzzy logic control are given. To conclude, the results of the literature search are given, discussing relevant material from previous research articles.

In Chapter 3, the equations pertinent to the model of the study are formulated. This includes the formulation of the vehicle roll-plane model, as well as the semiactive damping control policy models. Then, in Chapter 4, the actual simulation program of these models is discussed. To conclude the chapter, the simulation is validated through the estimation of the uncoupled system response parameters. In Chapter 5, the actual results of the research simulation are discussed. First, the vehicle model parameters, inputs, and initial

conditions used to generate the simulation responses are given. Next, the configuration of the outputs from the response to be examined is discussed. Finally, the actual simulation responses are analyzed. In the final chapter, Chapter 6, the conclusions of the research, based on the simulation results, are given, along with recommendations for future research in the area of vehicle suspension damping control.