A comparison of control strategies for the switchable damper suspension system

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Abstract: Theoretical comparisons of control strategies for the switchable damper suspension system are made. Practical limitations involving switching time delays and threshold delay values are modelled and their effect on ride comfort quantified. The three- setting switchable damper is compared with the two-setting switchable damper. The effect of damper linearization is studied. It is shown that the three-setting switchable damper offers worthwhile improvements over the passive and two-setting switchable damper.

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1 Introduction

When the wheel was first used as a means for transportation, primary suspension systems probably found their initial application. Since that time, many innovations have been developed to improve springs, shock absorbers and other suspension components, and many researchers have examined the possibility of intelligent suspension systems (Sharp and Wilson, 1989; Chalasani, 1986). A recent, clear review attempting to summarize various types of intelligent suspension systems is written by Sharp and Crolla (1987). Although active suspensions offer the best overall performance, they are considered impractical because of the extremely high costs involved.

During the past four years, some Japanese motor manufacturers and other car manufacturers have studied various systems and started fitting their cars with variable shock absorber systems, either as a standard fitting or an optional extra (Hine and Pearce, 1988; Meller and Fruhauf, 1988; Yokaya *et al.*; and Mizuguchi *et al.*). Although these systems use various empirically derived control laws to improve ride/handling performance, published details of hardware limitations and their effect on performance are still scarce. The past two years, however, have seen some research into the effect of such limitations on switchable damper systems. Meller (1988) used a single degree of freedom model to study damper behaviour but this simple model appears to misrepresent the important aspect of dynamic tyre/ground load. Firth (1989) solved this problem using a two degrees of freedom, quarter-car model incorporating a two-state switchable damper. This paper will use a two degrees of freedom, quarter-vehicle model with a three-setting switchable damper with a control strategy based on optimal control theory. The aims of the work are:

- To compare the three-setting switchable damper with the two-setting switchable damper results using the same vehicle data and road input.