Abstract

Vehicle suspension design necessitates achieving complex compromise between various performance objectives. Active vehicle suspension systems (AVSS) outperforms all the other suspension types in this regard but at the cost of higher bandwidth and power consumption as well as, physical space constraint. This limitations have however not hindered research on AVSS as some of the automobile manufacturers have started introducing AVSS in their products thereby prompting improvement of its current level of performance.

The challenges of AVSS design centres around the inherent nonlinearities and uncertainties. This explains the recent interests in the introduction of intelligent control techniques to AVSS design. Neuro-adaptive controllers designed in this work are able to leverage on the combination of the strengths in chosen nonlinear techniques (that is, feedback linearisation and model predictive control) and model-based neural networks, thus avoiding the traditional need for linearisation.

The design of an indirect adaptive, neural network-based model predictive control (NNMPC) for a 7DOF nonlinear full-vehicle suspension design has been presented in this thesis. Its performance was benchmarked against that of PID controller in the presence of both random and deterministic road disturbance inputs. Improved system control was achieved by stabilising the actuator dynamics using PID control sub-loops. The performance of the NNMPC was superior, though the control process was slower because of the internal optimisation routine of the NNMPC.

Control voltage, actuator force and actuator spool-valve displacement are bounded within the specified limits. They are also well regulated (except at the instance of disturbance, however steady state was restored within about 0.5s) without chattering. The result presented improved ride comfort, handling and road holding without violating the suspension travel limits. The weighted RMS body acceleration values for the vehicle sprung mass were evaluated based on international standards. Frequency domain analysis also showed that the AVSS was relatively insensitive to changes in the physical parameters between 7-80Hz.