University of Reading

Control of an Electromagnetic Vehicle Suspension

A thesis submitted for the degree of Doctor of Philosophy

by

Neil Stuart McLagan

Department of Engineering

June 1992

Control of an Electromagnetic Vehicle Suspension

Control of an electromagnetic vehicle suspension

This dissertation describes the analysis of an electromagnetic vehicle suspension and the proposal and synthesis of a sophisticated suspension control system. The difficulties associated with the control of electromagnetic suspension providing both primary and secondary suspension functionality are first discussed in the light of existing research and development progress. The strengths and weaknesses of existing control techniques are then identified, and a structured control strategy is proposed. This in turn involves a new, nonlinear electromagnet force control algorithm which employs air gap and current feedback, and a sophisticated suspension control algorithm which consists of an absolute position controller, with a position reference supplied by a guideway following algorithm. Three feedback states are measured for each electromagnet, namely air gap, current, and acceleration. The suspension control algorithm is applied to the vehicle heave, pitch, roll and torsion motions independently. The resultant electromagnet force demands are fed into force controllers which provide dominantly linear and independent electromagnet force actuation. An experimental control system is developed using transputers, and the control algorithms are implemented using the occam parallel programming language. The proposed control theory is validated by presenting both simulation results, and responses from the experimental system. The results clearly show the efficacy of the proposed control method.

Acknowledgements

I am very grateful to my supervisor, Pradip Sinha, for igniting my interest in the problems of controlling electromagnetic suspensions, and also for giving me the opportunity to carry out the research described in this dissertation.

I would like to thank my friends and family for their encouragement and support. I am particularly indebted to Greg Pye, Nigel Kneebone and Jeremy Hinton for the many hours spent discussing various issues and reviewing this dissertation. Last, but not least, I would like to thank Gail Tucker for her patience, tolerance and help.

The research and equipment described in this dissertation was funded by the Science and Engineering Research Council.

Contents

Appendices