Ph.D. Dissertation

Vehicle Ride and Handling Control Using Active Hydraulically Interconnected Suspension

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Certification of Original Authorship

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text. I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

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Dedication

I dedicate this thesis to all my dearest family: my darling wife Anastasia who loves me and tirelessly takes care of me all the time and who came to Australia with me, my parents Anatoly and Tatyana who brought me up in a difficult time and also love me so much and always support me in any situation, my younger sister Elena who is my best friend forever and who knows me like herself! I would like to specially mention here my dear grandmother Valentina who passed away in the year 2016. She worked as a teacher of English at a school for 40 years and she taught me not only English but so many other good things that I feel very grateful for. And, of course, I want to say thanks to all my good friends who share their love and support and always make me laugh and always make me happy!

If you are reading and recognising yourself in these lines then, Hi there! :)

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Abstract

In this thesis, is proposed a different actuator layout for active anti-roll hydraulically interconnected vehicle suspension. Unlike other designs, the layout suggested, is a closed circuit which is powered by a hydro-mechanical actuator and neither needs a storage tank for the fluid, nor it needs a pump for charging the storage tank. The project includes four main components: modelling, simulations, the practical part and the experimental part. In the modelling part, the author derived an augmented half-car model which additionally takes lateral acceleration as a disturbance. The model of active hydraulically interconnected suspension system was also obtained. The practical component of the author's work focuses on the upgrade of the existing half-car testing rig the Dynamics Laboratory at UTS. A precise CAD modelling of the half-car testing rig was done. Then, were proposed the upgrades. The setup was upgraded in compliance with the models designed. After the upgrades, followed the experimental part. The experiments were conducted in three stages: the identification experiments, the implementation of a real LQG compensator and the validation experiments. The author adopted a methodology known as a classical approach in control theory in which the models of a physical system are identified in the frequency domain prior to the design of a control system. In the thesis, it is discussed in detail how the experiments were conducted and the data analysed. All theoretical derivations, mechanical drawings, and codes are thoroughly explained. The experimental results indicate two significant outcomes: the identified models demonstrate high prediction power, the LQG compensator improves frequency response characteristics of the system and achieves significant roll angle reduction across the range

of frequencies of the interest including the resonance. Overall, the results obtained experimentally come in excellent agreement with the simulations which confirms the integrity of current research.