UTS UNIVERSITY OF TECHNOLOGY SYDNEY

A Study on Active Suspension System with Reinforcement Learning

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Thesis submitted in fulfilment of the requirements for the degree of

Master by Research

under the supervision of Dongbin Wei, Thorsten Lammers

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Certificate of Original Authorship

CERTIFICATE OF ORIGINAL AUTHORSHIP

I, Daoyu Shen declare that this thesis, is submitted in fulfilment of the requirements for the award of Master by Research Degree, in the School of Mechanical & Mechatronic Engineering/ Faculty of Engineering and IT at the University of Technology Sydney.

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I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of the requirements for a degree at any other academic institution.

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Abbreviations

EV	**Electric vehicle**
PSS	**Passive suspension system**
ASS	**Active suspension system**
RL	**Reinforcement learning**
PSD	**Power spectral density**
NN	**Neural Network**
DOF	**Degrees of Freedom**
RBF	**Radial basis function**
PID Controller	**Proportional–integral–derivative Controller**
DQN	**Deep Q Net**
DDPG	**Deep Deterministic Policy Gradient**
FCN	**Fully connected network**

Abstract

The research conducted in this paper focuses on providing a superior solution for controlling the active suspension system through machine learning algorithm. An active suspension system is embedded with an extra actuator and can provide more flexibility in dealing with different road situation than a passive suspension system that only contains a fixed set of spring and damper.

Among various control methods, the machine learning control strategy has demonstrated its optimality in dealing with different classes of roads depending on its self-learning capability. In this study, an advanced method of creating pavement signal has been presented to guarantee the quality of the simulation, together with Twin Delayed Deep Deterministic Policy Gradients (TD3) in suspension control that is an application of one of the cutting-edge algorithms in Reinforcement Learning (RL). To be able to realize the research, policy gradient algorithm, Markov decision process, and neural network modelling have been adopted.

To achieve such a proposed frame structure, a vehicle suspension model has been established together with a frame of reinforcement learning algorithm and an input signal of road pavement. The performance of the proposed twin delayed reinforcement agent has been compared against Deep Deterministic Policy Gradients (DDPG) and Deep Q-Learning (DQN) algorithms under different types of pavement input. The simulation result shows its superiority, robustness, and learning efficiency over other reinforcement learning algorithms.

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