Distributed Adaptive Consensus for Multi-Agent Systems Subject to Uncertainties

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Statement of Originality

I hereby certify that the work embodied in the thesis is my own work, conducted under normal supervision. The thesis contains no material which has been accepted, or is being examined, for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made. I give consent to the final version of my thesis being made available worldwide when deposited in the University's Digital Repository, subject to the provisions of the Copyright Act 1968 and any approved embargo.

Imil Hamda Imran

Acknowledgement of Authorship

I hereby certify that the work embodied in this thesis contains submitted papers of which I am a joint author. I have included as part of the thesis a written declaration endorsed in writing by my supervisors, Prof. Minyue Fu and Prof. Zhiyong Chen, attesting to my contribution to the joint publications.

By signing below I confirm that Imil Hamda Imran contributed towards idea generation, theoretical development and other works for the publications as listed in Section 6.3.

Prof. Minyue Fu

Prof. Zhiyong Chen

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Contents

List of Figures

LIST OF FIGURES

Abstract

Research on cooperative control of multi-agent systems has drawn increased attention from control engineers in recent decades. Inspired by natural phenomena, this research has been developed to become more practical and reliable in implementation. Consensus is one of the most active and very crucial research topics in cooperative control of multi-agent systems. One of the unavoidable problems in developing consensus control for multi-agent systems is the presence of uncertainties in the dynamic models. Adaptive control is a research line applied to solve consensus problems for multi-agent systems subject to uncertainties. In this thesis, we establish a distributed adaptive consensus framework for multi-agent systems with uncertain dynamics.

There are two main problems in designing distributed adaptive consensus control for general multi-agent systems. First, the adaptive law cannot always be implemented in a distributed fashion because it depends on the gradient of a (centrally constructed) Lyapunov function. Consequently, distributed adaptive consensus can only be applied for limited cases. In this thesis, we establish a distributed adaptive consensus framework to overcome this problem by proposing a novel distributed adaptive scheme that does not rely on the gradient of a Lyapunov function. An application of our framework is presented to solve the consensus problem in second-order multi-agent systems under a directed topology.

The second problem is the presence of nonlinearly parameterized dynamics in multi-agent systems. It is always difficult to handle nonlinearly parameterized uncertainties in adaptive control. Some results have been obtained for special cases. In addition, none of the existing results are applicable to

networked systems with nonlinearly parameterized dynamics. In this thesis, we develop a distributed adaptive framework for multi-agent systems subject to nonlinearly parameterized uncertainties. The linear parameterization assumption is removed by proposing a novel distributed adaptive update law. Therefore, our scheme is more applicable to general nonlinear multi-agent systems. A specific implementation of our framework is presented for nonlinear second-order multi-agent systems. To illustrate our approaches, we present some numerical examples and simulations with various settings.