

## Abstract

Distributed coordination of multi-agent systems (MASs) has caught considerable attention over years owing to its great diversity of applications in various areas. Serving as the theoretical foundation of many typical coordination tasks, the consensus of MASs has long been of significant interest to the MAS community and the broader systems and control community. It is ubiquitous in real-world situations that agents are subject to certain constraints, so there emerges the constrained consensus problem of MASs. Towards a solution to the problem, this thesis studies the consensus of MASs with time-varying state constraints, covering issues including time-varying directed topologies, agent uncertainties, and external disturbances.

We begin with a distributed leaderless consensus control framework for first- and second-order nonlinear MASs with time-varying asymmetric state constraints, uncertainties, and disturbances under switching directed graphs. In such a framework, original constrained states of agents are first transformed into free states in a transformed state space. To deal with directed topologies, we drive agents towards consensus in the transformed space by leveraging a model reference control scheme, and it is sufficient that the original states reach consensus strictly subject to the time-varying constraints under mild assumptions. A single-layer neural network with weights adapted online is used to approximate uncertainties in agent dynamics. For the external disturbances and reconstruction errors in the approximation, we introduce a robust term with an adaptive gain for compensation. Distributed consensus control algorithms are proposed, respectively, for multi-agent systems with first- or second-order dynamics.

Then we modify our algorithms to improve the overall performance of the proposed algorithms. By imposing prescribed performance constraints on tracking errors, we introduce an error transformation and then design controllers to drive MASs towards consensus while ensuring the state constraints and performance constraints are both met. On the basis of the proposed framework, modified consensus algorithms with prescribed performance for both first- and second-order multi-agent systems are presented. We offer theoretical proof of convergence to consensus via Lyapunov analysis along with all the proposed algorithms.

Finally, the thesis ends with numerical simulations and physical experiments with applications of the algorithms on wheeled robots. Results of the simulations and the experiments both validate the effectiveness of the proposed consensus framework and the control algorithms.

**Keywords:** multi-agent systems, consensus, directed graphs, state constraints, distributed control