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LEADER-FOLLOWER COORDINATION OF LINEAR TIME-INVARIANT MULTI-AGENT SYSTEMS

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Abstract. In this paper, a leader-follower consensus problem for the general linear time-invariant multi-agent systems (LTI-MASs) is investigated, where the leader agent has the same dynamic equations with the followers. To solve the leader-follower consensus problem for LTI-MASs, the consensus tracking algorithm for single-integrator multi-agent systems is generalized to a general case with n-order dynamics. A linear matrix inequality approach is proposed to calculate the consensus gains. Then the proposed method is generalized to the multi-agent systems with unknown parameters. Moreover, a formation tracking problem with a reference state is solved with a similar algorithm. Finally, some numerical examples are given to illustrate the obtained results.

Keywords. Leader-follower consensus, Linear time-invariant multi-agent systems, Unknown parameters, Dynamic formation, Linear matrix inequality.

1 Introduction

A coordination of multi-agent systems (MASs) has been witnessed for many years, since Vicsek *it. al.* [28] first proposed a discrete-time mode for multi-agent systems. Broad applications could be found in many areas such as cooperative control [5] [8] [9] [15] [18] , formation control [3] [4] [10] [29], flocking control [17] [25] and so on. Jadbabaie [8] first gave a mathematical analysis for the Vicsek model. Then, based on the algebraic graph theory, Olfati-Saber and Murray introduced a theoretical framework for posing and solving the consensus problem for MASs with the first order integrator dynamics and strongly connected digraphs [16]. After that, further theoretical extensions appeared. For example, Ren and Beard [20] weakened the strong connection as the existence of a spanning tree. Similar result was obtained by Lin *et. al* [11]. For MASs with the second order integrator dynamics, Ren and Atkins [23] designed a consensus protocols such that state of each agent converges to a constant or a linear function with respect to the time. For the second order discrete MASs with stochastic switching topology, Zhang and Tian [32] proposed a mean square consensus protocols and provided a method to transform the consensus problem to a stability problem of a reduced-order system. Recently, Ren [21] studied the synchronization of coupled second-order linear harmomic oscillators with local interaction, that means the state of each agent converges to the same periodic function. Zhu, Tian and Kuang [33] gave a more general second-order protocol, which can realize different consensus dynamics with different feedback