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ASYNCHRONOUSLY-COUPLED CONSENSUS OF SECOND-ORDER DYNAMIC AGENTS WITH COMMUNICATION DELAY

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Abstract. *Asynchronously-coupled consensus problem of two second-order dynamic agents under dynamical consensus algorithm with communication delay is investigated in this paper. Based on the frequency domain analysis, sufficient and necessary conditions, which depend on the communication delay and the control parameters, are obtained for the continuous-time and the sampled-data dynamic agents converging to the stationary consensus respectively. Moreover, the consensus condition for the sampled-data dynamic agents is also dependent on the sampling interval, and the consensus cannot be achieved when the sampling interval is larger than the critical value. Simulation results illustrate the correctness of the results.*

Keywords: Asynchronously-coupled consensus, Second-order dynamic agents, Communication delay, Sampled information

1. **Introduction.** Coordination control of multiple dynamic agents has attracted more and more attention from various research communities in recent years. Consensus problem, which requires the outputs of several distributed agents to reach a common value without recursion to a central controller or global communication [1], is one of the most important and fundamental issues in coordination control of multiple dynamic agents, and has also been studied in many other research societies, e.g., synchronization of chaotic systems [2], communication network [3], belief functions [4], etc.

For the first-order multi-agent systems with agents' dynamics modeled by single integrators, various conditions have been obtained for the agents asymptotically converging to a consensus with fixed or switched interconnection topology [5, 6, 7, 8]. In reality, a double integrator is often needed to model the agents' dynamic, and the agent modeled by a double integrator is usually called second-order dynamic agent. Many consensus algorithms have been constructed to solve the consensus problem of the second-order multi-agent systems, and sufficient conditions have been obtained for the agents asymptotically converging to the stationary and dynamical consensus respectively [9, 10].

Recently, much more attention has been paid on the consensus problem under the communication delays existing between neighboring agents. For the first-order multi-agent systems, many analysis methods have been proposed to obtain the consensus conditions, such as frequency domain analysis [11, 12], Lyapunov functions [13, 14], the concept of delayed and hierarchical graphs [15, 16], etc. However, the consensus analysis of the second-order multi-agent systems subject to the communication delays is mostly on the synchronously-coupled consensus algorithm [17, 18, 19], of which self-delays introduced for each agent in the coordination control part are equivalent to the corresponding communication delays. In reality, the synchronously-coupled consensus algorithm cannot be robust