Multiple Intentional Delays can Facilitate Fast Consensus and Noise Reduction in a Multi-Agent System

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A class of multi-agent system (MAS) is considered in this study with the main focus being achieving fast consensus by means of pole placement. Specifically, we propose a delay-based controller, called the Proportional-Retarded (PR) protocol, for each agent. Here, the agents dynamics are captured by either single or double integrators. One challenge in designing PR controllers for MAS is that the design problem becomes a large scale one. A remedy to this issue is to establish certain decomposition properties of the corresponding eigenvalue problem, mainly, by decomposing the entire system into subsystems and separately treating the design of each subsystem with established tools based on Lambert W function or discriminant operations. Although such a decomposition idea is beneficial, the main challenge in this design problem is that the PR controller designed based on one of the subsystems may not be necessarily an ideal one for the remaining subsystems. That is, subsystems compete against each other. As a remedy, we summarize from [1,2] how the PR parameters must be tuned such that, despite subsystem competition, one still achieves a desired performance from the MAS. We show that PR controllers can be tuned to place system rightmost roots to achieve fast consensus, and under certain conditions achieve at the same time a desired spectrum separation. Case studies are presented where the agents states are affected by high-frequency noise to demonstrate how the delay-based controller performs on the consensus dynamics.

[1] Ramírez A., Sipahi R., Multiple intentional delays can facilitate fast consensus and noise reduction in a multi-agent system, *IEEE Transactions on Cybernetics*, accepted.

[2] Ramírez A., Sipahi R., Single-delay and multiple-delay proportional-retarded protocols for fast consensus in a large-scale network, *IEEE Transactions on Automatic Control*, submitted.

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