Distributed formation control: A generalized framework for multi-agent and network systems

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Abstract: In multi-agent systems theory, the main interest is to deploy agents to specific points only using relative and/or distributed information. The specific points could be relative states or could be absolute states, and the relative information could be defined with respect to local coordinate frames or global coordinate frame. The distributed information would be obtained with local relative measurements or with local communications. The most well-known algorithm is a consensus law, which deploys agents to a common point (from multi-agent systems perspective) or to an agreement (from network systems perspective). The consensus algorithm uses local relative information, when targeting a convergence to a common point; but when the desired goal is to deploy agents to specific points with a given topological constraint, the consensus algorithm uses relative information defined in a common global coordinate frame. Unlike the consensus algorithm, the formation control laws use relative information defined in local coordinate frames; thus, from a sensing perspective, the formation control laws are fully distributed. The formation control laws have been mainly used for the control of multi-agent systems, including coordination of a group of mobile agents, formation flying of UAVs, platooning of a group of autonomous vehicles, and rendezvous of spacecrafts. Although these applications have been quite successful from a theoretical point of view, it is still limited to distributed mobile multi-agent systems. In this talk, we would like to seek a further opportunity for applying the formation control algorithms to network systems including information fusion, analysis of social networks, complex network systems, and data encoding/decoding. The talk is composed of three parts. The first part is a review of distributed formation control laws and comparison with consensus algorithms. The second part delivers various formation control laws with real experiments, and the third part is for possible applications to network systems.

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