# The 36th Chinese Control Conference

## Plenary Speaker

**Title:** The Certainty Equivalence Principle and the Cooperative Control of Multi-agent Systems

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**Abstract:** The past decade has witnessed a tremendous advance on the research of multi-agent control systems. The research has reached the stage to develop systematic methodologies for dealing with complex multi-agent systems characterized by heterogeneity, uncertainty, nonlinearity, and disconnected switching topologies. What most distinguishes the cooperative control of multi-agent systems from the conventional centralized control is that the control law for multi-agent systems has to satisfy various time-varying communication constraints. Such a control law is called distributed control law. This talk will describe a systematic framework for designing a distributed control law. This framework is based on two premises. First, the control problem of each pair of follower and leader is solvable by a conventional control law assuming utilizing the output of the leader is available for the follower. The collection of all these individual control laws is called a purely decentralized control law for the multi-agent system. Second, a so-called distributed observer for the leader system exists which is able to provide the estimation of the leader's output to each follower for feedback control without knowing the global information of the leader. Under these two premises, a distributed control law can be synthesized by replacing the leader's output in the purely decentralized control law with the estimated leader's signals. Such designed distributed control law is called certainty equivalence distributed control law. If the certainty equivalence distributed control law can accomplish the same task as the purely decentralized control law, then this control law is said to satisfy the certainty equivalent principle. The success of this design philosophy depends on two key issues: the existence of the distributed observer and the satisfaction of the certainty equivalence principle. While the first issue depends on both the leader's dynamics and the network topology, the second issue both the follower's dynamics and the network topology. The talk will first summarize, to what extent, these two issues have been addressed, and then demonstrate some applications of this design framework to such problems as consensus/synchronization, connective preservation, coorperative output regulation of various multi-agent systems.