Title: Evolution of the Distributed Observer and the certainty equivalence principle.

Abstract: A typical multi-agent system is composed of a so-called follower system consisting of multiple subsystems called followers and a so-called leader system whose output is to be tracked by the followers. What makes the control of a multi-agent system interesting is that the control law has to be distributed in the sense that it must satisfy time-varying communication constraints. A special case of the distributed control is where all the followers can access the information of the leader. For this special case, one can design, for each follower, a conventional control law based on the measured output of itself and the information of the leader. The collection of these conventional control laws constitutes the so-called purely decentralized control law for the multi-agent system. Nevertheless, the purely decentralized control is generally not feasible due to the communication constraints. In this talk, we will introduce a framework for designing a distributed control law by composing a purely decentralized control law and a so-called distributed observer, which is a dynamic compensator that can estimate and transmit the leader's information to each follower through the communication network of the multi-agent system. Such designed control law is called the distributed observer based control law and is said to satisfy the certainty equivalence principle if it can accomplish what the purely decentralized control law can in the presence of communication constraints. The core of this design framework is the distributed observer, which was initiated in 2010 for dealing with the cooperative output regulation problem, and has experienced three phases of developments. In the first phase, the distributed observer is only capable of estimating and transmitting the leader's signal to every follower assuming every follower knows the dynamics of the leader. In the second phase, the distributed observer is rendered the capability of estimating and transmitting not only the leader's signal but also the dynamics of the leader to every follower provided that the leader's children know the information of the leader. Such a dynamic compensator is called adaptive distributed observer. Recently, the distributed observer has entered its third phase of development, where neither the leader's signal nor the leader's dynamics is available for any follower. Such a dynamic compensator is called adaptive distributed observer for an unknown leader. Since 2010, the distributed observer based design framework has proved itself an effective tool for dealing with various cooperative control problems for complex multi-agent systems. This talk will also illustrate

some applications of this design framework to such problems as consensus, synchronization, flocking, and formation.

Biography: Jie Huang studied Power Engineering at Fuzhou University from 1977 to 1979 and Circuits and Systems at Nanjing University of Science and Technology (NUST) from 1979 to 1982 for a Master degree. He completed his Ph.D. study in automatic control at the Johns Hopkins University in 1990. After a year with Johns Hopkins University as a postdoctoral fellow and four years with industry in USA, he joined the Department of Mechanical and Automation Engineering, the Chinese University of Hong Kong (CUHK) in September 1995, and is now a Choh-Ming Li Professor and Chairman of Department of Mechanical and Automation Engineering, CUHK. His research interests include nonlinear control, robotics and automation, networked control, and guidance and control of flight vehicles. He has authored/coauthored three monographs and some papers. He was elected HKIE Fellow in 2017, CAA Fellow in 2010, IFAC Fellow in 2009, and IEEE Fellow in 2005.