

# Progress on Nonstandard LQ Control and Applications in Networked Control Systems

Huanshui Zhang

The linear quadratic (LQ) control is the core of modern control theory, which has attracted great attention since the 1950s. However, there still exist some challenging fundamental problems that need to be addressed, which have also posed obstacles in areas of networked control systems (NCSs) and other related areas. For example, the stochastic LQR with time-delay has never been properly solved even for the most basic case of single input delay, although the delay-free case has been fully addressed by J. Bismut in the 70's. As a result, control of NCSs faces fundamental difficulty in the cases of simultaneous packet loss and delay of control or state. Another problem is irregular LQ control, i.e., the related Riccati equation is irregular which leads to the LQ controller not being solvable even though it exists. This arises when the weighting matrix of control is semi-positive or indefinite. Irregular LQR has been a long-standing problem since the 70's. In this talk, we will first identify the challenges in the LQ control; second, we will address these challenges by establishing the unity of LQ control with forward and backward differential/difference equations (FBDEs). Finally, by solving the FBDEs, we will present the solutions to various problems identified, including irregular LQ control, stochastic LQ control with delay, optimal control, and stabilization in NCSs with asymmetric information and/or with simultaneous packet loss and delay.

This talk is based on joint work of the speaker with Juanjuan Xu of Shandong University