TEXAS TECH UNIVERSITY
Department of Mechanical Engineering

Ph.D. Defense Announcement

Robust Control of Uncertain Nonlinear Systems

By

Jiguo Dai

Ph.D. Advisor: Dr. Beibei Ren

The defense will take place:
June, Friday, 21st, 2019
ME 106

Abstract

The robust control algorithms to achieve trajectory tracking and disturbance rejection is a vital goal of modern control theory. Among different robust control approaches, the uncertainty and disturbance estimator (UDE)-based robust control, has obtained much attention in recent years. It adopts a proper filter to estimate and compensate the lumped uncertainty, which may include the model uncertainties and external disturbances. This approach possesses a simple structure, easy tuning and robust performance. However, the classical UDE-based robust control still has some challenge problems which need to be solved before applying this approach to more general systems. The first challenge is how to achieve the asymptotic tracking and disturbance rejection performance. A systematically design principle for the filter and reference model is clarified based on the internal model principle. The second challenge is the filter design for the PDE systems while an infinite dimensional filter is proposed. The third challenge is the dealing with the mismatched uncertainties and disturbances. The backstepping structural is integrated into the controller design to relax the structural constraint. The fourth challenge is the requirement of output feedback which only the system output is measurable and available. A first order linear model is then introduced to reduce the system order, and a simple output feedback control architecture is proposed.

Besides addressing above challenge problems, this thesis applies the proposed control algorithm to practical control systems. One is the motion control of a piezoelectric nanopositioning stage, the other one is the continuous phase tuning of Vanadium Dioxide (VO_2) thin film. Both practical applications demonstrate the high accuracy, robustness and efficiency of the proposed control method.