Mohammad K. Ababneh, “Digital Redesign of Uncertain Nonlinear Control Systems”

Advisors: G.R. Chen and L.S. Shieh

Designing robust controllers for uncertain systems has been an active research topic in recent years. However, most of the research efforts have been concentrated on the design of continuous-time controllers for continuous-time systems or discrete-time controllers for discrete-time systems. In this thesis, the hybrid continuous-discrete case is considered, where a new and systematic method for designing discrete-time robust controllers for continuous-time uncertain nonlinear systems with structured uncertainties is presented. In the proposed methodology, the robust controller is designed in terms of the optimal linear model representation of the nominal system around each operating point of the system trajectory, while the uncertainties are decomposed such that the uncertain nonlinear system can be rewritten as a set of local linear models with disturbing inputs. Applying conventional robust control techniques, a continuoustime robust controller is first designed to eliminate the effects of the uncertainties in the underlying system. A robust H¥ digital controller is then obtained as the result of a digital redesign of the pre-designed continuous-time robust controller using the state-matching technique. The proposed methodology is successfully applied to the case of hybrid observer-based controllers and the case of hybrid synchronization problems. An important aspect of this methodology is its robustness to fix uncertainties in the system such as the structured uncertainty. The performance and the effectiveness of the developed methodology is simulated and illustrated through numerous numerical examples of digital control of complex chaotic systems.