Abstract

Sliding mode control (SMC) is one of the most efficient robust methods for controlling systems with uncertainty. SMC methods provide some advantages such as easy and straightforward realisation, quick response and low sensitivity to uncertainties in the model of the system and disturbances. The target of this thesis is to provide a comprehensive investigation of functional state estimation based SMC for discrete-time stochastic systems and propounds an idea of discrete-time stochastic SMC. SMC for discrete-time stochastic systems with bounded disturbances is proposed in this work. Subsequently, SMC is designed for the discrete-time stochastic system such that the states will lie within the specified band. Furthermore, this result has been extended for the incomplete state information. In that case, states are estimated by the Kalman filter approach and SMC is designed.

A functional observer based SMC is designed for discrete-time stochastic systems. The control signal is calculated by a functional observer method. In many cases, the disturbances in the system may not always satisfy the matching condition. Therefore, a functional observer based SMC is designed for discrete-time stochastic systems with unmatched uncertainty. A disturbance dependent based sliding surface method is proposed to ameliorate the effect of unmatched uncertainty in the stochastic system. Next, SMC design using functional state estimation is proposed for parametric uncertain discrete-time stochastic systems. A sufficient condition of stability is proposed based on Gershgorin disc theorem, which provides the estimate of the eigenvalues location of the matrix.

Most of engineering systems have an inherent time-delay such as sensor measurements and communication delays. This thesis also proposes SMC method for linear discrete-time delayed stochastic systems. Subsequently, the stability and convergence analysis of the proposed method are provided. Furthermore, SMC of a delayed stochastic system for incomplete state information has also been considered, where states are estimated by the Kalman filter approach. Moreover, a functional observer based SMC method for the discrete-time delayed stochastic system is proposed. Therefore, SMC has been calculated by the functional observer approach. Finally, functional observer-based state feedback and SMC law are compared graphically as well as numerically.
Further, extending the previous results for uncertain parameters, which are present in the system and the state delay matrix. Functional observer-based SMC is developed for uncertain state-delayed systems. Subsequently, the SMC method for discrete-time delayed stochastic systems is investigated. Finally, SMC has been calculated by using a functional observer approach. A sufficient condition of stability is proposed based on Gershgorin disc theorem, which provides the estimate of the eigenvalues location of the given matrix. Finally, in the last chapter, a summary of the thesis contributions is presented and future directions of research are identified.

**Keywords:** Sliding mode control, Functional observers, Time delay, Discrete-time systems, Stochastic systems.