



**INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS**

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SHORT ABSTRACT

Generally, a conventional optimal controller designed for a system cannot guarantee its performance when the system is affected by uncertainties caused by modeling error, parameter change or external disturbance. In order to address this problem, this thesis attempts to design a robust optimal controller for uncertain systems. The focus of the research work is to design an optimal sliding mode controller which can minimize the control input and ensures that its performance does not degrade even when the system is affected by parametric uncertainty and external noise. The optimal controller is designed by using classical optimal control algorithm. A sliding mode controller (SMC) is integrated with the optimal controller to impart robustness. This thesis develops an optimal second order sliding mode controller (OSOSMC) which can mitigate high frequency chattering present in conventional first order sliding mode controllers. The optimal control law for linear systems is based on simple linear quadratic regulator (LQR) technique. An optimal adaptive sliding mode controller is designed for linear uncertain systems where the upper bound of uncertainty is unknown. For nonlinear systems, extended linearization is used to represent it in a linear like structure having state dependent coefficient (SDC) matrices and a state dependent Riccati equation (SDRE) based optimal controller is designed for the nominal part. For nonlinear systems which cannot be represented as linear like structures, the optimal control strategy is developed by using the control Lyapunov function (CLF). The second order sliding mode strategy is realized by designing a non-singular terminal sliding mode control based on the integral sliding surface.

Conventional SMCs cannot tackle the mismatched uncertainty. A disturbance observer based OSOSMC is proposed here for nonlinear systems affected by mismatched uncertainties. The optimal sliding mode controller is designed for both linear and nonlinear uncertain systems affected by matched as well as mismatched types of uncertainties. Extensive simulation studies are conducted to evaluate performance of the optimal second order sliding mode controller (OSOSMC) and compared with some existing control schemes. The proposed OSOSMC design is extended to multi input multi output (MIMO) systems also. Stability of the proposed controller is established by using Lyapunov's criterion.