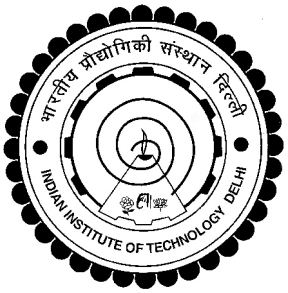
MULTIRATE OUTPUT FUNCTIONAL OBSERVER DESIGN AND ITS CONTROL APPLICATIONS

NEELI SATYANARAYANA



DEPARTMENT OF ELECTRICAL ENGINEERING
INDIAN INSTITUTE OF TECHNOLOGY DELHI
JANUARY 2014

MULTIRATE OUTPUT FUNCTIONAL OBSERVER DESIGN AND ITS CONTROL APPLICATIONS

by

NEELI SATYANARAYANA

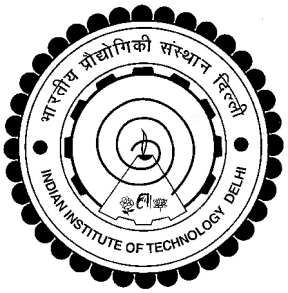
DEPARTMENT OF ELECTRICAL ENGINEERING

Submitted

in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

to the



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Certificate

This is to certify that the thesis entitled **"Multirate Output Functional Observer Design and Its Control Applications"**, submitted by **Neeli Satyanarayana** to the Indian Institute of Technology Delhi, for the award of the degree of Doctor of Philosophy in Electrical Engineering, is a record of the original, bona fide research work carried out by him under my supervision and guidance. The thesis has reached the standards fulfilling the requirements of the regulations related to the award of the degree.

The results contained in this thesis have not been submitted in part or in full to any other university or institute for the award of any degree or diploma, to the best of my knowledge.

Thesis Supervisor:

Dr. S. Janardhanan

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Abstract

The design of linear functional observers to estimate a linear function of the state vector, which is the subject of this dissertation, is increasingly becoming a popular researched topic because of the many advantages it presents in estimation and control system design. Multirate output sampling based state estimation is considered here as an alternative to the classical observer in the design of functional observers.

Multirate output sampling is the concept of sampling the system output at a faster rate as compared to the control input. In this work, it is considered in the design of a non-dynamical functional observer for linear time-invariant deterministic, unknown input and time-delay systems to realize a linear function of state in terms of past outputs and control inputs and is used to implement the feedback control law. Necessary and sufficient conditions are derived for the existence of such a functional observer with minimal number of output samples. This work also includes the design of a minimum variance dynamical functional filtering algorithm for the stochastic systems based on multirate output sampling.

This thesis also presents an approach to the design of discrete-time sliding mode control for uncertain dynamical systems using the concept of non-dynamical functional observers developed earlier. Finally, a dynamical functional observer design is proposed with the combination of multirate output sampling technique and the classical functional observer theory, so that the number of output samples required is less in comparison with non-dynamical functional observer for deterministic systems.

Keywords: Multirate output sampling, functional observer, functional filtering, non-dynamical observer, state feedback, discrete-time systems, uncertain systems, time-delay systems, stochastic systems.

Contents