"Analysis and Development of Nonlinear Observability Problem in Electrical Drive Systems"

By: Sadegh Esmaeil Zadeh Soudjani
Supervisor: Dr. Farzad Rajaei Salmasi
Field: Electrical Engineering, Control
Date: 07/14/2009

Abstract of M.Sc. Thesis:

The thesis deals with the nonlinear observability problem in electrical drive systems. In spite of linear dynamical systems, observability analysis is a very difficult task for nonlinear dynamical systems. Furthermore, observable systems, linear or nonlinear, do not show same behaviors with different observers. Estimating the state of some systems are easier than others with the same type of observers. Through these observations a definition for comparing the observability of systems is presented. Two filters are considered, an optimal filter (Kalman filter) and a robust filter (H_∞ filter). Both of them are applied to DC motors and application of the definition is examined by simulation.

Global observability analysis of permanent magnet synchronous motors (PMSM) is also carried out. It is first shown that PMSM's are globally observable in rotating reference dq frame. Then all indistinguishable trajectories of interior PMSM's, i.e. pairs of state trajectories with the same input/output behavior, are described by some differential algebraic equations (DAE's) in stationary reference $\alpha\beta$ frame. Moreover, it is shown that surface mounted PMSM's are globally detectable in this frame.

At the end nonlinear H_∞ filter with deterministic input is presented, it is designed for two PMSM's, and observability of these two motors is compared based on H_∞ filter.