VARIABLE STRUCTURE CONTROL DESIGN FOR LARGE-SCALE SYSTEMS

By

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CERTIFICATE

This is to certify that the thesis entitled "Variable Structure Control Design for Large-Scale Systems" being submitted by Hemamalini Khurana, for the award of the degree of Doctor of Philosophy to the Indian Institute of Technology, Delhi, is a record of bonafide research work she has carried out under our guidance and supervision. The results contained in this thesis have not been submitted to any other University or Institute for the award of any degree or diploma.

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A C K N O W L E D G E M E N T S

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Abstract

Research in the past several years has shown that the theory of variable structure systems (V.S.S.) provides a powerful control design method for scalar and multivariable systems. The V.S.S. approach stabilizes a system through a fast switching control which forces the original system to behave as a stable linear time-invariant system. By introducing sliding modes in the system one can achieve stabilization, disturbance rejection and a low sensitivity to plant parameter variations.

There is an exhaustive amount of literature in the field of scalar applications of variable structure controllers. For multivariable V.S.S. some methods like the control hierarchy method have been suggested by Utkin. In this thesis an attempt is made to extend the V.S.S. theory to large-scale systems utilizing the concepts of multi-level control theory for partitioning a large composite system into a number of subsystems. The stabilization problem of large-scale systems is thus reduced to the V.S.S. design of lower order subsystems. Local switching controllers are designed at the subsystem level and at the second level a corrective controller is obtained which accounts for the interactions within the subsystems.

For decomposing a large system into a number of subsystems various transformation techniques and a graph-theoretic approach

are utilized. The proposed hierarchical method is compared with other results which have been presented for the stabilization of large scale ~~multivariable~~ systems.

There has been considerable interest in the application of the V.S.S. technique to power system problems. The researchers in the area of load-frequency controller design have generally ignored the interactions and have designed decentralized controllers. However, as this approach works well only with certain models we present in this thesis both decentralized and hierarchical load-frequency controller design for multi-area power systems. A new proportional-plus-integral type V.S.S. for load-frequency control is designed. Some theoretical results, pertaining to the stability analysis of systems employing the hierarchical controllers are obtained.

Throughout this thesis the design of the sliding hyperplanes is based on a geometric concept employing projector theory which is one of the methods present in the literature. Comparisons with the classical integral control and the optimal control schemes is also conducted.

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