

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 ~~multivariable~~ <sup>large scale</sup> 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~~ <sup>we present in this thesis</sup> 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~~ <sup>is designed</sup>. (Some theoretical results, pertaining to the stability analysis of systems employing the hierarchical controllers are obtained.) <sup>shift</sup>

Throughout this thesis the design of the sliding hyperplanes is based on a geometric concept employing projector theory which ~~is one of the methods~~ <sup>is one of the methods</sup> present in the literature. (Comparisons with the classical integral control and the optimal control schemes is also conducted.) ~~not~~ <sup>shift</sup>

## CONTENTS

	Page No.
Chapter 1: Introduction	1
1.1 Hierarchical/Decentralized Control	3
1.2 Variable Structure Systems	6
1.3 Scope of the thesis	8
Chapter 2: Variable structure systems-concepts and Design Approaches	10
2.1 Basic concepts: a second-order example	12
2.2 Fillipov's construction and the method of 'Equivalent Control'	16
2.3 Conditions for the existence and attainment of the sliding mode	20
2.4 Methods for constructing discontinuity hyperplanes	23
2.4.1 The method of Utkin and Young	23
2.4.2 The method of El-Ghezawi et. al.	26
2.5 Properties of systems in the sliding mode	31
2.6 Multivariable variable structure systems	33
2.7 Conclusions	35

Chapter 3: Hierarchical variable-structure control Design	36
3.1 A Hierarchical algorithm for variable structure Design	37
3.1.1 Design of the local controllers	41
3.1.2 Design of the corrective controller	41
3.2 Transformation to input decentralized forms	42
3.3 A two-level algorithm for nonlinear systems	45
3.4 Comparison with other methods for large-scale systems	47
3.5 Numerical Examples	50
3.6 Conclusions	54
Chapter 4: A graph - theoretic approach to variable structure systems design	55
4.1 Hierarchical Decomposition using Graph Theory	56
4.2 Variable structure controller design	59
4.3 Numerical Examples	60
4.4 Comparison with control hierarchy technique	71
4.5 Conclusions	71
Chapter 5: Stability Analysis of Hierarchical Variable Structure Systems	73
5.1 Lyapunov functions for systems with discontinuous control	75
5.2 Vector Lyapunov functions for stability analysis	78
5.3 A stability result for Hierarchical V.S.S.	85
5.4 Example	87
5.5 Conclusions	89

Chapter 6: Variable structure Load-frequency control	90
6.1 Single area variable structure L.F.C	92
6.2 Decentralized variable structure L.F.C	104
6.3 Hierarchical variable structure LFC	111
6.4 Integrated Control using V.S.S.	120
6.5 Conclusions	124
Chapter 7: Summary and Suggestions	125
7.1 Summary of Results	126
7.2 Suggestions for further work	128
Bibliography	130
Appendix I The Luenberger Transformation	136
Appendix II The Ray and Warshall Algorithm	138
Appendix III Gram-Schmidt Orthogonalization Procedure	139
Appendix IV Power System Models	141