Preface

In recent years, numerous variable-structure approaches have been developed for the control of nonlinear dynamic systems and for the model-based estimation of non-measurable states and parameters. These approaches typically make use of first-order as well as higher order sliding mode techniques and related procedures that are characterized by a variable-structure nature. One of their main advantages is the inherent proof of asymptotic stability. This stability proof is either performed offline during the corresponding controller and estimator design or online by the real-time evaluation of a suitable candidate for a Lyapunov function.

The methodological framework for variable-structure control and estimation approaches is quite well developed in the case of continuous-time and discrete-time systems, for which process models are accurately known.

Nevertheless, research efforts are still necessary to make the corresponding procedures applicable when only worst-case bounds are available for specific parameters. This type of uncertainty is often caused by non-negligible, however, inevitable manufacturing tolerances. Moreover, significant stochastic disturbances—for example, as a result of measurement noise—may act as further system inputs in many practically relevant applications. To enhance robustness in such cases, it is possible to combine variable-structure approaches with techniques which are for instance based on interval analysis, stochastic differential equations, or linear matrix inequalities.

This book aims at presenting current research activities in the field of robust variable-structure systems. The scope equally consists in highlighting novel methodological aspects as well as in presenting the use of variable-structure techniques in industrial applications including their implementation on hardware for real-time control.

Besides variable-structure approaches for the design of feedback control strategies and state estimation procedures, computational techniques for simulation—as included in predictive controllers—robustness and stability analysis, as well as for the identification of system models which are characterized by an inherent variable-structure behavior are included. Such models may result from a mathematical representation of state-dependent transitions between various state-space representations, for example, due to faults of selected system components or due to different system models depending on the current operating conditions of the considered system.

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