SLIDING MODE CONTROL:
MATHEMATICAL TOOLS, DESIGN AND APPLICATIONS.

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ABSTRACT: Sliding Mode Control has for many years been recognized as one of the key approaches for the systematic design of robust controllers for complex nonlinear dynamic systems operating under uncertainty conditions.

The major advantage of sliding mode controllers is inherent insensitivity to parameter variations and disturbances once in the sliding mode, thereby eliminating the necessity of exact modeling. Sliding mode control enables separation of the overall system motion into independent partial components of lower dimensions, and as a result reducing the complexity of the control design.

The potential of control resources may be used to the fullest extent within the framework of nonlinear control methods since the actuator limitations and other performance specifications may be included in the design procedure.

The scope of sliding mode control studies embraces heterogeneous problems (mathematical methods, design principles, applications).

The first problem concerns with development of the tools to derive the equations governing sliding modes and the conditions for this motion to exist. The problem needs development of special methods, since the existence-uniqueness-solution theorems of the conventional differential equation theory are not applicable for the equations with discontinuous right-hand parts.

The design of feedback control in the systems with sliding modes implies design of manifolds in the state space where control components undergo discontinuities, and control functions enforcing motions along the manifolds. The design methodology is illustrated by sliding mode control in linear systems (eigenvalue placement, optimization, disturbance rejection, identification).

Implementation issues – suppression of chattering, caused by unmodeled dynamics and discrete-time control actions, deriving information on systems state and parameters – are addressed. The application part of the course is oriented towards control of a wide range of electrical and mechanical systems (electric drives, robots and manipulators, lumped and flexible mechanical structures).

The major attention in the course is paid to sliding mode control design for finite-dimensional systems, governed by ordinary differential equations. Recent developments for infinite-dimensional and discrete-time systems are provided.

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