



Sliding Mode Control

**Yuri Shtessel, Christopher
Edwards, Leonid Fridman, Arie Levant**



Sliding Mode Control:

Sliding Mode Control in Electro-Mechanical Systems Vadim Utkin, Juergen Guldner, Jingxin Shi, 2017-12-19 Apply Sliding Mode Theory to Solve Control Problems Interest in SMC has grown rapidly since the first edition of this book was published This second edition includes new results that have been achieved in SMC throughout the past decade relating to both control design methodology and applications In that time Sliding Mode Control SMC has continued to gain increasing importance as a universal design tool for the robust control of linear and nonlinear electro mechanical systems Its strengths result from its simple flexible and highly cost effective approach to design and implementation Most importantly SMC promotes inherent order reduction and allows for the direct incorporation of robustness against system uncertainties and disturbances These qualities lead to dramatic improvements in stability and help enable the design of high performance control systems at low cost Written by three of the most respected experts in the field including one of its originators this updated edition of Sliding Mode Control in Electro Mechanical Systems reflects developments in the field over the past decade It builds on the solid fundamentals presented in the first edition to promote a deeper understanding of the conventional SMC methodology and it examines new design principles in order to broaden the application potential of SMC SMC is particularly useful for the design of electromechanical systems because of its discontinuous structure In fact where the hardware of many electromechanical systems such as electric motors prescribes discontinuous inputs SMC becomes the natural choice for direct implementation This book provides a unique combination of theory implementation issues and examples of real life applications reflective of the authors own industry leading work in the development of robotics automobiles and other technological breakthroughs *Sliding Mode Control In Engineering* Wilfrid Perruquetti, Jean-Pierre Barbot, 2002-01-29 Provides comprehensive coverage of the most recent developments in the theory of non Archimedean pseudo differential equations and its application to stochastics and mathematical physics offering current methods of construction for stochastic processes in the field of p adic numbers and related structures Develops a new theory for parabolic equat *Sliding Mode Control in Electro-mechanical Systems* Vadim Utkin, Juergen Guldner, Ma Shijun, 1999-04-22 Sliding Mode Control SMC is gaining increasing importance as a universal design tool for the robust control of linear and nonlinear systems The strengths of sliding mode controllers result from the ease and flexibility of the methodology for their design and implementation They provide inherent order reduction direct incorporation of robustness against system uncertainties and disturbances and an implicit stability proof They also allow for the design of high performance control systems at low costs SMC is particularly useful for electro mechanical systems because of its discontinuous structure In fact since the hardware of many electro mechanical systems such as electric motors prescribes discontinuous inputs SMC has become the natural choice for direct implementation The book is intended primarily for engineers and establishes an interdisciplinary bridge between control science electrical and mechanical engineering *Sliding Mode Control and*

Observation Yuri Shtessel, Christopher Edwards, Leonid Fridman, Arie Levant, 2013-06-01 The sliding mode control methodology has proven effective in dealing with complex dynamical systems affected by disturbances uncertainties and unmodeled dynamics Robust control technology based on this methodology has been applied to many real world problems especially in the areas of aerospace control electric power systems electromechanical systems and robotics Sliding Mode Control and Observation represents the first textbook that starts with classical sliding mode control techniques and progresses toward newly developed higher order sliding mode control and observation algorithms and their applications The present volume addresses a range of sliding mode control issues including Conventional sliding mode controller and observer design Second order sliding mode controllers and differentiators Frequency domain analysis of conventional and second order sliding mode controllers Higher order sliding mode controllers and differentiators Higher order sliding mode observers Sliding mode disturbance observer based control Numerous applications including reusable launch vehicle and satellite formation control blood glucose regulation and car steering control are used as case studies Sliding Mode Control and Observation is aimed at graduate students with a basic knowledge of classical control theory and some knowledge of state space methods and nonlinear systems while being of interest to a wider audience of graduate students in electrical mechanical aerospace engineering and applied mathematics as well as researchers in electrical computer chemical civil mechanical aeronautical and industrial engineering applied mathematicians control engineers and physicists Sliding Mode Control and Observation provides the necessary tools for graduate students researchers and engineers to robustly control complex and uncertain nonlinear dynamical systems Exercises provided at the end of each chapter make this an ideal text for an advanced course taught in control theory

Emerging Trends in Sliding Mode Control Axaykumar Mehta, Bijan Bandyopadhyay, 2020-12-21 This book compiles recent developments on sliding mode control theory and its applications Each chapter presented in the book proposes new dimension in the sliding mode control theory such as higher order sliding mode control event triggered sliding mode control networked control higher order discrete time sliding mode control and sliding mode control for multi agent systems Special emphasis has been given to practical solutions to design involving new types of sliding mode control This book is a reference guide for graduate students and researchers working in the domain for designing sliding mode controllers The book is also useful to professional engineers working in the field to design robust controllers for various applications

Advances and Applications in Sliding Mode Control systems Ahmad Taher Azar, Quanmin Zhu, 2014-11-01 This book describes the advances and applications in Sliding mode control SMC which is widely used as a powerful method to tackle uncertain nonlinear systems The book is organized into 21 chapters which have been organised by the editors to reflect the various themes of sliding mode control The book provides the reader with a broad range of material from first principles up to the current state of the art in the area of SMC and observation presented in a clear matter of fact style As such it is appropriate for graduate students with a basic knowledge of classical control

theory and some knowledge of state space methods and nonlinear systems The resulting design procedures are emphasized using Matlab Simulink software

Variable-Structure Systems and Sliding-Mode Control Martin Steinberger, Martin Horn, Leonid Fridman, 2020-02-10 The book covers the latest theoretical results and sophisticated applications in the field of variable structure systems and sliding mode control This book is divided into four parts Part I discusses new higher order sliding mode algorithms including new homogeneous controllers and differentiators Part II then explores properties of continuous sliding mode algorithms such as saturated feedback control reaching time and orbital stability Part III is focused on the usage of variable structure systems VSS controllers for solving other control problems for example unmatched disturbances Finally Part IV discusses applications of VSS these include applications within power electronics and vehicle platooning Variable structure Systems and Sliding Mode Control will be of interest to academic researchers students and practising engineers

Applications of Sliding Mode Control in Science and Engineering Sundarapandian

Vaidyanathan, Chang-Hua Lien, 2017-04-06 Gathering 20 chapters contributed by respected experts this book reports on the latest advances in and applications of sliding mode control in science and engineering The respective chapters address applications of sliding mode control in the broad areas of chaos theory robotics electrical engineering physics chemical engineering memristors mechanical engineering environmental engineering finance and biology Special emphasis has been given to papers that offer practical solutions and which examine design and modeling involving new types of sliding mode control such as higher order sliding mode control terminal sliding mode control super twisting sliding mode control and integral sliding mode control This book serves as a unique reference guide to sliding mode control and its recent applications for graduate students and researchers with a basic knowledge of electrical and control systems engineering

Discrete-Time Sliding Mode Control for Networked Control System Dipesh H. Shah, Axaykumar Mehta, 2018-03-16 This book presents novel algorithms for designing Discrete Time Sliding Mode Controllers DSMCs for Networked Control Systems NCSs with both types of fractional delays namely deterministic delay and random delay along with different packet loss conditions such as single packet loss and multiple packet loss that occur within the sampling period Firstly the switching type and non switching type algorithms developed for the deterministic type fractional delay where the delay is compensated using Thiran's approximation technique A modified discrete time sliding surface is proposed to derive the discrete time sliding mode control algorithms The algorithm is further extended for the random fractional delay with single packet loss and multiple packet loss situations The random fractional delay is modelled using Poisson's distribution function and packet loss is modelled by means of Bernoulli's function The condition for closed loop stability in all above situations are derived using the Lyapunov function Lastly the efficacy of the proposed DSMC algorithms are demonstrated by extensive simulations and also experimentally validated on a servo system

Road Map for Sliding Mode Control Design Vadim Utkin, Alex Poznyak, Yury V. Orlov, Andrey Polyakov, 2020-04-13 This book is devoted to control of finite and infinite dimensional

processes with continuous time and discrete time control focusing on suppression problems and new methods of adaptation applicable for systems with sliding motions only Special mathematical methods are needed for all the listed control tasks These methods are addressed in the initial chapters with coverage of the definition of the multidimensional sliding modes the derivation of the differential equations of those motions and the existence conditions Subsequent chapters discusses various areas of further research The book reflects the consensus view of the authors regarding the current status of SMC theory It is addressed to a broad spectrum of engineers and theoreticians working in diverse areas of control theory and applications It is well suited for use in graduate and postgraduate courses in such university programs as Electrical Engineering Control of Nonlinear Systems and Mechanical Engineering

Advances in Variable Structure Systems and Sliding Mode Control—Theory and Applications Shihua Li,Xinghuo Yu,Leonid Fridman,Zhihong Man,Xiangyu Wang,2017-08-10 This book reflects the latest developments in variable structure systems VSS and sliding mode control SMC highlighting advances in various branches of the VSS SMC field e g from conventional SMC to high order SMC from the continuous time domain to the discrete time domain from theories to applications etc The book consists of three parts and 16 chapters in the first part new VSS SMC algorithms are proposed and their properties are analyzed while the second focuses on the use of VSS SMC techniques to solve a variety of control problems the third part examines the applications of VSS SMC to real time systems The book introduces postgraduates and researchers to the state of the art in VSS SMC field including the theory methodology and applications Relative academic disciplines include Automation Mathematics Electrical Engineering Mechanical Engineering Instrument Science and Engineering Electronic Engineering Computer Science and Technology Transportation Engineering Energy and Power Engineering etc

Advances in Discrete-Time Sliding Mode Control Ahmadreza Argha,Steven Su,Li Li,Hung Tan Nguyen,Branko George Celler,2018-06-14 The focus of this book is on the design of a specific control strategy using digital computers This control strategy referred to as Sliding Mode Control SMC has its roots in continuous time relay control This book aims to explain recent investigations output in the field of discrete time sliding mode control DSMC The book starts by explaining a new robust LMI based state feedback and observer based output feedback DSMC including a new scheme for sparsely distributed control It includes a novel event driven control mechanism called actuator based event driven scheme using a synchronized rate biofeedback system for heart rate regulation during cycle ergometer Key Features Focuses on LMI based SMC sliding mode control for uncertain discrete time system using novel nonlinear components in the control law Makes reader understand the techniques of designing a discrete controller based on the flexible sliding functions Proposes new algorithms for sparsifying control and observer network through multi objective optimization frameworks Discusses a framework for the design of SMC for two dimensional systems along with analyzing the controllability of two dimensional systems Discusses novel schemes for sparsifying the control network

Sliding Mode Control Christopher Edwards,Sarah K. Spurgeon,1998-08-27 In the formation of any control problem there

will be discrepancies between the actual plant and the mathematical model for controller design Sliding mode control theory seeks to produce controllers to overcome such mismatches This text provides the reader with a grounding in sliding mode control and is appropriate for the graduate with a basic knowledge of classical control theory and some knowledge of state space methods

Modern Sliding Mode Control Theory Giorgio Bartolini, Leonid Fridman, Alessandro Pisano, Elio Usai, 2008-04-05 This concise book covers modern sliding mode control theory The authors identify key contributions defining the theoretical and applicative state of the art of the sliding mode control theory and the most promising trends of the ongoing research activities

Sliding Mode Control Andrzej Bartoszewicz, 2011-04-11 The main objective of this monograph is to present a broad range of well worked out recent application studies as well as theoretical contributions in the field of sliding mode control system analysis and design The contributions presented here include new theoretical developments as well as successful applications of variable structure controllers primarily in the field of power electronics electric drives and motion steering systems They enrich the current state of the art and motivate and encourage new ideas and solutions in the sliding mode control area

Sliding-Mode Control and Variable-Structure Systems Tiago Roux Oliveira, Leonid Fridman, Liu Hsu, 2023-10-31 This book reflects the latest developments in sliding mode control SMC and variable structure systems VSS comprising contributions by leading researchers and an international range of experts Such contributions highlight advances in various branches of the field conventional and higher order SMC with continuous and discrete time implementation and theory and applications both receive attention The book consists of six parts In the first new SMC VSS algorithms are proposed and their properties are analyzed The second part focuses on the use of observers to solve the estimation and output feedback control problems The third part discusses the discretization aspects of SMC algorithms Parts IV and V provide important insights on the use of adaptation laws for non overestimated control gains and chattering alleviation The last part examines the applications of these SMC VSS ideas to real world systems

Sliding Mode Control and Variable Structure Systems introduces postgraduates and researchers to the state of the art in the field It includes theory methods and applications relevant to workers in disciplines including control automation applied mathematics electrical and mechanical engineering instrumentation electronics computer science robotics transportation and power engineering Its clear style and deep exposition help readers to keep in touch with tools that are thanks to the robustness and insensitivity to perturbations of the SMC VSS paradigm among the most efficient for dealing with uncertain systems

Sliding Mode Control Hebertt Sira-Ramírez, 2015-05-25 This monograph presents a novel method of sliding mode control for switch regulated nonlinear systems The Delta Sigma modulation approach allows one to implement a continuous control scheme using one or multiple independent switches thus effectively merging the available linear and nonlinear controller design techniques with sliding mode control

Sliding Mode Control The Delta Sigma Modulation Approach combines rigorous mathematical derivation of the unique features of Sliding Mode Control and Delta Sigma modulation with

numerous illustrative examples from diverse areas of engineering. In addition, engineering case studies demonstrate the applicability of the technique and the ease with which one can implement the exposed results. This book will appeal to researchers in control engineering and can be used as a graduate level textbook for a first course on sliding mode control.

Sliding Mode Control Using Novel Sliding Surfaces B. Bandyopadhyay, Fulwani Deepak, Kyung-Soo Kim, 2009-09-23

After a survey paper by Utkin in the late 1970s, sliding mode control methodologies emerged as an effective tool to tackle uncertainty and disturbances which are inevitable in most of the practical systems. Sliding mode control is a particular class of variable structure control which was introduced by Emel'yanov and his colleagues. The design paradigms of sliding mode control has now become a mature design technique for the design of robust controller of uncertain system. In sliding mode technique, the state trajectory of the system is constrained on a chosen manifold or within some neighborhood thereof by an appropriate control action. This manifold is also called a switching surface or a sliding surface. During sliding mode system dynamics is governed by the chosen manifold which results in a well celebrated invariance property towards certain classes of disturbance and model mismatches. The purpose of this monograph is to give a different dimension to sliding surface design to achieve high performance of the system. Design of the switching surface is vital because the closed loop dynamics is governed by the parameters of the sliding surface. Therefore, sliding surface should be designed to meet the closed loop specifications. Many systems demand high performance with robustness. To address this issue of achieving high performance with robustness, we propose nonlinear surfaces for different classes of systems. The nonlinear surface is designed such that it changes the system's closed loop damping ratio from its initial low value to a final high value.

Sliding Mode Control of a Nonlinear Ducted-fan UAV Model Maryam Bakhtiari-Nejad, 2006

Advanced Sliding Mode Control for Mechanical Systems

Jinkun Liu, Xinhua Wang, 2012-09-07. *Advanced Sliding Mode Control for Mechanical Systems: Design, Analysis, and MATLAB Simulation* takes readers through the basic concepts covering the most recent research in sliding mode control. The book is written from the perspective of practical engineering and examines numerous classical sliding mode controllers including continuous time sliding mode control, discrete time sliding mode control, fuzzy sliding mode control, neural sliding mode control, backstepping sliding mode control, dynamic sliding mode control, sliding mode control based on observer, terminal sliding mode control, sliding mode control for robot manipulators, and sliding mode control for aircraft. This book is intended for engineers and researchers working in the field of control. Dr. Jinkun Liu works at Beijing University of Aeronautics and Astronautics and Dr. Xinhua Wang works at the National University of Singapore.

Sliding Mode Control Book Review: Unveiling the Power of Words

In a world driven by information and connectivity, the ability of words has become more evident than ever. They have the ability to inspire, provoke, and ignite change. Such may be the essence of the book **Sliding Mode Control**, a literary masterpiece that delves deep to the significance of words and their impact on our lives. Published by a renowned author, this captivating work takes readers on a transformative journey, unraveling the secrets and potential behind every word. In this review, we shall explore the book's key themes, examine its writing style, and analyze its overall effect on readers.

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