Discrete Sliding Mode Control for Electromagnetic Levitation System
Event-Triggered Sliding Mode Control
2018 IEEE 27th International Symposium on Industrial Electronics (ISIE)
Recent Developments in Sliding Mode Control
Sliding Mode Control Variable Structure and Lyapunov Control
Advanced Sliding Mode Control for Mechanical Systems
Sliding Mode Control in Electro-Mechanical Systems
Road Map for Sliding Mode Control Design
Discrete-time Sliding Mode Control
Sliding Mode Control and Observation Advances in Discrete-Time Sliding Mode Control
2019 IEEE 8th Data Driven Control and Learning Systems Conference (DDCLS)
Sliding Mode Control in Electro-mechanical Systems
Discrete-time Sliding Mode Control
Discrete Sliding Mode Control for Nonlinear Sampled Data Systems
Sliding Mode Control of Switching Power Converters
Sliding Mode Control in Engineering
Advanced and Optimization Based Sliding Mode Control: Theory and Applications
Emerging Trends in Sliding Mode Control
Emerging Trends in Sliding Mode Control
State Variable Methods in Automatic Control
Advances and Applications in Sliding Mode Control systems
Sliding Mode Control in Electro-Mechanical Systems
Trends in Advanced Intelligent Control, Optimization and Automation
Frequency-Shaped and Observer-Based Discrete-time Sliding Mode Control
Sliding Mode Control of Semi-Markovian Jump Systems
Recent Advances in Sliding Modes: From Control to Intelligent Mechatronics
Recent Trends in Sliding Mode Control Applications of Sliding Mode Control
Modern Sliding Mode Control Theory
Sliding Mode Control Using Novel Sliding Surfaces
Advances in Sliding Mode Control
Advanced Discrete-Time
Discrete Sliding Mode Control for Electromagnetic Levitation System

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.

Event-Triggered Sliding Mode Control

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.

2018 IEEE 27th International Symposium on Industrial Electronics (ISIE) This book
extrapolates many of the concepts that are well defined for discrete-time deterministic
sliding-mode control for use with discrete-time stochastic systems. It details sliding-
function designs for various categories of linear time-invariant systems and its
application for control. The resulting sliding-mode control addresses robustness issues
and the functional-observer approach reduces the observer order substantially. Sliding-
mode control (SMC) is designed for discrete-time stochastic systems, extended so that
states lie within a specified band, and able to deal with incomplete information.
Functional-observer-based SMC is designed for various clauses of stochastic systems:
discrete-time; discrete-time with delay; state time-delayed; and those with parametric
uncertainty. Stability considerations arising because of parametric uncertainty are taken
into account and, where necessary, the effects of unmatched uncertainties mitigated. A
simulation example is used to explain the use of the functional-observer approach to SMC
design. Discrete-Time Stochastic Sliding-Mode Control Using Functional Observation will
interest all researchers working in sliding-mode control and will be of particular
assistance to graduate students in understanding the changes in design philosophy that
arise when changing from continuous- to discrete-time systems. It helps to pave the way
for further progress in applications of discrete-time SMC.

Recent Developments in Sliding Mode Control Sliding Mode Control Using MATLAB provides many sliding mode controller design examples, along with simulation examples and MATLAB® programs. Following the review of sliding mode control, the book includes sliding mode control for continuous systems, robust adaptive sliding mode control, sliding mode control for underactuated systems, backstepping, and dynamic surface sliding mode control, sliding mode control based on filter and observer, sliding mode control for discrete systems, fuzzy sliding mode control, neural network sliding mode control, and sliding mode control for robot manipulators. The contents of each chapter are independent, providing readers with information they can use for their own needs. It is suitable for the readers who work on mechanical and electronic engineering, electrical automation engineering, etc., and can also be used as a teaching reference for universities. Provides many sliding mode controller design examples to help readers solve their research and design problems. Includes various, implementable, robust sliding mode control design solutions from engineering applications. Provides the simulation examples and MATLAB programs for each sliding mode control algorithm.

Sliding Mode Control 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

Variable Structure and Lyapunov Control 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.
Advanced Sliding Mode Control for Mechanical Systems Sliding Mode Control of Switching Power Converters: Techniques and Implementation is perhaps the first in-depth account of how sliding mode controllers can be practically engineered to optimize control of power converters. A complete understanding of this process is timely and necessary, as the electronics industry moves toward the use of renewable energy sources and widely varying loads that can be adequately supported only by power converters using nonlinear controllers. Of the various advanced control methods used to handle the complex requirements of power conversion systems, sliding mode control (SMC) has been most widely investigated and proved to be a more feasible alternative than fuzzy and adaptive control for existing and future power converters. Bridging the gap between power electronics and control theory, this book employs a top-down instructional approach to discuss traditional and modern SMC techniques. Covering everything from equations to analog implantation, it: Provides a comprehensive general overview of SMC principles and methods Offers advanced readers a systematic exposition of the mathematical machineries and design principles relevant to construction of SMC, then introduces newer approaches Demonstrates the practical implementation and supporting design rules of SMC, based on analog circuits Promotes an appreciation of general nonlinear control by presenting it from a practical perspective and using familiar engineering terminology With specialized coverage of modeling and implementation that is useful to students and professionals in electrical and electronic engineering, this book clarifies SMC principles and their application to power converters. Making the material equally accessible to all readers, whether their background is in analog circuit design, power electronics, or control engineering, the authors—experienced researchers in their own right—elegantly and practically relate theory, application, and mathematical
concepts and models to corresponding industrial targets.

Sliding Mode Control in Electro-Mechanical Systems 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.

Road Map for Sliding Mode Control Design
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 control 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.

Discrete-time Sliding Mode Control Using numerous worked examples and problems, this book provides an introduction to the use of state space methods in control system analysis and design. It has been written for those with a very basic background in linear control theory and linear algebra. It provides physical insight into the various procedures considered as well as presenting the theoretical derivations. State Variable Methods in Automatic Control will be of interest to students and lecturers involved with courses on control engineering, specifically those involving state space methods. It will also be valuable for professional engineers involved in systems and circuit theory, as well as control system design.

Sliding Mode Control and Observation 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 Discrete-Time Sliding Mode Control Nonlinear control theory has been successfully applied to continuous, nonlinear, autonomous plant models. Implementation of these continuous control laws, using digital computers, has relied upon high sample frequencies to approximate the performance of continuous control. This thesis extends the design of continuous sliding mode control to discrete and to sampled data systems. Continuous, nonlinear, autonomous, second order dynamic plant models are discretized using an approximation to a Taylor series expansion. The discretization process accounts for the Zero Order Hold circuit, used to convert the discrete control output of the digital computer, into a piecewise continuous control input to the plant. A Discrete Sliding Mode Control is developed using Feedback Linearization to account for plant model nonlinearities, and Lyapunov Stability analysis to guarantee convergence to the sliding manifold. A five step design process systematizes the design technique. The design technique was applied to two unstable nonlinear second order plant models. Stability was confirmed by simulation studies. Comparison with the Continuous Sliding Mode Control implemented digitally, at a sample rate five times the plant model fundamental
frequency, showed that the Discrete Sliding Mode Control retained asymptotic stability while the Continuous Sliding Mode Control did not.

2019 IEEE 8th Data Driven Control and Learning Systems Conference (DDCLS) This book presents essential studies and applications in the context of sliding mode control, highlighting the latest findings from interdisciplinary theoretical studies, ranging from computational algorithm development to representative applications. Readers will learn how to easily tailor the techniques to accommodate their ad hoc applications. To make the content as accessible as possible, the book employs a clear route in each paper, moving from background to motivation, to quantitative development (equations), and lastly to case studies/illustrations/tutorials (simulations, experiences, curves, tables, etc.). Though primarily intended for graduate students, professors and researchers from related fields, the book will also benefit engineers and scientists from industry.

Sliding Mode Control in Electro-mechanical Systems The main purpose of control engineering is to steer the regulated plant in such a way that it operates in a required manner. The desirable performance of the plant should be obtained despite the unpredictable influence of the environment on the control system and no matter if the plant parameters are precisely known. Even though the parameters may change with time and load, still the system should preserve its nominal properties and ensure the required behavior of the plant. In other words, the principal objective of control engineering is to design systems that are robust with respect to external disturbances and modeling uncertainty. This objective may be very well achieved using the sliding mode technique, which is the subject of this book.
Discrete-time Sliding Mode Control 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 over some 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. From this basis, more advanced theoretical results are developed. Two industrial case studies, which present the results of sliding mode controller implementations, are used to illustrate the successful practical application theory.

Discrete Sliding Mode Control for Nonlinear Sampled Data Systems This edited monograph provides a comprehensive and in-depth analysis of sliding mode control, focusing on event-triggered implementation. The technique allows to prefix the steady-state bounds of the system, and this is independent of any boundary disturbances. The idea of event-triggered SMC is developed for both single input / single output and multi-input / multi-output linear systems. Moreover, the reader learns how to apply this method to nonlinear systems. The book primarily addresses research experts in the field of sliding mode control, but the book may also be beneficial for graduate students.

Sliding Mode Control of Switching Power Converters The conference will provide a forum for discussions and presentations of advancements in knowledge, new methods and technologies relevant to industrial electronics, along with their applications and future developments.
Sliding Mode Control In Engineering This book covers a wide spectrum of systems such as linear and nonlinear multivariable systems as well as control problems such as disturbance, uncertainty and time-delays. The purpose of this book is to provide researchers and practitioners a manual for the design and application of advanced discrete-time controllers. The book presents six different control approaches depending on the type of system and control problem. The first and second approaches are based on Sliding Mode control (SMC) theory and are intended for linear systems with exogenous disturbances. The third and fourth approaches are based on adaptive control theory and are aimed at linear/nonlinear systems with periodically varying parametric uncertainty or systems with input delay. The fifth approach is based on Iterative learning control (ILC) theory and is aimed at uncertain linear/nonlinear systems with repeatable tasks and the final approach is based on fuzzy logic control (FLC) and is intended for highly uncertain systems with heuristic control knowledge. Detailed numerical examples are provided in each chapter to illustrate the design procedure for each control method. A number of practical control applications are also presented to show the problem solving process and effectiveness with the advanced discrete-time control approaches introduced in this book.

Advanced and Optimization Based Sliding Mode Control: Theory and Applications "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.

Emerging Trends in Sliding Mode Control This book describes recent advances in the theory, properties, methods and applications of SMC, including a discussion about the advantages and disadvantages of different SMC algorithms.

Emerging Trends in Sliding Mode Control A compendium of the authors’ recently published results, this book discusses sliding mode control of uncertain nonlinear systems, with a particular emphasis on advanced and optimization based algorithms. The authors survey classical sliding mode control theory and introduce four new methods of advanced sliding mode control. They analyze classical theory and advanced algorithms, with numerical results complementing the theoretical treatment. Case studies examine applications of the algorithms to complex robotics and power grid problems. Advanced and Optimization Based Sliding Mode Control: Theory and Applications is the first book to systematize the theory of optimization based higher order sliding mode control and illustrate advanced algorithms and their applications to real problems. It presents systematic treatment of event-triggered and model based event-triggered sliding mode control schemes, including schemes in combination with model predictive control, and presents adaptive algorithms as well as algorithms capable of dealing with state and
input constraints. Additionally, the book includes simulations and experimental results obtained by applying the presented control strategies to real complex systems. This book is suitable for students and researchers interested in control theory. It will also be attractive to practitioners interested in implementing the illustrated strategies. It is accessible to anyone with a basic knowledge of control engineering, process physics, and applied mathematics.

State Variable Methods in Automatic Control This volume contains the proceedings of the KKA 2017 - the 19th Polish Control Conference, organized by the Department of Automatics and Biomedical Engineering, AGH University of Science and Technology in Kraków, Poland on June 18-21, 2017, under the auspices of the Committee on Automatic Control and Robotics of the Polish Academy of Sciences, and the Commission for Engineering Sciences of the Polish Academy of Arts and Sciences. Part 1 deals with general issues of modeling and control, notably flow modeling and control, sliding mode, predictive, dual, etc. control. In turn, Part 2 focuses on optimization, estimation and prediction for control. Part 3 is concerned with autonomous vehicles, while Part 4 addresses applications. Part 5 discusses computer methods in control, and Part 6 examines fractional order calculus in the modeling and control of dynamic systems. Part 7 focuses on modern robotics. Part 8 deals with modeling and identification, while Part 9 deals with problems related to security, fault detection and diagnostics. Part 10 explores intelligent systems in automatic control, and Part 11 discusses the use of control tools and techniques in biomedical engineering. Lastly, Part 12 considers engineering education and teaching with regard to automatic control and robotics.
Advances and Applications in Sliding Mode Control systems

Sliding Mode Control in Electro-Mechanical Systems It is well established that the sliding mode control strategy provides an effective and robust method of controlling the deterministic system due to its well-known invariance property to a class of bounded disturbance and parameter variations. Advances in microcomputer technologies have made digital control increasingly popular among the researchers worldwide. And that led to the study of discrete-time sliding mode control design and its implementation. This brief presents, a method for multi-rate frequency shaped sliding mode controller design based on switching and non-switching type of reaching law. In this approach, the frequency dependent compensator dynamics are introduced through a frequency-shaped sliding surface by assigning frequency dependent weighing matrices in a linear quadratic regulator (LQR) design procedure. In this way, the undesired high frequency dynamics or certain frequency disturbance can be eliminated. The states are implicitly obtained by measuring the output at a faster rate than the control. It is also known that the vibration control of smart structure is a challenging problem as it has several vibratory modes. So, the frequency shaping approach is used to suppress the frequency dynamics excited during sliding mode in smart structure. The frequency content of the optimal sliding mode is shaped by using a frequency dependent compensator, such that a higher gain can be obtained at the resonance frequencies. The brief discusses the design methods of the controllers based on the proposed approach for the vibration suppression of the intelligent structure. The brief also presents a design of discrete-time reduced order observer using the duality to discrete-time sliding surface design. First, the duality between the coefficients of the discrete-time reduced order observer and the sliding
surface design is established and then, the design method for the observer using Riccati equation is explained. Using the proposed method, the observer for the Power System Stabilizer (PSS) for Single Machine Infinite Bus (SMIB) system is designed and the simulation is carried out using the observed states. The discrete-time sliding mode controller based on the proposed reduced order observer design method is also obtained for a laboratory experimental servo system and verified with the experimental results.

Trends in Advanced Intelligent Control, Optimization and Automation

Frequency-Shaped and Observer-Based Discrete-time Sliding Mode Control This monograph investigates the existence of higher order sliding mode in discrete-time systems and propounds a new concept of discrete-time higher order sliding mode. The authors propose a definition of discrete-time higher order sliding mode and a control law is designed by means of a concept for an uncertain linear-time invariant system, as well as the behavior of the closed-loop system is analyzed. Moreover, the book includes a thorough treatment of the probabilistic and non-deterministic case, i.e. stochastic discrete-time higher order sliding mode. The target audience primarily comprises research experts in control theory but the book may also be beneficial for graduate students alike.

Sliding Mode Control of Semi-Markovian Jump Systems This volume is dedicated to Professor Okyay Kaynak to commemorate his life time impactful research and scholarly achievements and outstanding services to profession. The 21 invited chapters have been written by leading researchers who, in the past, have had association with Professor
Kaynak as either his students and associates or colleagues and collaborators. The focal theme of the volume is the Sliding Modes covering a broad scope of topics from theoretical investigations to their significant applications from Control to Intelligent Mechatronics.

Recent Advances in Sliding Modes: From Control to Intelligent Mechatronics 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.

Recent Trends in Sliding Mode Control

Applications of Sliding Mode Control 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.

Modern Sliding Mode Control Theory 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 Using Novel Sliding Surfaces** 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

Page 18/25
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.

Advances in Sliding Mode Control Sliding mode control is a simple and yet robust control technique, where the system states are made to confine to a selected subset. With the increasing use of computers and discrete-time samplers in controller implementation in the recent past, discrete-time systems and computer based control have become important topics. This monograph presents an output feedback sliding mode control philosophy which can be applied to almost all controllable and observable systems, while at the same time being simple enough as not to tax the computer too much. It is shown that the solution can be found in the synergy of the multirate output sampling concept and the concept of discrete-time sliding mode control.

Advanced Discrete-Time Control 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
Applications 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.
Discrete-Time Sliding Mode Control for Networked Control System

This book presents analysis and design for a class of stochastic systems with semi-Markovian jump parameters. It explores systematic analysis of semi-Markovian jump systems via sliding mode control strategy which makes up the shortages in the analysis and design of stochastic systems. This text provides a novel estimation method to deal with the stochastic stability of semi-Markovian jump systems along with design of novel integral sliding surface. Finally, Takagi-Sugeno fuzzy model approach is brought to deal with system nonlinearities and fuzzy sliding mode control laws are provided to ensure the stabilization purpose. Features: Presents systematic work on sliding mode control (SMC) of semi-Markovian jump systems. Explores SMC methods, such as fuzzy SMC, adaptive SMC, with the presence of generally uncertain transition rates. Provides novel method in dealing with stochastic systems with unknown switching information. Proposes more general theories for semi-Markovian jump systems with generally uncertain transition rates. Discusses practical examples to verify the effectiveness of SMC theory in semi-Markovian jump systems. This book aims at graduate and postgraduate students and for researchers in all engineering disciplines, including mechanical engineering, electrical engineering and applied mathematics, control engineering, signal processing, process control, control theory and robotics.

Discrete-Time Stochastic Sliding Mode Control Using Functional Observation Data driven control and learning has been developed quickly both in theory and applications recently. The deep involvement of information science in practical processes poses enormous challenges to the existing control science and engineering due to their size, distributed nature and complexity. Modeling these processes accurately using first principles or
identification is almost impossible although these plants produce huge amount of
operation data in every moment The high tech hardware software and the cloud
computing enable us to perform complex real time computation, which makes
implementation of data driven control and method for these complex practical plants
possible It would be very significant if we can learn the systems behaviors, discover the
relationship of system variables by making full use of on line or off line process data, to
directly design controller, predict and assess system states, make decisions, perform real
time optimization and conduct fault diagnosis

Sliding Mode Control Using MATLAB The sliding mode control paradigm has become a
mature technique for the design of robust controllers for a wide class of systems
including nonlinear, uncertain and time-delayed systems. This book is a collection of
plenary and invited talks delivered at the 12th IEEE International Workshop on Variable
Structure System held at the Indian Institute of Technology, Mumbai, India in January
2012. After the workshop, these researchers were invited to develop book chapters for
this edited collection in order to reflect the latest results and open research questions in
the area. The contributed chapters have been organized by the editors to reflect the
various themes of sliding mode control which are the current areas of theoretical
research and applications focus; namely articulation of the fundamental underpinning
toory of the sliding mode design paradigm, sliding modes for decentralized system
representations, control of time-delay systems, the higher order sliding mode concept,
results applicable to nonlinear and underactuated systems, sliding mode observers,
discrete sliding mode control together with cutting edge research contributions in the
application of the sliding mode concept to real world problems. This book provides the
reader with a clear and complete picture of the current trends in Variable Structure Systems and Sliding Mode Control Theory.

Advances in Discrete-Time Sliding Mode Control 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.

Discrete-Time Higher Order Sliding Mode 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.

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