



# Discretetime Sliding Mode Control

**Axaykumar Mehta,Bijnan  
Bandyopadhyay**



### **Discrete-time Sliding Mode Control:**

*Discrete-Time Higher Order Sliding Mode* Nalin Kumar Sharma, Janardhanan Sivaramakrishnan, 2018-09-10 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.

**Discrete-Time Stochastic Sliding Mode Control Using Functional Observation** Satnesh Singh, S. Janardhanan, 2019-11-25 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 classes 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.

**Discrete-time Sliding Mode Control** B. Bandyopadhyay, S. Janardhanan, 2005-10-17 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.

**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

**Discrete-time Sliding Mode Control** B. Bandyopadhyay, S. Janardhanan, 2009-09-02 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

*Discrete-time Sliding Mode Control* Govert Monsees, 2002

**Continuous and Discrete-time Sliding Mode Control Design Techniques** Ali Jafari Koshkouei, 1997

**Frequency-Shaped and Observer-Based Discrete-time Sliding Mode Control** Axaykumar Mehta, Bijan Bandyopadhyay, 2015-01-05 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

*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

**Discrete-Time Sliding Mode Control with Outputs of Relative Degree More Than One** Sohom Chakrabarty, 2017 This work deals with sliding mode control of discrete time systems where the outputs are defined or chosen to be of relative degrees more than one The analysis brings forward important advancements in the direction of discrete time sliding mode control such as improved robustness and performance of the system It is proved that the ultimate band about the sliding surface could be greatly reduced by the choice of higher relative degree outputs thus increasing the robustness of the system Moreover finite time stability in absence of uncertainties is proved for such a choice of higher relative degree output In presence of uncertainties the system states become finite time ultimately bounded in nature The work presents in some detail the case with relative degree two outputs deducing switching and non switching reaching laws for the same while for arbitrary relative degree outputs it shows a general formalisation of a control structure specific for a certain type of linear systems

*A Minimum Function-Based Discrete Sliding Mode Control: Theory and Applications* Shyam Kamal, Parijat Prasun, 2025-12-12 This monograph is driven by the ambition to thoroughly investigate and advance the field of discrete time sliding mode design based on difference equations with minima for dynamical systems The motivation behind this exploration lies in the recognition of limitations inherent in classical and conventional control techniques prompting a

quest for methodologies that can effectively address the evolving demands of modern applications The overarching objective of this monograph is to introduce innovative approaches capable of enabling timely and precise control even in the presence of uncertainties and exogenous perturbations Through the development of sophisticated discrete control strategies designed to ensure finite time convergence this research aims to enhance the capabilities and operational efficiency of diverse engineering systems thereby contributing to the ongoing evolution of control methodologies in response to contemporary challenges

**Discrete Time Sliding Mode Control [microform]** Jeff K. (Jeff Kurt) Pieper, 1992

**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

Discrete time sliding mode control strategies applied to a multiphase brushless DC machine Godoi Dias, Milena Sabrina, 2017 Nowadays environmental issues motivates the replacement of mechanical hydraulic and pneumatic system by electrical system in the transport sector aiming to reduce emissions generated by burning of fossil fuels in vehicles The electrical system must ensure high electrical efficiency and should not exceed the weight of the substituted components To attend these high performance requirements a fault tolerant multiphase brushless DC machine was chosen for this research The present work introduces a six phase 600W brushless DC machine with 8 poles The main challenge for the control issues of this machine is the mutual magnetic coupling between the phases due to the wave winding machine configuration In this context theoretical and practical investigations of different current control strategies based on the sliding mode control approach applied to the six phase brushless DC machine are presented

**Advanced Control of Piezoelectric Micro-/Nano-Positioning Systems** Qingsong Xu, Kok Kiong Tan, 2015-08-28 This book explores emerging methods and algorithms that enable precise control of micro nano positioning systems The text describes three control strategies hysteresis model based feedforward control and hysteresis model free feedback control based on and free from state observation Each paradigm receives dedicated attention within a particular part of the text Readers are shown how to design validate and apply a variety of new control approaches in micromanipulation hysteresis modelling discrete time sliding mode control and model reference adaptive control Experimental results are provided throughout and build up to a detailed treatment of practical applications in the fourth part of the book The applications focus on control of piezoelectric grippers Advanced Control of Piezoelectric Micro Nano Positioning Systems will assist academic researchers and practising control and mechatronics engineers interested in

suppressing sources of nonlinearity such as hysteresis and drift when combining position and force control of precision systems with piezoelectric actuation

### **Discrete-Time Sliding Mode Protocols for Discrete Multi-Agent System**

Keyurkumar Patel, Axaykumar Mehta, 2020-08-27 This book presents few novel Discrete time Sliding Mode DSM protocols for leader following consensus of Discrete Multi Agent Systems DMASs. The protocols intend to achieve the consensus in finite time steps and also tackle the corresponding uncertainties. Based on the communication graph topology of multi agent systems the protocols are divided into two groups namely i Fixed graph topology and ii Switching graph topology. The coverage begins with the design of Discrete time Sliding Mode DSM protocols using Gao's reaching law and power rate reaching law for the synchronization of linear DMASs by using the exchange of information between the agents and the leader to achieve a common goal. Then in a subsequent chapter analysis for no. of fixed time steps required for the leader following consensus is presented. The book also includes chapters on the design of Discrete time Higher order Sliding Mode DHSM protocols, Event triggered DSM protocols for the leader following consensus of DMASs. A chapter is also included on the design of DHSM protocols for leader following consensus of heterogeneous DMASs. Special emphasis is given to the practical implementation of each proposed DSM protocol for achieving leader following consensus of helicopter systems, flexible joint robotic arms and rigid joint robotic arms. This book offers a ready reference guide for graduate students and researchers working in the areas of control automation and communication engineering and in particular the cooperative control of multi agent systems. It will also benefit professional engineers working to design and implement robust controllers for power systems, autonomous vehicles, military surveillance, smartgrids, microgrids, vehicle traffic management, robotic teams and aerial robots.

### **Investigation of Spatial Control Strategies with Application to Advanced Heavy Water Reactor**

Ravindra Munje, Balasaheb Patre, Akhilanand Tiwari, 2017-10-13 This book examines the different spatial control techniques for regulation of spatial power distribution in advanced heavy water reactors AHWR. It begins with a review of the literature pertinent to the modeling and control of large reactors. It also offers a nodal core model based on finite difference approximation since the AHWR core is considered to be divided into 17 relatively large nodes. Further it introduces a nonlinear model characterizing important thermal hydraulics parameters of AHWR and integrates it into the neutronics model to obtain a coupled neutronics thermal hydraulics model of AHWR. The book also presents a vectorized nonlinear model of AHWR and implements it in MATLAB Simulink environment. The model of the reactor is then linearized at the rated power and put into standard state variable form. It is characterized by 90 states, 5 inputs and 18 outputs. Lastly it discusses control techniques for a nonlinear model of AHWR. This book will prove to be a valuable resource for professional engineers and implementation specialists, researchers and students.

### **Output Sampling Based Sliding Mode Control for Discrete**

**Time Systems** Srinath Govindaswamy, 2012

### **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 Applied

Electromagnetics and Computational Technology II Hajime Tsuboi, I. Vajda, 2000 The Fifth Japan Hungary Joint Seminar on Applied Electromagnetics in Materials and Computational Technology is held on September 24-26 1998 in Budapest Hungary The Seminar is organised by the Super Tech Consortium Hungary the Hungarian Society of Applied Electronics Hungary and the Japan Society of Applied Electromagnetics and Mechanics Japan The objective of the Seminar is to stimulate the exchange of creative ideas to promote new achievements by bringing together the engineers and scientists of Japan and Hungary working in the field of applied electromagnetics and related areas as well as to discuss the topics of future co operative research A special attention will be paid for the work of young scientists The scientific program covers the following topics Numerical Analysis of Electromagnetic Fields Material Modelling in Electromagnetic Fields Electromagnetic Non destructive Testing and Inverse Problems High Tc Superconducting Materials and Applications Controlled Electrical Drives This book will be published as the Proceedings of the Fifth Japan Hungary Joint Seminar including the selected papers which are presented at the Seminar

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## **Table of Contents Discretetime Sliding Mode Control**

1. Understanding the eBook Discretetime Sliding Mode Control
  - The Rise of Digital Reading Discretetime Sliding Mode Control
  - Advantages of eBooks Over Traditional Books
2. Identifying Discretetime Sliding Mode Control
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Discretetime Sliding Mode Control
  - User-Friendly Interface
4. Exploring eBook Recommendations from Discretetime Sliding Mode Control
  - Personalized Recommendations
  - Discretetime Sliding Mode Control User Reviews and Ratings
  - Discretetime Sliding Mode Control and Bestseller Lists
5. Accessing Discretetime Sliding Mode Control Free and Paid eBooks
  - Discretetime Sliding Mode Control Public Domain eBooks
  - Discretetime Sliding Mode Control eBook Subscription Services
  - Discretetime Sliding Mode Control Budget-Friendly Options

6. Navigating Discretetime Sliding Mode Control eBook Formats
  - ePub, PDF, MOBI, and More
  - Discretetime Sliding Mode Control Compatibility with Devices
  - Discretetime Sliding Mode Control Enhanced eBook Features
7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Discretetime Sliding Mode Control
  - Highlighting and Note-Taking Discretetime Sliding Mode Control
  - Interactive Elements Discretetime Sliding Mode Control
8. Staying Engaged with Discretetime Sliding Mode Control
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Discretetime Sliding Mode Control
9. Balancing eBooks and Physical Books Discretetime Sliding Mode Control
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Discretetime Sliding Mode Control
10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
11. Cultivating a Reading Routine Discretetime Sliding Mode Control
  - Setting Reading Goals Discretetime Sliding Mode Control
  - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Discretetime Sliding Mode Control
  - Fact-Checking eBook Content of Discretetime Sliding Mode Control
  - Distinguishing Credible Sources
13. Promoting Lifelong Learning
  - Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
14. Embracing eBook Trends
  - Integration of Multimedia Elements

- Interactive and Gamified eBooks

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for immigration you would be helping someone whether a family member friend or employee with their immigration application

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