



# Sliding Mode Control In Engineering

**William S. Levine**



## **Sliding Mode Control In Engineering:**

**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 equations

**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

**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

**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

**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

**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

**Sliding Modes in Control and Optimization** Vadim I. Utkin, 2013-03-12 The book is devoted to systems with discontinuous control The study of discontinuous dynamic systems is a multifacet problem which embraces mathematical control theoretic and application

aspects Times and again this problem has been approached by mathematicians physicists and engineers each profession treating it from its own positions Interestingly the results obtained by specialists in different disciplines have almost always had a significant effect upon the development of the control theory It suffices to mention works on the theory of oscillations of discontinuous nonlinear systems mathematical studies in ordinary differential equations with discontinuous righthand parts or variational problems in nonclassic statements The unremitting interest to discontinuous control systems enhanced by their effective application to solution of problems most diverse in their physical nature and functional purpose is in the author's opinion a cogent argument in favour of the importance of this area of studies It seems a useful effort to consider from a control theoretic viewpoint the mathematical and application aspects of the theory of discontinuous dynamic systems and determine their place within the scope of the present day control theory The first attempt was made by the author in 1975 1976 in his course on The Theory of Discontinuous Dynamic Systems and The Theory of Variable Structure Systems read to post graduates at the University of Illinois USA and then presented in 1978 1979 at the seminars held in the Laboratory of Systems with Discontinuous Control at the Institute of Control Sciences in Moscow

**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 graduate level textbook for a first course on sliding mode control

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

*Recent Developments in Sliding Mode Control*

Andrzej Bartoszewicz, 2017-06-28 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

**Modelling and Control of Mechatronic and Robotic Systems** Alessandro Gasparetto,Stefano Seriani,2021-09-02  
Currently the modelling and control of mechatronic and robotic systems is an open and challenging field of investigation in both industry and academia The book encompasses the kinematic and dynamic modelling analysis design and control of mechatronic and robotic systems with the scope of improving their performance as well as simulating and testing novel devices and control architectures A broad range of disciplines and topics are included such as robotic manipulation mobile systems cable driven robots wearable and rehabilitation devices variable stiffness safety oriented mechanisms optimization of robot performance and energy saving systems     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 equations over non Archimedean fields in relation to Markov processes     Systems, Automation and Control Nabil Derbel,Faouzi Derbel,Olfar Kanoun,2017-12-04 The fifth volume of the Series Advances in Systems Signals and Devices is dedicated to fields related to Systems Automation and Control The scope of this issue encompasses all aspects of the research development and applications of the science and technology in these fields Topics of this issue concern system design system identification biological and economical models control modern control theory nonlinear observers control and application of chaos adaptive non adaptive backstepping control techniques advances in linear control theory systems optimization multivariable control large scale and infinite dimension systems nonlinear control distributed control predictive control geometric control adaptive control optimal and stochastic control robust control neural control fuzzy control intelligent control systems diagnostics fault tolerant control robotics and mechatronics navigation robotics and human machine interaction hierarchical and man machine systems etc Authors are encouraged to submit novel contributions which include results of research or experimental work discussing new developments in the field of systems automation and control The series can be also addressed for editing special issues for novel developments in specific fields The aim of this volume is to promote an international scientific progress in the fields of systems automation and control It provides at the same time an opportunity to be informed about interesting results that have been reported during the international SSD conferences

*Recent Developments in Control, Automation and Power Engineering* Hemender Pal Singh,Ishak B. Aris,Anwar Shahzad

Siddiqui,2025-05-23 This book contains original peer reviewed research papers from the 5th international conference RDCAPE 2023 This book presents the latest developments in the field of electrical engineering and related areas distinctively and engagingly The book discusses issues related to new challenges of renewable energy new control paradigms for efficient automation and decentralized power systems new economics of open auction based electricity generation transmission and distribution markets etc Apart from these many other topics of interest for readers are also covered The papers presented here share the latest findings on various issues as mentioned above It makes the book a useful resource for researchers scientists industry people and students alike *Recent Advances in Engineering Mathematics and Physics* Mohamed Hesham Farouk,Maha Amin Hassanein,2020-08-03 This book gathers the proceedings of the 4th conference on Recent Advances in Engineering Math computational intelligence photonics physical measurements and big data analytics physics and nano technologies and optimization and mathematical analysis **The Control Handbook (three volume set)** William S. Levine,2018-10-08 At publication The Control Handbook immediately became the definitive resource that engineers working with modern control systems required Among its many accolades that first edition was cited by the AAP as the Best Engineering Handbook of 1996 Now 15 years later William Levine has once again compiled the most comprehensive and authoritative resource on control engineering He has fully reorganized the text to reflect the technical advances achieved since the last edition and has expanded its contents to include the multidisciplinary perspective that is making control engineering a critical component in so many fields Now expanded from one to three volumes The Control Handbook Second Edition brilliantly organizes cutting edge contributions from more than 200 leading experts representing every corner of the globe They cover everything from basic closed loop systems to multi agent adaptive systems and from the control of electric motors to the control of complex networks Progressively organized the three volume set includes Control System Fundamentals Control System Applications Control System Advanced Methods Any practicing engineer student or researcher working in fields as diverse as electronics aeronautics or biomedicine will find this handbook to be a time saving resource filled with invaluable formulas models methods and innovative thinking In fact any physicist biologist mathematician or researcher in any number of fields developing or improving products and systems will find the answers and ideas they need As with the first edition the new edition not only stands as a record of accomplishment in control engineering but provides researchers with the means to make further advances **Model-based calibration of automated transmissions** Huang, Hua,2016-11-18 With continuous restrictions on emission standards and demands for higher driving comfort the calibration of shift quality is linked deeply and widely to automated transmission control algorithms This calibration process is typically implemented with real vehicles on the road under poorly reproducible conditions where the calibration engineer has no other choice but to try different control parameters till the subjective assessment on the shift quality meets certain requirements such as shifting comfort or sportiness Compared with today s multiplying number of variants in vehicle engine transmission

combinations and exponential growth of control parameters this traditional method is backward and costly. An efficient way to rise to the challenge is the model based automatic calibration. In contrast to the conventional shift quality calibration this novel method uses a closed loop approach based on a dynamic model instead of human know how. A shift quality correlated position trajectory is proposed. Compared to the traditional control parameter adjustment method the guided trajectory has a higher tolerance to the system's hardware components and a better compatibility with TCUs from diverse suppliers. Since shift quality is not restricted to a general summarized grade e.g. comfort and sportiness are always two conflicting influence factors in the terms of shift quality calibrations a multi objective evolutionary algorithm is applied to search the set of Pareto optimal front which includes all the optimal compromised control parameters of the gear shifting trajectory for possible choice. In this work a hydro mechanical AMT synchronization system is used as an example to explain the proposed optimization process. A Modelica based non linear hydro mechanical AMT system is modeled which describes the transient behavior during gear shifting in detail. An effective fuzzy sliding mode position controller is designed for the referenced position tracking during synchronization in contrast to the conventional trial and error tuning method a genetic algorithm is applied to automatically identify and optimize the sliding mode controller parameters. A novel multi objective evolutionary algorithm MLIA is developed to find out the optimal control set for the synchronization trajectories. Verification at a transmission test bench shows that this model based multi objective optimization method has a guiding capability in automated transmission calibration.

Mit deutlich strengeren gesetzlichen Anforderungen hinsichtlich der Abgasemissionen und einer zunehmend anspruchsvolleren Nachfrage bezüglich des Fahrkomforts rückt die Frage nach der Schaltqualität stärker in den Fokus der Getriebeentwicklung. Die Kalibrierung umgangssprachlich die Applikation ist deshalb ein Schwerpunkt bei der Entwicklung von Algorithmen für die Schaltqualität von automatisierten Getriebesteuerungen. Der Kalibrierungsprozess wird in der Regel im Fahrzeugversuch auf der Straße durchgeführt. Der Applikationsingenieur versucht unter diesen nicht reproduzierbaren Bedingungen verschiedene Steuerparameter zu adaptieren. Dies wird für eine Schaltung solange durchgeführt bis die subjektive Beurteilung der Schaltqualität und die zugehörigen Eigenschaften wie zum Beispiel Schaltkomfort und Sportlichkeit erfüllt ist. Dieser beschriebene Prozess ist zeit und personalaufwendig was mit dem aktuellen Angebot an Motor Getriebe Fahrzeugvarianten kaum bewältigt werden kann. Als weitere Herausforderung steigt die Anzahl der kalibrierbaren Parameter der Regler und Steuerungsmethoden stetig um die Kundenbedürfnisse zu befriedigen weshalb auch aus Kostensicht ein besserer Prozess gefunden werden muss. Eine effiziente Möglichkeit zur Lösung der skizzierten Problemstellungen ist die modellbasierte automatische Kalibrierung. Im Gegensatz zu der herkömmlich auf Fahrversuche basierende Kalibrierung der Schaltqualität verwendet dieses neue Verfahren ein dynamisches Modell in einer geschlossenen Schleife. Anstelle des Applikationsingenieurs für die Fahrvorgaben wird in der Schleife ein Fahrerregler und ein Optimierungsalgorithmus verwendet um so eine hohe Reproduzierbarkeit des Schaltereignisses sicherzustellen. Es wird

vorgeschlagen die Bewegung der Schaltstellung zu optimieren da diese mit der Schaltqualität korreliert. Diametral steht dem die allgemein übliche Regleranpassung verschiedener Parameter für die Synchronisation gegenüber. Die vorgeschlagene Methode der geplanten Schaltbewegung weist eine deutlich höhere Toleranz gegenüber der Varianz an Hardwarekomponenten und damit eine bessere Kompatibilität zu den Getriebesteuergeräten TCUs verschiedener Lieferanten auf. Die Schaltqualität lässt sich nicht auf ein subjektives Kriterium zusammenfassen es werden immer unterschiedliche Faktoren wie z.B. Komfort und Sportlichkeit den Schaltvorgang bestimmen. Deshalb wird für die Optimierung des Schaltvorgangs eine mehrkriterieller evolutionärer Algorithmus angewandt um die Paretofront zu identifizieren was alle Kompromisse der Schaltbewegungsregelung einschließt. Es wird ein Modell eines hydromechanischen Synchronisationssystems für ein automatisiertes Getriebe als Beispielanwendung benutzt um den vorgeschlagenen Optimierungsprozess zu demonstrieren. Das nichtlineare hydromechanische Synchronisationssystem wird mit der objektorientierten Sprache Modelica modelliert. Mit dem Modell werden Schaltvorgänge detailliert beschrieben. Ein Fuzzy Sliding Mode Regler wird für die jeweilige Bewegung der Schaltung während der Synchronisation benutzt. Im Gegensatz zur herkömmlichen empirischen Anpassung der Reglerparameter wird ein genetischer Algorithmus angewendet um die automatische Erkennung und Bewertung der Parameter vom Fuzzy Sliding Mode Regler zu optimieren. Ein neuartiger evolutionärer mehrkriterieller Algorithmus MLIA wurde angewandt um eine optimale Bewegung der Schaltstellung während der Synchronisierung zu finden. Die Validierung am Getriebeprüfstand zeigt dass diese modellbasierte Methode der mehrkriteriellen Optimierung in der automatisierten Getriebekalibrierung eine deutliche Verbesserung darstellt.

**Advanced Intelligent Computing Theories and Applications** De-Shuang Huang, Laurent Heutte, Marco Loog, 2007-08-10 This volume in conjunction with the two volumes LNCS 4681 and LNAI 4682 constitutes the refereed proceedings of the Third International Conference on Intelligent Computing held in Qingdao China in August 2007. The conference sought to establish contemporary intelligent computing techniques as an integral method that underscores trends in advanced computational intelligence and links theoretical research with applications.

**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.

*Nonlinear Control Systems 2004* Frank Allgower, Michael

Zeitz,2005-02-02

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