

## Sliding Mode Neurocontrol with Applications

Alexander Poznyak, Isaac Chairez<sup>(1)</sup>, Tatyana Poznyak<sup>(2)</sup>

**Abstract**—In this study the tracking problem for a class of nonlinear uncertain systems is tackled. A new sliding mode neurocontroller is suggested to solve this problem. The designing of this controller includes the construction of on-line state estimates and the corresponding tracking control based on sliding mode approach using obtained state estimates. We apply a special sliding mode technique during the “off-line training” to estimate the right-hand side of the given dynamics in finite-time and then to use these estimates for the best (in LQ-sense) nominal weights selection in the designed neuro observer. A switching (sign) type term is incorporated in to the observer structure to correct the current state estimates using only available and on-line measurable output data supplied with a new learning procedure with a relay term. The illustrative example dealing with a real water sanitation process is presented.

### I. INTRODUCTION

Over the past decades, considerable research efforts had been undertaken on control design for uncertain nonlinear dynamic systems. Uncertainties in dynamic systems, commonly occurred in actual applications, provoke considerable troubles in any control realization being a source of instability or poor performance. Several approaches are known to synthesize a control in this situation. Two most effective of them, as it is widely recognized, are the Neural Network Approach and the Sliding Mode technique. Practically, there are few publications considering the application of both of them simultaneously [13], [10]. Such combinations of basic ideas of both methods seems to be very promising providing a new instrument for identification and control of a wide class of systems with uncertainties. This paper presents the realization of this idea and suggests the control design based on both *Dynamic Neural Network Observation* and *Sliding Mode Technique*, applied to the obtained neural network model. Below this approach is referred to as *Sliding Mode Neurocontrol*.

Research on *adaptive output feedback control of uncertain nonlinear dynamic systems* is of paramount importance today, particularly considering the growing interest in the use of unconventional control devices such as chemical sensors, piezoelectric actuators, etc. In a large number of practical problems there are important disturbances, uncertainties or several parameter variations. In these situations a solution of the control problem is given by the, so-called, unconventional adaptive control supplied by a mechanism for

adjusting the parameters of controllers [1]. A solution of the output feedback stabilization problem for systems in which nonlinearities depend only upon the available measurement, is given in [14]. In [8], backstepping -based approach is used and its extension is in [6], [7] and [17].

There exists another effective approach to identify and control a wide class of unknown systems: it is *Sliding Mode Control* (SMC) [18] which applies the relay (discontinuous) feedback to reach and maintain the closed-loop dynamics on a certain manifold (in the state space) with a corresponding desired properties. This control offers significant potential advantages comparing to other identification and control techniques: good transient behavior, global exponential stability of a small estimation error, no modeled disturbance rejection capability, insensitivity to plant nonlinearities or parameter variations and remarkable stability and performance robustness [16], [18]. In this study we suggest a dynamic neuro observer (see the subsection below), which incorporates switching type term to correct current state estimates using only available measurable output data.

Artificial Neural Networks (NN) have shown good identification properties in the presence of some uncertainties or external disturbances. There are known two type of NN: *static* one, using the, so-called, back-propagation technique [5] and *dynamic* neural networks (DNN), [15]. The first one deal with the class of global optimization problems trying to adjust the weights of such NN to minimize an identification error. The second approach, exploiting the feedback properties of the applied DNN, permits to avoid many problems related to global extremum search converting the learning process to an adequate feedback design, [10], [9]. Several approaches dealing with state estimation problem are widely used in practical applications. Among them there are the Lie-algebraic method [7], Lyapunov-like observers [16], high gain observation [4], the reduced-order nonlinear observers [3] and others. Dynamic neuro-observers are studied in [10], [12] and [13].

#### A. Motivation

One of the most attractive feature of the SMC approach is its finite-time convergence for controlled trajectories to a desired sliding surface [18]. The realization of such control demands the complete knowledge of all current states of the system to be controlled. Obviously when dealing with SMC and only output (no state) information is available for a designer, it turns out to be useless when it's applied directly. Thus SMC application demands state observer designing to keep all its attractive features. When a nonlinear model of a controlled system is a priori unknown exactly, the state

<sup>(1)</sup>Department of Automatic Control, CINVESTAV-IPN, AP. 14740, Av. Instituto Politécnico Nacional No. 2508, C.P. 07360, México D.F., México, e-mail: apoznyak@ctrl.cinvestav.mx

<sup>(2)</sup>Superior School of Chemical Engineering and Extractive Industries (ESQIE-IPN), Edif. 7, UPALM, C.P. 07738, México, D.F., México, e-mail: tpoznyak@qspn.mx

# Neurocontrol And Its Applications

**Didier Musso**



## **Neurocontrol And Its Applications:**

## Decoding **Neurocontrol And Its Applications**: Revealing the Captivating Potential of Verbal Expression

In a period characterized by interconnectedness and an insatiable thirst for knowledge, the captivating potential of verbal expression has emerged as a formidable force. Its power to evoke sentiments, stimulate introspection, and incite profound transformations is genuinely awe-inspiring. Within the pages of "**Neurocontrol And Its Applications**," a mesmerizing literary creation penned by way of a celebrated wordsmith, readers embark on an enlightening odyssey, unraveling the intricate significance of language and its enduring affect our lives. In this appraisal, we shall explore the book is central themes, evaluate its distinctive writing style, and gauge its pervasive influence on the hearts and minds of its readership.

<https://staging.gilderlehrman.org/data/uploaded-files/index.jsp/rival%20rigelians%20agent%20x.pdf>

### **Table of Contents Neurocontrol And Its Applications**

1. Understanding the eBook Neurocontrol And Its Applications
  - The Rise of Digital Reading Neurocontrol And Its Applications
  - Advantages of eBooks Over Traditional Books
2. Identifying Neurocontrol And Its Applications
  - 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 Neurocontrol And Its Applications
  - User-Friendly Interface
4. Exploring eBook Recommendations from Neurocontrol And Its Applications
  - Personalized Recommendations
  - Neurocontrol And Its Applications User Reviews and Ratings
  - Neurocontrol And Its Applications and Bestseller Lists

5. Accessing Neurocontrol And Its Applications Free and Paid eBooks
  - Neurocontrol And Its Applications Public Domain eBooks
  - Neurocontrol And Its Applications eBook Subscription Services
  - Neurocontrol And Its Applications Budget-Friendly Options
6. Navigating Neurocontrol And Its Applications eBook Formats
  - ePub, PDF, MOBI, and More
  - Neurocontrol And Its Applications Compatibility with Devices
  - Neurocontrol And Its Applications Enhanced eBook Features
7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Neurocontrol And Its Applications
  - Highlighting and Note-Taking Neurocontrol And Its Applications
  - Interactive Elements Neurocontrol And Its Applications
8. Staying Engaged with Neurocontrol And Its Applications
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Neurocontrol And Its Applications
9. Balancing eBooks and Physical Books Neurocontrol And Its Applications
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Neurocontrol And Its Applications
10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
11. Cultivating a Reading Routine Neurocontrol And Its Applications
  - Setting Reading Goals Neurocontrol And Its Applications
  - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Neurocontrol And Its Applications
  - Fact-Checking eBook Content of Neurocontrol And Its Applications
  - 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

### **Neurocontrol And Its Applications Introduction**

Neurocontrol And Its Applications Offers over 60,000 free eBooks, including many classics that are in the public domain. Open Library: Provides access to over 1 million free eBooks, including classic literature and contemporary works. Neurocontrol And Its Applications Offers a vast collection of books, some of which are available for free as PDF downloads, particularly older books in the public domain. Neurocontrol And Its Applications : This website hosts a vast collection of scientific articles, books, and textbooks. While it operates in a legal gray area due to copyright issues, its a popular resource for finding various publications. Internet Archive for Neurocontrol And Its Applications : Has an extensive collection of digital content, including books, articles, videos, and more. It has a massive library of free downloadable books. Free-eBooks Neurocontrol And Its Applications Offers a diverse range of free eBooks across various genres. Neurocontrol And Its Applications Focuses mainly on educational books, textbooks, and business books. It offers free PDF downloads for educational purposes. Neurocontrol And Its Applications Provides a large selection of free eBooks in different genres, which are available for download in various formats, including PDF. Finding specific Neurocontrol And Its Applications, especially related to Neurocontrol And Its Applications, might be challenging as theyre often artistic creations rather than practical blueprints. However, you can explore the following steps to search for or create your own Online Searches: Look for websites, forums, or blogs dedicated to Neurocontrol And Its Applications, Sometimes enthusiasts share their designs or concepts in PDF format. Books and Magazines Some Neurocontrol And Its Applications books or magazines might include. Look for these in online stores or libraries. Remember that while Neurocontrol And Its Applications, sharing copyrighted material without permission is not legal. Always ensure youre either creating your own or obtaining them from legitimate sources that allow sharing and downloading. Library Check if your local library offers eBook lending services. Many libraries have digital catalogs where you can borrow Neurocontrol And Its Applications eBooks for free, including popular titles. Online Retailers: Websites like Amazon, Google Books, or Apple Books often sell eBooks. Sometimes, authors or publishers offer promotions or free periods for certain books. Authors Website Occasionally, authors provide excerpts or short stories for free on their websites. While this might not be the Neurocontrol And Its Applications full book , it can give you a taste of the authors writing style. Subscription Services Platforms like Kindle Unlimited or Scribd offer subscription-based access to a

wide range of Neurocontrol And Its Applications eBooks, including some popular titles.

## **FAQs About Neurocontrol And Its Applications Books**

1. Where can I buy Neurocontrol And Its Applications books? Bookstores: Physical bookstores like Barnes & Noble, Waterstones, and independent local stores. Online Retailers: Amazon, Book Depository, and various online bookstores offer a wide range of books in physical and digital formats.
2. What are the different book formats available? Hardcover: Sturdy and durable, usually more expensive. Paperback: Cheaper, lighter, and more portable than hardcovers. E-books: Digital books available for e-readers like Kindle or software like Apple Books, Kindle, and Google Play Books.
3. How do I choose a Neurocontrol And Its Applications book to read? Genres: Consider the genre you enjoy (fiction, non-fiction, mystery, sci-fi, etc.). Recommendations: Ask friends, join book clubs, or explore online reviews and recommendations. Author: If you like a particular author, you might enjoy more of their work.
4. How do I take care of Neurocontrol And Its Applications books? Storage: Keep them away from direct sunlight and in a dry environment. Handling: Avoid folding pages, use bookmarks, and handle them with clean hands. Cleaning: Gently dust the covers and pages occasionally.
5. Can I borrow books without buying them? Public Libraries: Local libraries offer a wide range of books for borrowing. Book Swaps: Community book exchanges or online platforms where people exchange books.
6. How can I track my reading progress or manage my book collection? Book Tracking Apps: Goodreads, LibraryThing, and Book Catalogue are popular apps for tracking your reading progress and managing book collections. Spreadsheets: You can create your own spreadsheet to track books read, ratings, and other details.
7. What are Neurocontrol And Its Applications audiobooks, and where can I find them? Audiobooks: Audio recordings of books, perfect for listening while commuting or multitasking. Platforms: Audible, LibriVox, and Google Play Books offer a wide selection of audiobooks.
8. How do I support authors or the book industry? Buy Books: Purchase books from authors or independent bookstores. Reviews: Leave reviews on platforms like Goodreads or Amazon. Promotion: Share your favorite books on social media or recommend them to friends.
9. Are there book clubs or reading communities I can join? Local Clubs: Check for local book clubs in libraries or community centers. Online Communities: Platforms like Goodreads have virtual book clubs and discussion groups.

10. Can I read Neurocontrol And Its Applications books for free? Public Domain Books: Many classic books are available for free as they're in the public domain. Free E-books: Some websites offer free e-books legally, like Project Gutenberg or Open Library.

### **Find Neurocontrol And Its Applications :**

#### **rival rigelians agent x**

*robert smythson and the elizabethan country house*

*rivers in action earths changing landscape s.*

robert silverbergs worlds of wonder first british edition

#### **robert guthrie the pku story**

#### **riviera liaisons**

~~roar and more~~

roanoke warrior

road dreams

*roadside revenants and other north carolina ghosts and legends*

#### **road-maps to prosperity**

~~riverside mathematics~~

roald amundsens siste ferd

*robert boyle a free enquiry into the vulgarly received notion of nature*

road to purgatory arc

### **Neurocontrol And Its Applications :**

Lab Equipment Worksheet Answer Key Lovely 9 Best Of ... Lab Equipment Worksheet Answer Key New Laboratory Apparatus Worksheet Answers ... Lab Equipment Worksheet Answer Key Lovely 9 Best Of Chemistry Lab Equipment ... Chemistry laboratory manual answer key: Fill out & sign ... Edit, sign, and share chemistry lab manual answers online. No need to install software, just go to DocHub, and sign up instantly and for free. Chemistry Lab Homework Help & Answers 24/7 Homework Q&A. chemistry lab. answers. Get chemistry lab help — Post your chemistry lab homework questions and get answers from qualified tutors. Solutions Lab Report - Laboratory Activity - Xavion Fletcher ... Instructions: In this laboratory activity, you will investigate how temperature, agitation, particle size, and dilution affect the taste of a drink. Lab Equipment

Worksheet Answer Key New ... 9 Best of Chemistry Lab Equipment Worksheet from lab equipment worksheet answer key , image source: www.worksheeto.com. Ap Chemistry Unit 6 Lab Answers - 688 Words Free Essay: Leticia Glass Intro to Chemistry Lab 3 Pre-Lab Questions: 1. What is the importance of significant figures in chemistry? The importance of... Safety in the Chemistry Laboratory by S Equipment — General. • All students must pass the Safety Quiz and sign a Safety Agreement before working in the lab. • State and Federal law require the use of splash ... Ex. 7 Answers .docx - Ex. 7 Answer Sheet- Hands on Labs... 7 Answer Sheet- Hands on Labs Getting Started, Rules for Success, and Lab Kit Safety ... Chemistry: An Introduction to General, Organic, and Biological Chemistry. Lab homework help: get your Lab answers here Search our homework answers. The answer you are looking for might already be there. FIAT M100 M115 M135 M160 Tractor Fiat Tractor M100 M115 M135 M160 service repair workshop manual book 6035432100. ... FIAT TRACTOR SERIES M SERVICE MANUAL Form no. 6035432100. Models: M100 & M115 ... New Holland CE 100-B, M100 Service Manual New Holland CE 100-B, M100 Motor Graders Repair Manual contains workshop manual, detailed removal, installation, disassembly and assembly, electrical wiring ... Service Repair Manual for Fiat Allis M100-B Motor Grader. This service repair manual is a must-have for owners of the Fiat Allis M100-B Motor Grader. It contains detailed information on maintaining and repairing the ... Fiat Allis M100 100-C 200-C Rear Wheel and Brake ... Used Fiat-Allis service manual for model M100/M100-B/100-C/150-C/200-C motor grader rear wheels and brakes. Manual number 70657712 dated 4/75. PDF Download | Motor grader, Repair manuals, Fiat Jan 19, 2022 - Fiat-Allis M100, 100-B, 100-C, 150-C, 200-C Motor Graders Service Repair Manual - PDF Download. New Holland M100 Manual - Flipbook by New Holland M100 Manual. Published on Oct 12,2015. New Holland M100 Manual Service Manual For New Holland Tractor 6635 - Educational ENGINE, 4835 W/ 8045.06 ... New Holland Tractor Manuals At Agrimanuals we supply manuals for all makes of tractors and farm machinery. We stock a wide range of construction machinery manuals ... New Holland Tractor 8160 8260 8360 8560 & M100 M115 ... WHILST THIS MANUAL IS NOT A FULL SERVICE MANUAL, WITH 100's & 100's OF PAGES IT DOES PROVIDE A LOT OF TECHNICAL INFORMATION AND. New Holland FiatAllis M100-B Motor Grader Hydraulic ... New Holland FiatAllis M100-B Motor Grader Hydraulic System Service Repair Manual (70651549) - PDF Download - HeyDownloads - Manual Downloads. New Holland Tractor 8160, 8260, 8360, 8560, M100, M115 ... Sep 14, 2022 — New Holland Tractor 8160, 8260, 8360, 8560, M100, M115, M135, M160 Service Manual 6035432000 Italian Size: 87.7 MB Format: pdf Kappa alpha psi scroller manual pdf: Fill out & sign online Edit, sign, and share kappa alpha psi scroller manual pdf online. No need to install software, just go to DocHub, and sign up instantly and for free. Kappa Alpha Psi Scroller Manual 1946 Phi Nu Pi ... This primer for the pledge offers history, exercises, and a test on the pledge's knowledge. This contains information not found in ANY of the history book ... The Scroller's Club Manual by Ricky of Shambala, via Flickr Jun 1, 2012 — Jun 2, 2012 - The Scroller's Club Manual by Ricky of Shambala, via Flickr. Winter Issue - National Founders Day The fraternity originally published “The Scroller of Kappa Alpha

Psi Fraternity, Inc. ... Scroller Club Manual. This manual was a guide which provided Scrollers ... The Scroller's Club Manual This book served as a guide for the pledging activities involved in preparing for initiation into Kappa Alpha Psi. Scrollers Club; Kappa Alpha PSI Fraternity Scrollers Club; Kappa Alpha PSI Fraternity ; T F P ; NYPL Catalog. This catalog provides online access to our holdings. Cataloging of the collection is ongoing ... 1964 SCROLLER CLUB HANDBOOK OF KAPPA ALPHA ... THE SCROLLER OF KAPPA ALPHA PSI edited by I W E Taylor, softbound, 108 pps., 6" by 9" cover, contents complete and binding good. Epub free Kappa alpha psi scrollers club manual (2023) Jun 9, 2023 — manual. Epub free Kappa alpha psi scrollers club manual (2023). The Scroller of Kappa Alpha Psi Fraternity, Inc Black Greek 101 Steppin' on ... Hymn Flashcards We'll keep thy faith and always will remember thee, dear scrollers club of noble Kappa Alpha Psi. ... KAPSI Study Guide. 138 terms. Profile Picture.