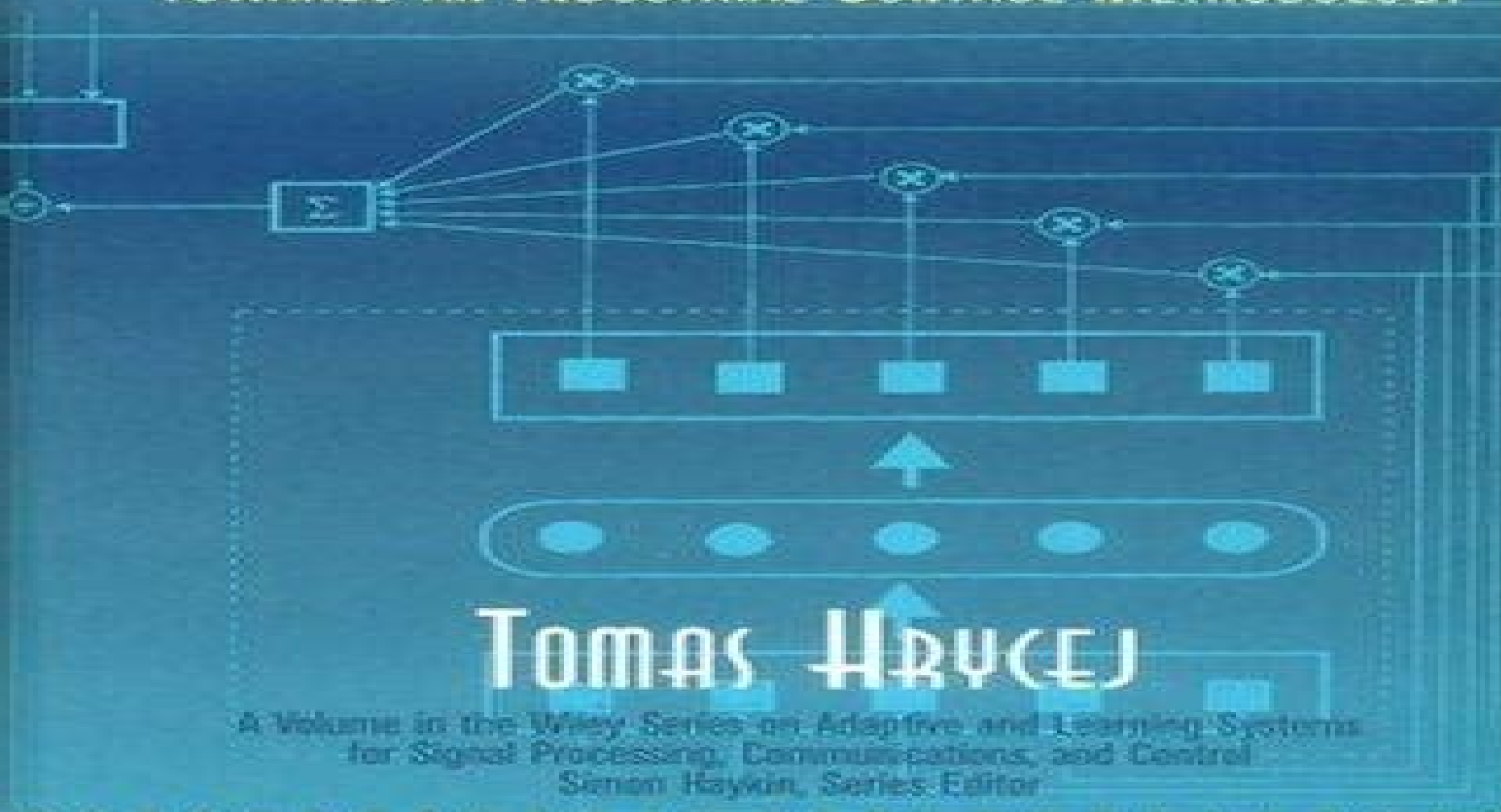


# NEUROCONTROL

TOWARDS AN INDUSTRIAL CONTROL METHODOLOGY



TOMAS HAYCEJ

A Volume in the Wiley Series on Adaptive and Learning Systems  
for Signal Processing, Communications, and Control  
Simon Haykin, Series Editor

# Neurocontrol Towards An Industrial Control Methodology

**Simon Haykin**



## **Neurocontrol Towards An Industrial Control Methodology:**

**Statistical Control** George E. P. Box, Alberto Luceño, 1997-09-22 A detailed practical accessible guide to efficient statistical control Efficient control is a key element in the improvement and maintenance of quality and productivity This book shows the advantages of bringing together the more commonly used methods of statistical quality control with appropriate techniques of feedback adjustment It uses recent research and practical experience to provide feedback methods of immediate use in the workplace Statistical Control by Monitoring and Feedback Adjustment introduces a new coordinated approach to quality control The authors clear and cogent presentation uses extensive graphical explanation supplemented by numerous examples and computational tables A helpful selection of problems and solutions further facilitates understanding Topics covered include A fresh look at process monitoring Using feedback adjustment charts Minimizing the size of adjustments Feedback techniques that minimize costs of adjustment and sampling Detection of special causes with Cuscore Statistics Efficient monitoring of operating feedback systems The roles of models optimization and robustness A brief review of time series analysis Statistical Control by Monitoring and Feedback Adjustment is important reading for quality control engineers and statisticians as well as graduate students in quality control industrial engineering and applied statistics

Kalman Filtering and Neural Networks Simon Haykin, 2004-03-24 State of the art coverage of Kalman filter methods for the design of neural networks This self contained book consists of seven chapters by expert contributors that discuss Kalman filtering as applied to the training and use of neural networks Although the traditional approach to the subject is almost always linear this book recognizes and deals with the fact that real problems are most often nonlinear The first chapter offers an introductory treatment of Kalman filters with an emphasis on basic Kalman filter theory Rauch Tung Striebel smoother and the extended Kalman filter Other chapters cover An algorithm for the training of feedforward and recurrent multilayered perceptrons based on the decoupled extended Kalman filter DEKF Applications of the DEKF learning algorithm to the study of image sequences and the dynamic reconstruction of chaotic processes The dual estimation problem Stochastic nonlinear dynamics the expectation maximization EM algorithm and the extended Kalman smoothing EKS algorithm The unscented Kalman filter Each chapter with the exception of the introduction includes illustrative applications of the learning algorithms described here some of which involve the use of simulated and real life data Kalman Filtering and Neural Networks serves as an expert resource for researchers in neural networks and nonlinear dynamical systems

**Neuro-Control and its Applications** Sigeru Omatu, Marzuki B. Khalid, Rubiyah Yusof, 2012-12-06 The series Advances in Industrial Control aims to report and encourage technology transfer in control engineering The rapid development of control technology impacts all areas of the control discipline New theory new controllers actuators sensors new industrial processes computer methods new applications new philosophies new challenges Much of this development work resides in industrial reports feasibility study papers and the reports of advance collaborative projects The series offers an opportunity for researchers to present an

extended exposition of such new work in all aspects of industrial control for wider and rapid dissemination Sigeru Omatu Marzuki Khalid and Rubiyah Yusof have pursued the new developments of fuzzy logic and neural networks to present a series volume on neuro control methods As they demonstrate in the opening pages of their book there is an explosion of interest in this field Publication and patent activity in these areas are ever growing according to international is timely databases and hence this volume The presentation of the material follows a complementary pattern Reviews of existing control techniques are given along side an exposition of the theoretical constructions of fuzzy logic controllers and controllers based on neural networks This is an extremely useful methodology which yields rewards in the applications chapters The series of applications includes one very thorough experimental sequence for the control of a hot water bath Neurocontrol Tomas Hrycej,1997-09-08 A complete guide to the design and implementation of successful neurocontrol applications Neurocontrol Towards an Industrial Control Methodology is the first and only volume that presents a unified framework for neural network based techniques It demystifies neurocontroller design and promotes the broad application of neurocontrol to nonlinear control problems Divided into two major parts the theoretical and the practical this book links neurocontrol with the concepts of classical control theory describes the steps necessary to implement a working algorithm and provides the information necessary to develop competitive applications of industrial size and complexity Throughout the focus is on the most important issues faced by control systems engineers working in this area including Fundamental approaches to neurocontrol viewed as optimization tasks Neural network architectures for neurocontrol Learning algorithms viewed as optimization algorithms Identification of plant models from measured data Training of an optimal neurocontroller Robustness adaptiveness stability and other special topics Implementation of neurocontrol applications Supplemented with case studies of real world industrial control applications from car drive train control to wastewater treatment plant control Neurocontrol is an important professional reference for control engineers in a wide range of industries as well as for automatic control and adaptive control researchers It is also an excellent text for graduate and senior undergraduate students in neurocontrol and automatic control *Mathematics Of Autonomy: Mathematical Methods For Cyber-physical-cognitive Systems* Vladimir G Ivancevic,Darryn J Reid,Michael J Pilling,2017-10-30 Mathematics of Autonomy provides solid mathematical foundations for building useful Autonomous Systems It clarifies what makes a system autonomous rather than simply automated and reveals the inherent limitations of systems currently incorrectly labeled as autonomous in reference to the specific and strong uncertainty that characterizes the environments they operate in Such complex real world environments demand truly autonomous solutions to provide the flexibility and robustness needed to operate well within them This volume embraces hybrid solutions to demonstrate extending the classes of uncertainty autonomous systems can handle In particular it combines physical autonomy robots cyber autonomy agents and cognitive autonomy cyber and embodied cognition to produce a rigorous subset of trusted autonomy Cyber Physical Cognitive autonomy CPC autonomy The body of the book

alternates between underlying theory and applications of CPC autonomy including Autonomous Supervision of a Swarm of Robots Using Wind Turbulence against a Swarm of UAVs and Unique Super Dynamics for All Kinds of Robots UAVs UGVs UUVs and USVs to illustrate how to effectively construct Autonomous Systems using this model It avoids the wishful thinking that characterizes much discussion related to autonomy discussing the hard limits and challenges of real autonomous systems In so doing it clarifies where more work is needed and also provides a rigorous set of tools to tackle some of the problem space

**Stable Adaptive Control and Estimation for Nonlinear Systems** Jeffrey T. Spooner, Manfredi Maggiore, Raúl Ordóñez, Kevin M. Passino, 2004-03-24 Thema dieses Buches ist die Anwendung neuronaler Netze und Fuzzy Logic Methoden zur Identifikation und Steuerung nichtlinear dynamischer Systeme Dabei werden fortgeschrittene Konzepte der herkömmlichen Steuerungstheorie mit den intuitiven Eigenschaften intelligenter Systeme kombiniert um praxisrelevante Steuerungsaufgaben zu lösen Die Autoren bieten viel Hintergrundmaterial ausgearbeitete Beispiele und Übungsaufgaben helfen Studenten und Praktikern beim Vertiefen des Stoffes Lösungen zu den Aufgaben sowie MATLAB Codebeispiele sind ebenfalls enthalten

Adaptive Control Design and Analysis Gang Tao, 2003-07-09 A systematic and unified presentation of the fundamentals of adaptive control theory in both continuous time and discrete time Today adaptive control theory has grown to be a rigorous and mature discipline As the advantages of adaptive systems for developing advanced applications grow apparent adaptive control is becoming more popular in many fields of engineering and science Using a simple balanced and harmonious style this book provides a convenient introduction to the subject and improves one's understanding of adaptive control theory Adaptive Control Design and Analysis features Introduction to systems and control Stability operator norms and signal convergence Adaptive parameter estimation State feedback adaptive control designs Parametrization of state observers for adaptive control Unified continuous and discrete time adaptive control L1 a robustness theory for adaptive systems Direct and indirect adaptive control designs Benchmark comparison study of adaptive control designs Multivariate adaptive control Nonlinear adaptive control Adaptive compensation of actuator nonlinearities End of chapter discussion problems and advanced topics As either a textbook or reference this self contained tutorial of adaptive control design and analysis is ideal for practicing engineers researchers and graduate students alike

**Bayesian Signal Processing** James V. Candy, 2016-06-20 Presents the Bayesian approach to statistical signal processing for a variety of useful model sets This book aims to give readers a unified Bayesian treatment starting from the basics Bayes's rule to the more advanced Monte Carlo sampling evolving to the next generation model based techniques sequential Monte Carlo sampling This next edition incorporates a new chapter on Sequential Bayesian Detection a new section on Ensemble Kalman Filters as well as an expansion of Case Studies that detail Bayesian solutions for a variety of applications These studies illustrate Bayesian approaches to real world problems incorporating detailed particle filter designs adaptive particle filters and sequential Bayesian detectors In addition to these major developments a variety of sections are expanded to fill in the gaps of

the first edition Here metrics for particle filter PF designs with emphasis on classical sanity testing lead to ensemble techniques as a basic requirement for performance analysis The expansion of information theory metrics and their application to PF designs is fully developed and applied These expansions of the book have been updated to provide a more cohesive discussion of Bayesian processing with examples and applications enabling the comprehension of alternative approaches to solving estimation detection problems The second edition of Bayesian Signal Processing features Classical Kalman filtering for linear linearized and nonlinear systems modern unscented and ensemble Kalman filters and the next generation Bayesian particle filters Sequential Bayesian detection techniques incorporating model based schemes for a variety of real world problems Practical Bayesian processor designs including comprehensive methods of performance analysis ranging from simple sanity testing and ensemble techniques to sophisticated information metrics New case studies on adaptive particle filtering and sequential Bayesian detection are covered detailing more Bayesian approaches to applied problem solving MATLAB notes at the end of each chapter help readers solve complex problems using readily available software commands and point out other software packages available Problem sets included to test readers knowledge and help them put their new skills into practice Bayesian Signal Processing Second Edition is written for all students scientists and engineers who investigate and apply signal processing to their everyday problems

*Nonlinear Dynamical Systems*  
Irwin W. Sandberg, James T. Lo, Craig L. Fancourt, José C. Principe, Shigeru Katagiri, Simon Haykin, 2001-02-21 The first truly up to date look at the theory and capabilities of nonlinear dynamical systems that take the form of feedforward neural network structures Considered one of the most important types of structures in the study of neural networks and neural like networks feedforward networks incorporating dynamical elements have important properties and are of use in many applications Specializing in experiential knowledge a neural network stores and expands its knowledge base via strikingly human routes through a learning process and information storage involving interconnection strengths known as synaptic weights In Nonlinear Dynamical Systems Feedforward Neural Network Perspectives six leading authorities describe recent contributions to the development of an analytical basis for the understanding and use of nonlinear dynamical systems of the feedforward type especially in the areas of control signal processing and time series analysis Moving from an introductory discussion of the different aspects of feedforward neural networks the book then addresses Classification problems and the related problem of approximating dynamic nonlinear input output maps The development of robust controllers and filters The capability of neural networks to approximate functions and dynamic systems with respect to risk sensitive error Segmenting a time series It then sheds light on the application of feedforward neural networks to speech processing summarizing speech related techniques and reviewing feedforward neural networks from the viewpoint of fundamental design issues An up to date and authoritative look at the ever widening technical boundaries and influence of neural networks in dynamical systems this volume is an indispensable resource for researchers in neural networks and a reference staple for libraries

*Modeling,*

*Diagnostics and Process Control* Józef Korbicz, Jan M. Koscielny, 2010-11-19 Modern control systems are complex in the sense of implementing numerous functions such as process variable processing digital control process monitoring and alarm indication graphic visualization of process running or data exchange with other systems or databases This book conveys a description of the developed DiaSter system as well as characteristics of advanced original methods of modeling knowledge discovery simulator construction process diagnosis as well as predictive and supervision control applied in the system The system allows early recognition of abnormal states of industrial processes along with faults or malfunctions of actuators as well as technological and measuring units The universality of solutions implemented in DiaSter facilitates its broad application for example in the power chemical pharmaceutical metallurgical and food industries The system is a world scale unique solution and due to its open architecture it can be connected practically with any other control systems The monograph presents theoretical and practical results of research into fault diagnosis and control conducted over many years within the cooperation of Polish research teams from the Warsaw University of Technology the University of Zielona G őr the Silesian University of Technology in Gliwice and the Technical University of Rzesz ów The book will be of great interest to researchers and advanced students in automatic control technical diagnostics and computer engineering and to engineers tasked with the development of advanced control systems of complex industrial processes

**Model-Based Signal Processing** James V. Candy, 2005-10-13 A unique treatment of signal processing using a model based perspective Signal processing is primarily aimed at extracting useful information while rejecting the extraneous from noisy data If signal levels are high then basic techniques can be applied However low signal levels require using the underlying physics to correct the problem causing these low levels and extracting the desired information Model based signal processing incorporates the physical phenomena measurements and noise in the form of mathematical models to solve this problem Not only does the approach enable signal processors to work directly in terms of the problem s physics instrumentation and uncertainties but it provides far superior performance over the standard techniques Model based signal processing is both a modeler s as well as a signal processor s tool Model Based Signal Processing develops the model based approach in a unified manner and follows it through the text in the algorithms examples applications and case studies The approach coupled with the hierarchy of physics based models that the author develops including linear as well as nonlinear representations makes it a unique contribution to the field of signal processing The text includes parametric e g autoregressive or all pole sinusoidal wave based and state space models as some of the model sets with its focus on how they may be used to solve signal processing problems Special features are provided that assist readers in understanding the material and learning how to apply their new knowledge to solving real life problems Unified treatment of well known signal processing models including physics based model sets Simple applications demonstrate how the model based approach works while detailed case studies demonstrate problem solutions in their entirety from concept to model development through simulation application to real data and

detailed performance analysis Summaries provided with each chapter ensure that readers understand the key points needed to move forward in the text as well as MATLAB r Notes that describe the key commands and toolboxes readily available to perform the algorithms discussed References lead to more in depth coverage of specialized topics Problem sets test readers knowledge and help them put their new skills into practice The author demonstrates how the basic idea of model based signal processing is a highly effective and natural way to solve both basic as well as complex processing problems Designed as a graduate level text this book is also essential reading for practicing signal processing professionals and scientists who will find the variety of case studies to be invaluable An Instructor s Manual presenting detailed solutions to all the problems in the book is available from the Wiley editorial department

### **Computational Intelligence in Automotive Applications**

Danil Prokhorov,2008-05-28 What is computational intelligence CI Traditionally CI is understood as a collection of methods from the elds of neural networks NN fuzzy logic and evolutionary computation Various de nitions and opinions exist but what belongs to CI is still being debated see e g 1 3 More recently there has been a proposal to de ne the CI not in terms of the tools but in terms of challenging problems to be solved 4 With this edited volume I have made an attempt to give a representative sample of contemporary CI activities in automotive applications to illustrate the state of the art While CI researchand achievements in some specialized elds described see e g 5 6 this is the rst volume of its kind dedicated to automotive technology As if re ecting the general lack of consensus on what constitutes the eld of CI this volume 1 illustrates automotive applications of not only neural and fuzzy computations which are considered to be the standard CI topics but also others such as decision trees graphicalmodels Support Vector Machines SVM multi agent systems etc This book is neither an introductory text nor a comprehensive overview of all CI research in this area Hopefully as a broad and representative sample of CI activities in automotive applications it will be worth reading for both professionals and students When the details appear insu cient the reader is encouraged to consult other relevant sources provided by the chapter authors

Autonomous Robots Research Advances Weihua Yang,2008 Autonomous robots are robots which can perform desired tasks in unstructured environments without continuous human guidance Many kinds of robots have some degree of autonomy Different robots can be autonomous in different ways A high degree of autonomy is particularly desirable in fields such as space exploration where communication delays and interruptions are unavoidable Some modern factory robots are autonomous within the strict confines of their direct environment The exact orientation and position of the next object of work and in the more advanced factories even the type of object and the required task must be determined This can vary unpredictably at least from the robot s point of view One important area of robotics research is to enable the robot to cope with its environment whether this be on land underwater in the air underground or in space This book presents the latest research from around the globe

Adaptive Approximation Based Control Jay A. Farrell,Marios M. Polycarpou,2006-04-20 A highly accessible and unified approach to the design and analysis of intelligent control systems Adaptive Approximation



Based Control is a tool every control designer should have in his or her control toolbox Mixing approximation theory parameter estimation and feedback control this book presents a unified approach designed to enable readers to apply adaptive approximation based control to existing systems and more importantly to gain enough intuition and understanding to manipulate and combine it with other control tools for applications that have not been encountered before The authors provide readers with a thought provoking framework for rigorously considering such questions as What properties should the function approximator have Are certain families of approximators superior to others Can the stability and the convergence of the approximator parameters be guaranteed Can control systems be designed to be robust in the face of noise disturbances and unmodeled effects Can this approach handle significant changes in the dynamics due to such disruptions as system failure What types of nonlinear dynamic systems are amenable to this approach What are the limitations of adaptive approximation based control Combining theoretical formulation and design techniques with extensive use of simulation examples this book is a stimulating text for researchers and graduate students and a valuable resource for practicing engineers

*Neural-Based Orthogonal Data Fitting* Giansalvo Cirrincione, Maurizio Cirrincione, 2011-04-06 The presentation of a novel theory in orthogonal regression The literature about neural based algorithms is often dedicated to principal component analysis PCA and considers minor component analysis MCA a mere consequence Breaking the mold Neural Based Orthogonal Data Fitting is the first book to start with the MCA problem and arrive at important conclusions about the PCA problem The book proposes several neural networks all endowed with a complete theory that not only explains their behavior but also compares them with the existing neural and traditional algorithms EXIN neurons which are of the authors invention are introduced explained and analyzed Further it studies the algorithms as a differential geometry problem a dynamic problem a stochastic problem and a numerical problem It demonstrates the novel aspects of its main theory including its applications in computer vision and linear system identification The book shows both the derivation of the TLS EXIN from the MCA EXIN and the original derivation as well as Shows TLS problems and gives a sketch of their history and applications Presents MCA EXIN and compares it with the other existing approaches Introduces the TLS EXIN neuron and the SCG and BFGS acceleration techniques and compares them with TLS GAO Outlines the GeTLS EXIN theory for generalizing and unifying the regression problems Establishes the GeMCA theory starting with the identification of GeTLS EXIN as a generalization eigenvalue problem In dealing with mathematical and numerical aspects of EXIN neurons the book is mainly theoretical All the algorithms however have been used in analyzing real time problems and show accurate solutions Neural Based Orthogonal Data Fitting is useful for statisticians applied mathematics experts and engineers

*Adaptive Signal Processing* Tulay Adali, Simon Haykin, 2010-06-25 Leading experts present the latest research results in adaptive signal processing Recent developments in signal processing have made it clear that significant performance gains can be achieved beyond those achievable using standard adaptive filtering approaches Adaptive Signal Processing presents the next

generation of algorithms that will produce these desired results with an emphasis on important applications and theoretical advancements This highly unique resource brings together leading authorities in the field writing on the key topics of significance each at the cutting edge of its own area of specialty It begins by addressing the problem of optimization in the complex domain fully developing a framework that enables taking full advantage of the power of complex valued processing Then the challenges of multichannel processing of complex valued signals are explored This comprehensive volume goes on to cover Turbo processing tracking in the subspace domain nonlinear sequential state estimation and speech bandwidth extension Examines the seven most important topics in adaptive filtering that will define the next generation adaptive filtering solutions Introduces the powerful adaptive signal processing methods developed within the last ten years to account for the characteristics of real life data non Gaussianity non circularity non stationarity and non linearity Features self contained chapters numerous examples to clarify concepts and end of chapter problems to reinforce understanding of the material Contains contributions from acknowledged leaders in the field Adaptive Signal Processing is an invaluable tool for graduate students researchers and practitioners working in the areas of signal processing communications controls radar sonar and biomedical engineering      Advances in Communications-Based Train Control Systems F. Richard Yu, 2015-11-05 With rapid population explosion improving rail transit speed and capacity is strongly desirable around the world Communication based train control CBTC is an automated train control system using high capacity bidirectional train ground communications to ensure the safe operation of rail vehicles This book presents the latest advances in CBTC      Radio Resource Management in Multi-Tier Cellular Wireless Networks Ekram Hossain, Long Bao Le, Dusit Niyato, 2013-11-25 Providing an extensive overview of the radio resource management problem in femtocell networks this invaluable book considers both code division multiple access femtocells and orthogonal frequency division multiple access femtocells In addition to incorporating current research on this topic the book also covers technical challenges in femtocell deployment provides readers with a variety of approaches to resource allocation and a comparison of their effectiveness explains how to model various networks using Stochastic geometry and shot noise theory and much more      Knowledge Based Radar Detection, Tracking and Classification Fulvio Gini, Muralidhar Rangaswamy, 2008-07-31 Discover the technology for the next generation of radar systems Here is the first book that brings together the key concepts essential for the application of Knowledge Based Systems KBS to radar detection tracking classification and scheduling The book highlights the latest advances in both KBS and radar signal and data processing presenting a range of perspectives and innovative results that have set the stage for the next generation of adaptive radar systems The book begins with a chapter introducing the concept of Knowledge Based KB radar The remaining nine chapters focus on current developments and recent applications of KB concepts to specific radar functions Among the key topics explored are Fundamentals of relevant KB techniques KB solutions as they apply to the general radar problem KBS applications for the constant false alarm rate processor KB control for space

time adaptive processing KB techniques applied to existing radar systems Integrated end to end radar signals Data processing with overarching KB control All chapters are self contained enabling readers to focus on those topics of greatest interest Each one begins with introductory remarks moves on to detailed discussions and analysis and ends with a list of references Throughout the presentation the authors offer examples of how KBS works and how it can dramatically improve radar performance and capability Moreover the authors forecast the impact of KB technology on future systems including important civilian military and homeland defense applications With chapters contributed by leading international researchers and pioneers in the field this text is recommended for both students and professionals in radar and sonar detection tracking and classification and radar resource management **Complex Valued Nonlinear Adaptive Filters** Danilo P.

Mandic, Vanessa Su Lee Goh, 2009-04-20 This book was written in response to the growing demand for a text that provides a unified treatment of linear and nonlinear complex valued adaptive filters and methods for the processing of general complex signals circular and noncircular It brings together adaptive filtering algorithms for feedforward transversal and feedback architectures and the recent developments in the statistics of complex variable under the powerful frameworks of CR Wirtinger calculus and augmented complex statistics This offers a number of theoretical performance gains which is illustrated on both stochastic gradient algorithms such as the augmented complex least mean square ACLMS and those based on Kalman filters This work is supported by a number of simulations using synthetic and real world data including the noncircular and intermittent radar and wind signals

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### Neurocontrol Towards An Industrial Control Methodology Introduction

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
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