

MATHEMATICAL MODELLING: THEORY AND APPLICATIONS

NONLINEAR SYSTEM IDENTIFICATION – INPUT-OUTPUT MODELING APPROACH

Volume 2: Nonlinear System Structure
Identification

Robert Haber and László Keviczky

Kluwer Academic Publishers

Nonlinear System Identification Input Output Modeling Approach

**Allamaraju Subrahmanyam, Ganti
Prasada Rao**



Nonlinear System Identification Input Output Modeling Approach:

Nonlinear System Identification — Input-Output Modeling Approach Robert Haber, L. Keviczky, 1999-07-31 The subject of the book is to present the modeling parameter estimation and other aspects of the identification of nonlinear dynamic systems The treatment is restricted to the input output modeling approach Because of the widespread usage of digital computers discrete time methods are preferred Time domain parameter estimation methods are dealt with in detail frequency domain and power spectrum procedures are described shortly The theory is presented from the engineering point of view and a large number of examples of case studies on the modeling and identifications of real processes illustrate the methods Almost all processes are nonlinear if they are considered not merely in a small vicinity of the working point To exploit industrial equipment as much as possible mathematical models are needed which describe the global nonlinear behavior of the process If the process is unknown or if the describing equations are too complex the structure and the parameters can be determined experimentally which is the task of identification The book is divided into seven chapters dealing with the following topics 1 Nonlinear dynamic process models 2 Test signals for identification 3 Parameter estimation methods 4 Nonlinearity test methods 5 Structure identification 6 Model validity tests 7 Case studies on identification of real processes Chapter I summarizes the different model descriptions of nonlinear dynamical systems

Nonlinear System Identification: Nonlinear system parameter identification Robert Haber, László Keviczky, 1999 The first of two volumes this handbook presents a comprehensive overview of nonlinear dynamic system parameter identification The volumes cover many aspects of nonlinear processes including modelling parameter estimation structure search nonlinearity and model validity tests

Nonlinear System Identification Oliver Nelles, 2013-03-09 Written from an engineering point of view this book covers the most common and important approaches for the identification of nonlinear static and dynamic systems The book also provides the reader with the necessary background on optimization techniques making it fully self contained The new edition includes exercises

Nonlinear System Identification Stephen A. Billings, 2013-09-23 Nonlinear System Identification NARMAX Methods in the Time Frequency and Spatio Temporal Domains describes a comprehensive framework for the identification and analysis of nonlinear dynamic systems in the time frequency and spatio temporal domains This book is written with an emphasis on making the algorithms accessible so that they can be applied and used in practice Includes coverage of The NARMAX nonlinear autoregressive moving average with exogenous inputs model The orthogonal least squares algorithm that allows models to be built term by term where the error reduction ratio reveals the percentage contribution of each model term Statistical and qualitative model validation methods that can be applied to any model class Generalised frequency response functions which provide significant insight into nonlinear behaviours A completely new class of filters that can move split spread and focus energy The response spectrum map and the study of sub harmonic and severely nonlinear systems Algorithms that can track rapid time variation in both linear and nonlinear systems The important

class of spatio temporal systems that evolve over both space and time Many case study examples from modelling space weather through identification of a model of the visual processing system of fruit flies to tracking causality in EEG data are all included to demonstrate how easily the methods can be applied in practice and to show the insight that the algorithms reveal even for complex systems NARMAX algorithms provide a fundamentally different approach to nonlinear system identification and signal processing for nonlinear systems NARMAX methods provide models that are transparent which can easily be analysed and which can be used to solve real problems This book is intended for graduates postgraduates and researchers in the sciences and engineering and also for users from other fields who have collected data and who wish to identify models to help to understand the dynamics of their systems **Block-oriented Nonlinear System Identification**

Fouad Giri,Er-Wei Bai,2010-08-18 Block oriented Nonlinear System Identification deals with an area of research that has been very active since the turn of the millennium The book makes a pedagogical and cohesive presentation of the methods developed in that time These include iterative and over parameterization techniques stochastic and frequency approaches support vector machine subspace and separable least squares methods blind identification method bounded error method and decoupling inputs approach The identification methods are presented by authors who have either invented them or contributed significantly to their development All the important issues e g input design persistent excitation and consistency analysis are discussed The practical relevance of block oriented models is illustrated through biomedical physiological system modelling The book will be of major interest to all those who are concerned with nonlinear system identification whatever their activity areas This is particularly the case for educators in electrical mechanical chemical and biomedical engineering and for practising engineers in process aeronautic aerospace robotics and vehicles control Block oriented Nonlinear System Identification serves as a reference for active researchers new comers industrial and education practitioners and graduate students alike **Nonlinear system identification. 2. Nonlinear system structure identification**

Robert Haber,László Keviczky,1999 This is the second part of a two volume handbook presenting a comprehensive overview of nonlinear dynamic system identification The books include many aspects of nonlinear processes such as modelling parameter estimation structure search nonlinearity and model validity tests *Nonlinear system identification. 1. Nonlinear system parameter identification*

Robert Haber,László Keviczky,1999 The first of two volumes this handbook presents a comprehensive overview of nonlinear dynamic system parameter identification The volumes cover many aspects of nonlinear processes including modelling parameter estimation structure search nonlinearity and model validity tests *Adaptive Nonlinear System Identification*

Tokunbo Ogunfunmi,2007-09-05 Focuses on System Identification applications of the adaptive methods presented but which can also be applied to other applications of adaptive nonlinear processes Covers recent research results in the area of adaptive nonlinear system identification from the authors and other researchers in the field **Model**

Validation and Uncertainty Quantification, Volume 3 Zhu Mao,2020-10-27 Model Validation and Uncertainty

Quantification Volume 3 Proceedings of the 38th IMAC A Conference and Exposition on Structural Dynamics 2020 the third volume of nine from the Conference brings together contributions to this important area of research and engineering The collection presents early findings and case studies on fundamental and applied aspects of Model Validation and Uncertainty Quantification including papers on Uncertainty Quantification in Material Models Uncertainty Propagation in Structural Dynamics Practical Applications of MVUQ Advances in Model Validation Uncertainty Quantification Model Updating Model Validation Uncertainty Quantification Industrial Applications Controlling Uncertainty Uncertainty in Early Stage Design Modeling of Musical Instruments Overview of Model Validation and Uncertainty **Electrical Generation and**

Distribution Systems and Power Quality Disturbances Gregorio Romero,Luisa Martinez,2011-11-21 The utilization of renewable energy sources such as wind energy or solar energy among others is currently of greater interest Nevertheless since their availability is arbitrary and unstable this can lead to frequency variation to grid instability and to a total or partial loss of load power supply being not appropriate sources to be directly connected to the main utility grid Additionally the presence of a static converter as output interface of the generating plants introduces voltage and current harmonics into the electrical system that negatively affect system power quality By integrating distributed power generation systems closed to the loads in the electric grid we can eliminate the need to transfer energy over long distances through the electric grid In this book the reader will be introduced to different power generation and distribution systems with an analysis of some types of existing disturbances and a study of different industrial applications such as battery charges **Methods of Model**

Based Process Control R. Berber,2012-12-06 Model based control has emerged as an important way to improve plant efficiency in the process industries while meeting processing and operating policy constraints The reader of Methods of Model Based Process Control will find state of the art reports on model based control technology presented by the world s leading scientists and experts from industry All the important issues that a model based control system has to address are covered in depth ranging from dynamic simulation and control relevant identification to information integration Specific emerging topics are also covered such as robust control and nonlinear model predictive control In addition to critical reviews of recent advances the reader will find new ideas industrial applications and views of future needs and challenges Audience A reference for graduate level courses and a comprehensive guide for researchers and industrial control engineers in their exploration of the latest trends in the area Design of Interpretable Fuzzy Systems Krzysztof Cpałka,2017-01-31 This book

shows that the term interpretability goes far beyond the concept of readability of a fuzzy set and fuzzy rules It focuses on novel and precise operators of aggregation inference and defuzzification leading to flexible Mamdani type and logical type systems that can achieve the required accuracy using a less complex rule base The individual chapters describe various aspects of interpretability including appropriate selection of the structure of a fuzzy system focusing on improving the interpretability of fuzzy systems designed using both gradient learning and evolutionary algorithms It also demonstrates how

to eliminate various system components such as inputs rules and fuzzy sets whose reduction does not adversely affect system accuracy It illustrates the performance of the developed algorithms and methods with commonly used benchmarks The book provides valuable tools for possible applications in many fields including expert systems automatic control and robotics

Dynamic Modelling of Gas Turbines Gennady G. Kulikov, Haydn A. Thompson, 2013-12-11 An extended survey of methods for the control and systems identification in gas turbines this book reviews current methods and presents a number of new perspectives Describes a total modelling and identification program for various classes of aeroengine allowing you to deal with an engine s behaviour over its complete life cycle and apply the program to a real engine balancing the theory with practical use Follows a comparative approach to the study of existing and newly derived techniques offering an informed choice of controllers and models Presents novel work in modelling optimal control and systems identification to help you get the most from your engine designs The editors collect the research of three groups of internationally recognised experts It will be of interest to academics working in aeroengine control and to industrial practitioners concerned with their design The work presented is easily extendible to other areas in which gas turbines play a role such as power engineering

The FitzHugh-Nagumo Model C. Rocsoreanu, A. Georgescu, N. Giurgiteanu, 2012-12-06 The present monograph analyses the FitzHugh Nagumo F N model Le the Cauchy problem for some generalized Van der Pol equation depending on three real parameters a band c This model given in 1 1 17 governs the initiation of the cardiac impulse The presence of the three parameters leads to a large variety of dy namics each of them responsible for a specific functioning of the heart For physiologists it is highly desirable to have aglobai view of all possible qualitatively distinct responses of the F N model for all values of the pa rameters This reduces to the knowledge of the global bifurcation diagram So far only a few partial results appeared and they were spread through out the literature Our work provides a more or less complete theoretical and numerical investigation of the complex phase dynamics and bifurca tions associated with the F N dynamical system This study includes the static and dynamic bifurcations generated by the variation of a band c and the corresponding oscillations of special interest for applications It enables one to predict all possible types of initiations of heart beats and the mechanism of transformation of some types of oscillations into others by following the dynamics along transient phase space trajectories Of course all these results hold for the F N model The global phase space picture enables one to determine the domain of validity of this model

Soft Computing Methods for Practical Environment Solutions: Techniques and Studies

Gestal Pose, Marcos, Rivero Cebrián, Daniel, 2010-05-31 This publication presents a series of practical applications of different Soft Computing techniques to real world problems showing the enormous potential of these techniques in solving problems Provided by publisher

Cluster Analysis for Data Mining and System Identification János Abonyi, Balázs Feil, 2007-06-22 The aim of this book is to illustrate that advanced fuzzy clustering algorithms can be used not only for partitioning of the data It can also be used for visualization regression classification and time series analysis hence fuzzy

cluster analysis is a good approach to solve complex data mining and system identification problems This book is oriented to undergraduate and postgraduate and is well suited for teaching purposes Identification of Continuous-Time Systems Allamaraju Subrahmanyam, Ganti Prasada Rao, 2019-12-06 Models of dynamical systems are required for various purposes in the field of systems and control The models are handled either in discrete time DT or in continuous time CT Physical systems give rise to models only in CT because they are based on physical laws which are invariably in CT In system identification indirect methods provide DT models which are then converted into CT Methods of directly identifying CT models are preferred to the indirect methods for various reasons The direct methods involve a primary stage of signal processing followed by a secondary stage of parameter estimation In the primary stage the measured signals are processed by a general linear dynamic operation computational or realized through prefilters to preserve the system parameters in their native CT form and the literature is rich on this aspect In this book Identification of Continuous Time Systems Linear and Robust Parameter Estimation Allamaraju Subrahmanyam and Ganti Prasada Rao consider CT system models that are linear in their unknown parameters and propose robust methods of estimation This book complements the existing literature on the identification of CT systems by enhancing the secondary stage through linear and robust estimation In this book the authors provide an overview of CT system identification consider Markov parameter models and time moment models as simple linear in parameters models for CT system identification bring them into mainstream model parameterization via basis functions present a methodology to robustify the recursive least squares algorithm for parameter estimation of linear regression models suggest a simple off line error quantification scheme to show that it is possible to quantify error even in the absence of informative priors and indicate some directions for further research This modest volume is intended to be a useful addition to the literature on identifying CT systems **CONTROL SYSTEMS, ROBOTICS AND AUTOMATION - Volume VI** Heinz D. Unbehauen, 2009-10-11 This Encyclopedia of Control Systems Robotics and Automation is a component of the global Encyclopedia of Life Support Systems EOLSS which is an integrated compendium of twenty one Encyclopedias This 22 volume set contains 240 chapters each of size 5000 30000 words with perspectives applications and extensive illustrations It is the only publication of its kind carrying state of the art knowledge in the fields of Control Systems Robotics and Automation and is aimed by virtue of the several applications at the following five major target audiences University and College Students Educators Professional Practitioners Research Personnel and Policy Analysts Managers and Decision Makers and NGOs Biomedical Engineering Fundamentals Joseph D. Bronzino, Donald R. Peterson, 2006-04-14 Over the last century medicine has come out of the black bag and emerged as one of the most dynamic and advanced fields of development in science and technology Today biomedical engineering plays a critical role in patient diagnosis care and rehabilitation As such the field encompasses a wide range of disciplines from biology and physiology **Soft Computing and Intelligent Systems** Madan M. Gupta, 1999-10-28 The field of soft computing is emerging from the cutting edge

research over the last ten years devoted to fuzzy engineering and genetic algorithms The subject is being called soft computing and computational intelligence With acceptance of the research fundamentals in these important areas the field is expanding into direct applications through engineering and systems science This book cover the fundamentals of this emerging filed as well as direct applications and case studies There is a need for practicing engineers computer scientists and system scientists to directly apply fuzzy engineering into a wide array of devices and systems

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