Identification Of Dynamic Systems An Introduction With Applications Advanced Textbooks In Control And Signal Processing

Safety in industrial process and production plants is a concern of rising importance but because the control devices which are now exploited to improve the performance of industrial processes include both sophisticated digital system design techniques and complex hardware, there is a higher probability of failure. Control systems must include automatic supervision of closed-loop operation to detect and isolate malfunctions quickly. A promising method for solving this problem is "analytical redundancy", in which residual signals are obtained and an accurate model of the system mimics real process behaviour. If a fault occurs, the residual signal is used to diagnose and isolate the malfunction. This book focuses on model identification oriented to the analytical approach of fault diagnosis and identification covering: choice of model structure; parameter identification; residual generation; and fault diagnosis and isolation. Sample case studies are used to demonstrate the application of these techniques. Neural Network Modeling and Identification of Dynamical Systems presents a new approach on how to obtain the adaptive neural network models for complex systems that are typically found in real-world applications. The book introduces the theoretical knowledge available for the modeled system into the purely empirical black box model, thereby converting the model to the gray box category. This approach significantly reduces the dimension of the resulting model and the required size of the training set. This book offers solutions for identifying controlled dynamical systems, as well as identifying characteristics of such systems, in particular, the aerodynamic characteristics of aircraft. Covers both types of dynamic neural networks (black box and gray box) including their structure, synthesis and training Offers application examples of dynamic neural network technologies, primarily related to aircraft Provides an overview of recent achievements and future needs in this area

This interim report introduces the mathematical development of a new method for identifying system transfer functions from input-output data. Discussion contained herein covers: The mathematical basis for the method; An analytical example to illustrate the application of the method; and, A computer example which provides the groundwork for the practical application of the method.

Marine Systems Identification, Modeling and Control is a concise, stand-alone resource covering the theory and practice of dynamic systems and control for marine engineering students and professionals. Developed from a distance learning CPD course on marine control taught by the authors, the book presents the essentials of the subject, including system representation and transfer, feedback control and closed loop stability. Simulation code and worked examples are provided for both Scilab and MATLAB, making it suitable for both those without access to expensive software and those using MATLAB in a professional setting. This title considers the key topics without superfluous detail and is illustrated with marine industry examples. Concise and practical, covering the relevant theory without excessive detail Industry-specific examples and applications for marine engineering students and professionals Clearly presents key topics of the subject, including system representation and transfer, feedback

control and closed loop stability, making it ideal for self-study or reference Simulation code and worked examples using Scilab and MATLAB provided on the book's companion website
Some novel approaches to estimate Nonlinear Output Error (NOE) models using TS fuzzy models for a class of nonlinear dynamic systems having variability in their outputs is presented in this dissertation. Instead of using unrealistic assumptions about uncertainty, the most common of which is normality, the proposed methodology tends to capture effects caused by the real uncertainty observed in the data. The methodology requires that the identification method must be repeated offline a number of times under similar conditions. This leads to multiple inputoutput time series from the underlying system. These time series are preprocessed using the techniques of statistics and probability theory to generate the envelopes of response at each time instant. By incorporating interval data in fuzzy modelling and using the theory of symbolic interval-valued data, a TS fuzzy model with interval antecedent and consequent parameters is obtained. The proposed identification algorithm provides for a model for predicting the center-valued response as well as envelopes as the measure of uncertainty in system output.
Electrical Engineering System Identification A Frequency DomainApproach How does one model a linear dynamic system from noisydata? This book presents a general approach to this problem, withboth practical examples and theoretical discussions that give thereader a sound understanding of the subject and of the pitfallsthat might occur on the road from raw data to validated model. Theemphasis is on robust methods that can be used with a minimum ofuser interaction. Readers in many fields of engineering will gainknowledge about: * Choice of experimental setup and experiment design * Automatic characterization of disturbing noise *

Generation of a good plant model * Detection, qualification, and quantification of nonlineardistortions * Identification of continuous- and discrete-time models * Improved model validation tools and from the theoretical side about: * System identification * Interrelations between time- and frequency-domainapproaches * Stochastic properties of the estimators * Stochastic analysis System Identification: A Frequency Domain Approach is written forpracticing engineers and scientists who do not want to delve intomathematical details of proofs. Also, it is written for researcherswho wish to learn more about the theoretical aspects of the proofs.Several of the introductory chapters are suitable forundergraduates. Each chapter begins with an abstract and ends withexercises, and examples are given throughout.

This book contains examples and exercises with modeling problems together with complete solutions. The contents is tailored to the book Ljung-Glad: Modeling and Identification of Dynamic Systems (Studentlitteratur, 2016). The exercises are of different levels of difficulty and cover general modeling principles (such as bond graphs) as well as practical tools like Modelica and Simscape. System identification, model and signal properties are also covered together with basic techniques for simulation. Most of the problems deal with issues from industrial applications, but also economic, social and medical cases are covered. The text requires certain knowledge in linear algebra, signal and systems and basic familiarity with physics and statistics. The computer exercises assume access to basic software such as Matlab and Simulink, and to some extent Modelica/Dymola/Simscape. The book is suitable for Master level courses in engineering, but also for practicing engineers.

This book gives an in-depth introduction to the areas of modeling, identification, simulation, and optimization. These scientific topics play an increasingly dominant part in many engineering areas such as electrotechnology, mechanical engineering, aerospace, and physics. This book represents a unique and concise treatment of the mutual interactions among these topics. Techniques for solving general nonlinear optimization problems as they arise in identification and many synthesis and design methods are detailed. The main points in deriving mathematical models via prior knowledge concerning the physics describing a system are emphasized. Several chapters discuss the identification of black-box models. Simulation is introduced as a numerical tool for calculating time responses of almost any mathematical model. The last chapter covers optimization, a generally applicable tool for formulating and solving many engineering problems.

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.

This book presents a detailed examination of the estimation techniques and problems in dynamic systems. Containing several illustrations and computer programs, the book promotes a better understanding of system modelling and parameter estimation.

Parameter estimation involves observation of a dynamic system to develop mathematical models that represent the system dynamics. With the increasing use of high speed digital computers, elegant and innovative techniques like filter error method, H° and artificial neural networks are finding more and more use in parameter estimation problems. The material is presented in an accessible manner and enables the user to implement and execute the programs and, therefore, gain first-hand experience of the estimation progress.

Identification of Dynamic Systems and Selection of Suitable Model.

System Identification shows the student reader how to approach the system identification problem in a systematic fashion. The process is divided into three basic steps: experimental design and data collection; model structure selection and parameter estimation; and model validation, each of which is the subject of one or more parts of the text. Following an introduction on system theory, particularly in relation to model representation and model properties, the book contains four parts covering: • data-based identification – non-parametric methods for use when prior system knowledge is very limited; • time-invariant identification for systems with constant parameters; • time-varying systems identification, primarily with recursive estimation techniques; and • model validation methods. A fifth part, composed of appendices, covers the various aspects of the underlying mathematics needed to begin using the text. The book uses essentially semi-physical or gray-box modeling methods although data-based, transfer-function system descriptions are also introduced. The approach is problem-based rather than rigorously mathematical. The use of finite input–output data is demonstrated for frequency- and time-domain identification in static, dynamic, linear, nonlinear, time-invariant and time-varying systems. Simple examples are used to show readers how to perform and emulate the identification steps involved in various control design methods with more complex illustrations derived from real physical, chemical and biological applications being used to demonstrate the practical applicability of the methods described. End-of-chapter exercises (for which a downloadable instructors' Solutions Manual is available from fill in URL here) will both help students to assimilate what they have learned and make the book suitable for self-tuition by practitioners looking to brush up on modern techniques. Graduate and final-year undergraduate students will find this text to be a practical and realistic course in system identification that can be used for assessing the processes of a variety of engineering disciplines. System Identification will help academic instructors teaching control-related to give their students a good understanding of identification methods that can be used in the real world without the encumbrance of undue mathematical detail.

This book enables readers to understand system identification and linear system modeling through 100 practical exercises without requiring complex theoretical knowledge. The contents encompass state-of-the-art system identification methods, with both time and frequency domain system identification methods covered, including the pros and cons of each. Each chapter features MATLAB exercises, discussions of the exercises, accompanying MATLAB downloads, and larger projects that serve as potential assignments in this learn-by-doing resource.

Dynamic System Identification: Experiment Design and Data Analysis

This monograph opens up new horizons for engineers and researchers in academia and in industry dealing with or interested in new developments in the field of system identification and control. It emphasizes guidelines for working solutions and practical advice for their implementation rather than the theoretical background of Gaussian process (GP) models. The book demonstrates the potential of this recent development in probabilistic machine-learning methods and gives the reader an intuitive understanding of the topic. The current state of the art is treated along with possible future directions for research. Systems control design relies on mathematical models and these may be developed from measurement data. This process of system identification, when based on GP models, can play an integral part of control design in data-based control and its description as such is an essential aspect of the text. The background of GP regression is introduced first with system identification and incorporation of prior knowledge then leading into full-blown control. The book is illustrated by extensive use of examples, line drawings, and graphical presentation of computer-simulation results and plant measurements. The research results presented are applied in real-life case studies drawn from successful applications including: a gas–liquid separator control; urban-traffic signal modelling and reconstruction; and prediction of atmospheric ozone concentration. A MATLAB® toolbox, for identification and simulation of dynamic GP models is provided for download.

This book concentrates on the problem of accurate modeling of linear systems. It presents a thorough description of a method of modeling a linear dynamic invariant system by its transfer function. The first two chapters provide a general introduction and review for those readers who are unfamiliar with identification theory so that they have a sufficient background knowledge for understanding the methods described later. The main body of the book looks at the basic method used by the authors to estimate the parameter of the transfer function, how it is possible to optimize the excitation signals. Further chapters extend the estimation method proposed. Applications are then discussed and the book concludes with practical guidelines which illustrate the method and offer some rules-of-thumb.

Mathematical models of real life systems and processes are essential in today's industrial work. To be able to construct such models is therefore a fundamental skill in modern engineering...

Precise dynamic models of processes are required for many applications, ranging from control engineering to the natural sciences and economics. Frequently, such precise models cannot be derived using theoretical considerations alone. Therefore, they must be determined experimentally. This book treats the determination of dynamic models based on measurements taken at the process, which is known as system identification or process identification. Both offline and online methods are presented, i.e. methods that post-process the measured data as well as methods that provide models during the measurement. The book is theory-oriented and application-oriented and most methods covered have been used successfully in practical applications for many different processes. Illustrative examples in this book with real measured data range from hydraulic and electric actuators up to combustion engines. Real experimental data is also provided on the Springer webpage, allowing readers to gather their first experience with the methods presented in this book. Among others, the book covers the following subjects: determination of the non-parametric frequency response, (fast) Fourier transform, correlation analysis, parameter estimation with a focus on the method of Least Squares and modifications, identification of time-variant processes, identification in closed-loop, identification of continuous time processes, and subspace methods. Some methods for nonlinear system identification are also considered, such as the Extended Kalman filter and neural networks. The different methods are compared by using a real three-mass oscillator process, a model of a drive train. For many identification methods, hints for the practical implementation and application are provided. The book is intended to meet the needs of students and practicing engineers working in research and development, design and manufacturing.

A Practical Approach to Dynamical Systems for Engineers takes the abstract mathematical concepts behind dynamical systems and applies them to real-world systems, such as a car traveling down the road, the ripples caused by throwing a pebble into a pond, and a clock pendulum swinging back and forth. Many relevant topics are covered, including modeling systems using differential equations, transfer functions, state-space representation, Hamiltonian systems, stability and equilibrium, and nonlinear system characteristics with examples including chaos, bifurcation, and limit cycles. In addition, MATLAB is used extensively to show how the analysis methods are applied to the examples. It is assumed readers will have an understanding of calculus, differential equations, linear algebra, and an interest in mechanical and electrical dynamical systems. Presents applications in engineering to show the adoption of dynamical system analytical methods Provides examples on the dynamics of automobiles, aircraft, and human balance, among others, with an emphasis on physical engineering systems MATLAB and Simulink are used throughout to apply the analysis methods and illustrate the ideas Offers in-depth discussions of every abstract concept, described in an intuitive manner, and illustrated using practical examples, bridging the gap between theory and practice Ideal resource for practicing engineers who need to understand background theory and how to apply it

Trends and Progress in System Identification is a three-part book that focuses on model considerations, identification methods, and experimental conditions involved in system identification. Organized into 10 chapters, this book begins with a discussion of model method in system identification, citing four examples differing on the nature of the models involved, the nature of the fields, and their goals. Subsequent chapters describe the most important aspects of model theory; the ""classical"" methods and time series estimation; application of least squares and related techniques for the estimation of dynamic system parameters; the maximum likelihood and error prediction methods; and the modern development of statistical methods. Non-parametric approaches, identification of nonlinear systems by piecewise approximation, and the minimax identification are then explained. Other chapters explore the Bayesian approach to system identification; choice of input signals; and choice and effect of different feedback configurations in system identification. This book will be useful for control engineers, system scientists, biologists, and members of other disciplines dealing withdynamical relations.

Written by a recognized authority in the field of identification and control, this book draws together into a single volume the important aspects of system identification AND physical modelling. KEY TOPICS: Explores techniques used to construct mathematical models of systems based on knowledge from physics, chemistry, biology, etc. (e.g., techniques with so called bond-graphs, as well those which use computer algebra for the modeling work). Explains system identification techniques used to infer knowledge about the behavior of dynamic systems based on observations of the various input and output signals that are available for measurement. Shows how both types of techniques need to be applied in any given practical modeling situation. Considers applications, primarily simulation. For practicing engineers who are faced with problems of modeling.

Most newcomers to the field of linear stochastic estimation go through a difficult process in understanding and applying the theory.This book minimizes the process while introducing the fundamentals of optimal estimation. Optimal Estimation of Dynamic Systems explores topics that are important in the field of control where the signals received are used to determine highly sensitive processes such as the flight path of a plane, the orbit of a space vehicle, or the control of a machine. The authors use dynamic models from mechanical and aerospace engineering to provide immediate results of estimation concepts with a minimal reliance on mathematical skills. The book documents the development of the central concepts and methods of optimal estimation theory in a manner accessible to engineering students, applied mathematicians, and practicing engineers. It includes rigorous theoretial derivations and a significant amount of qualitiative discussion and judgements. It also presents prototype algorithms, giving detail and discussion to stimulate development of efficient computer programs and intelligent use of them. This book illustrates the application of optimal estimation methods to problems with varying degrees of analytical and numercial difficulty. It compares various approaches to help develop a feel for the absolute and relative utility of different methods, and provides many applications in the fields of aerospace, mechanical, and electrical engineering.

Introduction to modeling and simulation - Models for dynamic systems and systems similarity - Modeling of engineering systems - Mechanical systems - Electrical systems - Fluid systems - Thermal systems - Mixed discipline systems - System dynamic response analysis - Frequency response - Time response and digital simulation - Engineering applications - System design and selection of components.

This beginning graduate textbook teaches data science and machine learning methods for modeling, prediction, and control of complex systems.

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.

Identification of Dynamic SystemsAn Introduction with ApplicationsSpringer Science & Business Media