This book presents the results of the successful Sensors Special Issue on Intelligent Vehicles that received submissions between March 2019 and May 2020. The Guest Editors of this Special Issue are Dr. David Fernández-Llorca, Dr. Ignacio Parra-Alonso, Dr. Iván García-Daza and Dr. Noelia Parra-Alonso, all from the Computer Engineering Department at the University of Alcalá (Madrid, Spain). A total of 32 manuscripts were finally accepted between 2019 and 2020, presented by top researchers from all over the world. The reader will find a well-representative set of current research and developments related to sensors and sensing for intelligent vehicles. The topics of the published manuscripts can be grouped into seven main categories: (1) assistance systems and automatic vehicle operation, (2) vehicle positioning and localization, (3) fault diagnosis and fail-x systems, (4) perception and scene understanding, (5) smart regenerative braking systems for electric vehicles, (6) driver behavior modeling and (7) intelligent sensing. We, the Guest Editors, hope that the readers will find this book to contain interesting papers for their research, papers that they will enjoy reading as much as we have enjoyed organizing this Special Issue.

Kalman Filters

In the field of psychology and developmental science, researchers often study the change of some underlying latent construct over time. It is of interest both to estimate the latent states that an individual is in and to extract patterns that would characterize the change process. Translated into dynamic modeling language, researchers are interested in the dual estimation of states and model parameters. Filtering methods, such as the commonly adopted Kalman filter, can aid in this process. However, when the linear and normality assumptions of the Kalman filter is challenged, the estimates may no longer be reliable. This thesis set out to investigate how one algorithm from the Kalman filter family, the extended Kalman filter (EKF), and an alternative, simulation-based approach of particle filter, behave under the ideal condition of normality and when the normality assumption is violated, through a set of simulations. Results from simulations show, for both algorithms, overall satisfactory performance under the ideal normal condition, and frequently biased parameter estimates when the distribution of process noises was skewed. The particle-filter-associated approach slightly outperforms the EKF-associated approach when the optimization problem becomes harder. Caveats regarding the interpretation of results are discussed along with potential future research directions.

Kalman Filtering

The accurate measurement of harmonics level is essential for designing harmonic filters, monitoring the stress to which the power system devices are subjected due to harmonics and...
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Extended Kalman Filter Based Methods For Pose Estimation

This project presents an integrated approach to design an optimal estimator of harmonic components of a power network in the presence of frequency variations. This has led to the study of Kalman, Extended Kalman and Unscented Kalman filter characteristics and a subsequent implementation of the study to design the optimal filter. We have employed the Extended Kalman filter and Unscented Kalman filter algorithms to estimate the power system voltage magnitude in the presence of random noise and distortions again taking into account the measurement noise. Kalman filter being an optimal estimator track the signal corrupted with noise and bearing harmonic distortion quite accurately. Adaptive tracking of harmonic components of a power system can easily be done using these algorithms. The proposed approaches are tested for only static signals. For a test signal both EKF and UKF algorithms are used and the results are compared.

Dual Estimation in State Space Models with Violation to Normality

Two methods of estimating the attitude position of a spacecraft are examined in this thesis: the extended Kalman filter (EKF) and the unscented Kalman filter (UKF). In particular, the Unscented Quaternion Estimator (USQUE) derived from [4] is implemented into a spacecraft model. For generalizations about the each of the filters, a simple problem is initially solved. These solutions display typical characteristics of each filter type. The UKF is very attractive in spacecraft attitude estimation, given that spacecraft dynamics are highly nonlinear. For nonlinear systems, the UKF is of particular interest because it uses a carefully selected set of sample points that more accurately map the probability distribution than the linearization of the standard extended Kalman filter. This leads to faster convergence of the attitude solution from largely inaccurate initial conditions. The filter created in this thesis is formulated based on Markley and Crassidis's work on standard attitude-vector measurements using a gyro-based model for attitude propagation. From the standard attitude vector measurements, the global attitude parameterization is found and given by a quaternion, while a generalized three-dimensional attitude representation is used to define the local attitude error. The multiplicative quaternion-error is then found from the local error. The simulation results indicate that the unscented filter is more robust than the extended Kalman filter.

Power System Estimation Using the Extended and the Unscented Kalman Filter Methods

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.

Multimodal Sentiment Analysis

This book presents the proceedings of the 17th Chinese Intelligent Systems Conference, held in Fuzhou, China, on Oct 16-17, 2021. It focuses on new theoretical results and techniques in the field of intelligent systems and control. This is achieved by providing in-depth study on a number of major topics such as Multi-Agent Systems, Complex Networks, Intelligent Robots, Complex System Theory and Swarm Behavior, Event-Triggered Control and Data-Driven Control, Robust and Adaptive Control, Big Data and Brain Science, Process Control, Intelligent Sensor and Detection Technology, Deep learning and Learning Control Guidance, Navigation and Control of Flight Vehicles and so on. The book is particularly suited for readers who are interested in learning intelligent system and control and artificial intelligence. The book can benefit researchers, engineers, and graduate students.

Kalman Filtering

This book is a comprehensive treatment of inference for hidden Markov models, including both algorithms and statistical theory. Topics range from filtering and smoothing of the hidden Markov chain to parameter estimation, Bayesian methods and estimation of the number of states. In a unified way the book covers both models with finite state spaces and models with continuous state spaces (also called state-space models) requiring approximate simulation-based algorithms that are also described in detail. Many examples illustrate the algorithms and theory. This book builds on recent developments to present a self-contained view.
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Kalman Filtering: Theory and Practice Using MATLAB, Fourth Edition is an ideal textbook in advanced undergraduate and beginning graduate courses in stochastic processes and Kalman filtering. It is also appropriate for self-instruction or review by practicing engineers and scientists who want to learn more about this important topic.

Applied Optimal Estimation

Sensor data fusion is the process of combining error-prone, heterogeneous, incomplete, and ambiguous data to gather a higher level of situational awareness. In principle, all living creatures are fusing information from their complementary senses to coordinate their actions and to detect and localize danger. In sensor data fusion, this process is transferred to electronic systems, which rely on some "awareness" of what is happening in certain areas of interest. By means of probability theory and statistics, it is possible to model the relationship between the state space and the sensor data. The number of ingredients of the resulting Kalman filter is limited, but its applications are not.

Statistical Learning and Pattern Analysis for Image and Video Processing

Graduate-level text extends studies of signal processing, particularly regarding communication systems and digital filtering theory. Topics include filtering, linear systems, and estimation; discrete-time Kalman filter; time-invariant filters; more. 1979 edition.

Structure from Motion using the Extended Kalman Filter

Abstract: The Extended Kalman Filter (EKF), Unscented Kalman Filter (UKF) and Ensemble Kalman Filter (EnKF) are commonly implemented practical solutions for solving nonlinear state space estimation problems; all based on the linear state space estimator, the Kalman Filter. Often, the UKF and EnKF are cited as a superior methods to the EKF with respect to error-based performance criteria. The UKF in turn has the advantage over the EnKF of smaller computational complexity. In practice however the UKF often fails to live up to this expectation, with performance which does not surpass the EKF and estimates which are not as robust as the EnKF. This work explores the geometry of alternative sigma point sets, which form the basis of the UKF, contributing several new sets along with novel methods used to generate them. In particular, completely novel systems of sigma points that preserve higher order statistical moments are found and evaluated. Additionally a new method for scaling and problem specific tuning of sigma point sets is introduced as well as a discussion of why this is necessary, and a new way of thinking about UKF systems in relation to the other two Kalman Filter methods. An Iterated UKF method is also introduced, similar to the smoothing iterates developed previously for the EKF. The performance of all of these methods is demonstrated using problem exemplars with the improvement of the contributed methods highlighted.

Adaptive Length Moving-horizon and Kernel Based Extended Kalman Filter for Non-linear Systems

Tenascin, a recently characterized extracellular matrix (ECM) protein which is expressed during embryonic and fetal development, wound healing and various benign and malignant tumors (but highly restricted in normal adult tissues) is believed to affect a number of cellular functions such as cellular growth, differentiation, adhesion and motility. It has been extensively studied in recent years to elucidate cellular phenomena that are associated with development, tissue regeneration and neoplastic growth and behavior. It may be a potential target in the treatment of cancers and other disorders. This book focuses mainly on tissue expression and the poorly known biological role of this ECM protein.

Modelling and Parameter Estimation of Dynamic Systems

The aim of this book is to provide an overview of recent developments in Kalman filter theory and their applications in engineering and scientific fields. The book is divided into 24
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- Chapters and organized in five blocks corresponding to recent advances in Kalman filtering theory, applications in medical and biological sciences, tracking and positioning systems, electrical engineering and, finally, industrial processes and communication networks.

Introduction and Implementations of the Kalman Filter

This book presents recent issues on theory and practice of Kalman filters, with a comprehensive treatment of a selected number of concepts, techniques, and advanced applications.

From an interdisciplinary point of view, the contents from each chapter bring together an international scientific community to discuss the state of the art on Kalman filter-based methodologies for adaptive/distributed filtering, optimal estimation, dynamic prediction, nonstationarity, robot navigation, global navigation satellite systems, moving object tracking, optical communication systems, and active power filters, among others. The theoretical and methodological foundations combined with extensive experimental explanation make this book a reference suitable for students, practicing engineers, and researchers in sciences and engineering.

A Kalman Filter Approach to Model-error Control Synthesis

Expert coverage of the design and implementation of state-estimation algorithms for tracking and navigation

Estimation with Applications to Tracking and Navigation

Power system state estimation is not only the foundation of power system dispatch, control and security assessment, but also the core of Energy Management System. The purpose of state estimation is using the measurements and the grid topology information to get the real time state of the power system. State estimation is typically performed using the Kalman filter method. Therefore, this project uses the Kalman filter method to solve the estimation problem in power systems. Along with the derivation of the Kalman filter algorithm, the principle of the extended Kalman filter method and its shortcomings were introduced. Then a relatively new Kalman filter, the unscented Kalman filter is discussed. This filter avoids the complexity and lengthy calculations of the derivative and also increases the precision of estimation. The simulation is done in MATLAB using models of systems from several published research papers. This report uses single machine and multi-machine systems as study cases to evaluate the performance of both methods. The results show that both methods did an excellent job in tracking the system.

Intelligent Systems

Localization of magnetoencephalography (MEG) dipole sources has critical applications in biomedical measurements. In this thesis, we have developed a series of Kalman filter-based methods to track and estimate dynamic MEG dipole sources. Using the Gauss-Markov modeling of the dipole source and the dipole components on the x-, y-, and z-directions of the dipole source, the Kalman Filter based method has the significant advantage of fast computational speed. We have also modeled a multicomponent vector sensor array to receive MEG signals to avoid the ambiguity associated with MEG measurements. We have developed tracking and estimating algorithms based on both the Extended Kalman Filter (EKF) and Sigma-Point Kalman Filter (SPKF). We have also combined the regular EKF and SPKF with a projector obtained from the signal subspace method. These modified EKF and SPKF algorithm successfully project out the interference corresponding to spontaneous brain activities. The modified EKF- and SPKF-based algorithms can tolerate difficult simulated environments involving strong temporally nonstationary background noise. Combining Generalized Least Square (GLS) estimation with the Kalman filter can adapt the Kalman filtering method to the case where the dipole components on the x-, y-, z-directions of the SOI dipole source do not satisfy the prerequisites of applying the Kalman filter. Smoothing has also been applied to improve the tracking and estimating performances.
Numerical Methods for Engineers and Scientists, 3rd Edition provides engineers with a more concise treatment of the essential topics of numerical methods while emphasizing MATLAB use. The third edition includes a new chapter, with all new content, on Fourier Transform and a new chapter on Eigenvalues (compiled from existing Second Edition content). The focus is placed on the use of anonymous functions instead of inline functions and the uses of subfunctions and nested functions. This updated edition includes 50% new or updated Homework Problems, updated examples, helping engineers test their understanding and reinforce key concepts.

Why are We Writing This Book? Visual data (graphical, image, video, and visualized data) affect every aspect of modern society. The cheap collection, storage, and transmission of vast amounts of visual data have revolutionized the practice of science, technology, and business. Innovations from various disciplines have been developed and applied to the task of designing intelligent machines that can automatically detect and exploit useful regularities (patterns) in visual data. One such approach to machine intelligence is statistical learning and pattern analysis for visual data. Over the past two decades, rapid advances have been made throughout the field of visual pattern analysis. Some fundamental problems, including perceptual grouping, image segmentation, stereomatching, object detection and recognition, and motion analysis and visual tracking, have become hot research topics and test beds in multiple areas of specialization, including mathematics, neuroscience, and cognition. A great diversity of models and algorithms stemming from these disciplines has been proposed.

To address the issues of ill-posed problems and uncertainties in visual pattern modeling and computing, researchers have developed rich toolkits based on pattern analysis theory, harmonic analysis and partial differential equations, geometry and group theory, graph matching, and graph grammars. Among these technologies involved in intelligent visual information processing, statistical learning and pattern analysis is undoubtedly the most popular and important approach, and it is also one of the most rapidly developing fields, with many achievements in recent years. Above all, it provides a unifying theoretical framework for intelligent visual information processing applications.

"Kalman Filtering with Real-Time Applications" presents a thorough discussion of the mathematical theory and computational schemes of Kalman filtering. The filtering algorithms are derived via different approaches, including a direct method consisting of a series of elementary steps, and an indirect method based on innovation projection. Other topics include Kalman filtering for systems with correlated noise or colored noise, limiting Kalman filtering for time-invariant systems, extended Kalman filtering for nonlinear systems, interval Kalman filtering for uncertain systems, and wavelet Kalman filtering for multiresolution analysis of random signals. The last two topics are new additions to this third edition. Most filtering algorithms are illustrated by using simplified radar tracking examples. The style of the book is informal, and the mathematics is elementary but rigorous. The text is self-contained, suitable for self-study, and accessible to all readers with a minimum knowledge.

This book contains the papers presented at the 20th UK Workshop on Computational Intelligence (UKCI 2021), held virtually by Aberystwyth University, 8–10th September 2021. This marks the 20th anniversary of UKCI; a testament to the increasing role and importance of Computational Intelligence (CI) and the continuing interest in its development. UKCI provides a forum for the academic community and industry to share ideas and experience in this field. EDMA 2021, the 4th International Engineering Data- and Model-Driven Applications workshop, is also incorporated and held in conjunction with UKCI 2021. Paper submissions were invited in the areas of fuzzy systems, neural networks, evolutionary computation, machine learning, data mining, cognitive computing, intelligent robotics, hybrid methods, deep learning and applications of CI.

Optimal Filtering

This thesis presents a kernel-based parameter and state estimator built on various implementations of Recursive Least Squares estimators. The project represented a system using kernels in Reproducing Kernel Hilbert Spaces (RKHS) and co-variance propagation. Subsequently, a parameter estimation problem is solved using stochastic multiple regression and Generalized Least Squares with co-variance weighting applied to resolve high noise. Additionally, multiple integrals of the kernel for noise rejection and for multiple regression of a high
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Extended Kalman Filter Based Methods For Pose Estimation

order non-linear system are developed. This recursive method is then extended to a Moving-Horizon batch estimator with an adaptive window length. Furthermore, shortcomings of all the methods implemented are discussed to improve the method into a robust kernel-based extended Kalman filter algorithm for joint state and parameter estimation of non-linear systems.

Biomedical signal processing in the medical field has helped optimize patient care and diagnosis within medical facilities. As technology in this area continues to advance, it has become imperative to evaluate other ways these computation techniques could be implemented. Computational Tools and Techniques for Biomedical Signal Processing investigates high-performance computing techniques being utilized in hospital information systems. Featuring comprehensive coverage on various theoretical perspectives, best practices, and emergent research in the field, this book is ideally suited for computer scientists, information technologists, biomedical engineers, data-processing specialists, and medical physicists interested in signal processing within medical systems and facilities.

This is the first book on the optimal estimation that places its major emphasis on practical applications, treating the subject more from an engineering than a mathematical orientation. Even so, theoretical and mathematical concepts are introduced and developed sufficiently to make the book a self-contained source of instruction for readers without prior knowledge of the basic principles of the field. The work is the product of the technical staff of The Analytic Sciences Corporation (TASC), an organization whose success has resulted largely from its applications of optimal estimation techniques to a wide variety of real situations involving large-scale systems. Arthur Gelb writes in the Foreword that “It is our intent throughout to provide a simple and interesting picture of the central issues underlying modern estimation theory and practice. Heuristic, rather than theoretically elegant, arguments are used extensively, with emphasis on physical insights and key questions of practical importance.” Numerous illustrative examples, many based on actual applications, have been interspersed throughout the text to lead the student to a concrete understanding of the theoretical material. The inclusion of problems with “built-in” answers at the end of each of the nine chapters further enhances the self-study potential of the text. After a brief historical prelude, the book introduces the mathematics underlying random process theory and state-space characterization of linear dynamic systems. The theory and practice of optimal estimation is then presented, including filtering, smoothing, and prediction. Both linear and non-linear systems, and continuous- and discrete-time cases, are covered in considerable detail. New results are described concerning the application of covariance analysis to non-linear systems and the connection between observers and optimal estimators. The final chapters treat such practical and often pivotal issues as suboptimal structure, and computer loading considerations. This book is an outgrowth of a course given by TASC at a number of US Government facilities. Virtually all of the members of the TASC technical staff have, at one time and in one way or another, contributed to the material contained in the work.

A general framework for constructing and using probabilistic models of complex systems that would enable a computer to use available information for making decisions. Most tasks require a person or an automated system to reason—to reach conclusions based on available information. The framework of probabilistic graphical models, presented in this book, provides a general approach for this task. The approach is model-based, allowing interpretable models to be constructed and then manipulated by reasoning algorithms. These models can also be learned automatically from data, allowing the approach to be used in cases where manually constructing a model is difficult or even impossible. Because uncertainty is an inescapable aspect of most real-world applications, the book focuses on probabilistic models, which make the uncertainty explicit and provide models that are more faithful to reality. Probabilistic Graphical Models discusses a variety of models, spanning Bayesian networks, undirected Markov networks, discrete and continuous models, and extensions to deal with dynamical systems and relational data. For each class of models, the text describes the three fundamental cornerstones: representation, inference, and learning, presenting both basic concepts and advanced techniques. Finally, the book considers the use of the proposed framework for causal reasoning and decision making under uncertainty. The main text in each chapter provides the detailed technical development of the key ideas. Most chapters also include boxes with additional material: skill boxes, which describe techniques; case study boxes, which discuss empirical cases related to the approach described in the text, including applications in computer vision, robotics, natural language understanding, and computational biology; and concept boxes, which present significant concepts drawn from the material in the chapter. Instructors (and readers) can group chapters in various combinations, from core topics to more technically advanced material, to suit their particular needs.
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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, $H_\infty$ 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 process.

Probabilistic Graphical Models

This thesis introduces two new techniques by which the model-error control synthesis approach can be implemented on a nonlinear system. The first method utilizes two separate extended Kalman filters. Among the two filters, one is strictly used for noise filtration/state estimation and the other is used for model error prediction. The second scheme exploits a single extended Kalman filter for the simultaneous estimation of the system states and the model error. The simulation results indicate that the new model-error control synthesis approaches are extremely effective in providing closed-loop robustness in the presence of noisy measurement signal. Finally, a sensitivity of the controlled closed-loop system stability with respect to the process noise covariance is presented.

Data-Driven Prediction for Industrial Processes and Their Applications

A bottom-up approach that enables readers to master and apply the latest techniques in state estimation. This book offers the best mathematical approaches to estimating the state of a general system. The author presents state estimation theory clearly and rigorously, providing the right amount of advanced material, recent research results, and references to enable the reader to apply state estimation techniques confidently across a variety of fields in science and engineering. While there are other textbooks that treat state estimation, this one offers special features and a unique perspective and pedagogical approach that speed learning: * Straightforward, bottom-up approach begins with basic concepts and then builds step by step to more advanced topics for a clear understanding of state estimation * Simple examples and problems that require only paper and pen to solve lead to an intuitive understanding of how theory works in practice * MATLAB-based source code that corresponds to examples in the book, available on the author's Web site, enables readers to recreate results and experiment with other simulation setups Armed with a solid foundation in the basics, readers are presented with a careful treatment of advanced topics, including unscented filtering, high order nonlinear filtering, particle filtering, constrained state estimation, reduced order filtering, robust Kalman filtering, and mixed Kalman/$H_\infty$ filtering. Problems at the end of each chapter include both written exercises and computer exercises. Written exercises focus on improving the reader's understanding of theory and key concepts, whereas computer exercises help readers apply theory to problems similar to ones they are likely to encounter in industry. With its expert blend of theory and practice, coupled with its presentation of recent research results, Optimal State Estimation is strongly recommended for undergraduate and graduate-level courses in optimal control and state estimation theory. It also serves as a reference for engineers and science professionals across a wide array of industries.

Inference in Hidden Markov Models

This latest volume in the series, Socio-Affective Computing, presents a set of novel approaches to analyze opinionated videos and to extract sentiments and emotions. Textual sentiment analysis framework as discussed in this book contains a novel way of doing sentiment analysis by merging linguistics with machine learning. Fusing textual information with audio and visual cues is found to be extremely useful which improves text, audio and visual based unimodal sentiment analyzer. This volume covers the three main topics of: textual preprocessing and sentiment analysis methods; frameworks to process audio and visual data; and methods of textual, audio and visual features fusion. The inclusion of key visualization and case studies will enable readers to understand better these approaches. Aimed at the Natural Language Processing, Affective Computing and Artificial Intelligence audiences, this comprehensive volume will appeal to a wide readership and will help readers to understand key details on multimodal sentiment analysis.
Online Library Extended Kalman Filter Based Methods For Pose Estimation

The objective of this research is to apply the Extended Kalman Filter and Nonlinear Control Theory to improve local mean power estimation in a mobile wireless communication system. This research contributes the following: 1) Application of a new Extended Kalman filter (NEKF) approach to improve local mean power estimation. The method is being validated using the Matlab/Simulink/GUI system model and was compared to existing methods, Kalman Filter (KF), in Gaussian and Non-Gaussian noise environments. Our analysis and experiments demonstrate that EKF is a more accurate method. 2) Development of an accurate estimation of parameters and higher order state space prediction for modeling shadow power. Statistical methods for parameter estimation of linear models in dynamic mobile communication systems have been developed. 3) Development of an algorithm introducing a discrete-time approach based on pilot signal strength measurements. Exact analytical expressions are developed evaluating path loss performance metrics for a mobile station moving along a straight-line trajectory in a mobile network.

Adaptive Processing of Sequences and Data Structures

This book presents modeling methods and algorithms for data-driven prediction and forecasting of practical industrial process by employing machine learning and statistics methodologies. Related case studies, especially on energy systems in the steel industry are also addressed and analyzed. The case studies in this volume are entirely rooted in both classical data-driven prediction problems and industrial practice requirements. Detailed figures and tables demonstrate the effectiveness and generalization of the methods addressed, and the classifications of the addressed prediction problems come from practical industrial demands, rather than from academic categories. As such, readers will learn the corresponding approaches for resolving their industrial technical problems. Although the contents of this book and its case studies come from the steel industry, these techniques can be also used for other process industries. This book appeals to students, researchers, and professionals within the machine learning and data analysis and mining communities.

Power System State Estimation

This book addresses a key technology for digital information processing: Kalman filtering, which is generally considered to be one of the greatest discoveries of the 20th century. It introduces readers to issues concerning various uncertainties in a single plant, and to corresponding solutions based on adaptive estimation. Further, it discusses in detail the issues that arise when Kalman filtering technology is applied in multi-sensor systems and/or multi-agent systems, especially when various sensors are used in systems like intelligent robots, autonomous cars, smart homes, smart buildings, etc., requiring multi-sensor information fusion techniques. Furthermore, when multiple agents (subsystems) interact with one another, it produces coupling uncertainties, a challenging issue that is addressed here with the aid of novel decentralized adaptive filtering techniques. Overall, the book's goal is to provide readers with a comprehensive investigation into the challenging problem of making Kalman filtering work well in the presence of various uncertainties and/or for multiple sensors/components. State-of-art techniques are introduced, together with a wealth of novel findings. As such, it can be a good reference book for researchers whose work involves filtering and applications; yet it can also serve as a postgraduate textbook for students in mathematics, engineering, automation, and related fields. To read this book, only a basic grasp of linear algebra and probability theory is needed, though experience with least squares, navigation, robotics, etc. would definitely be a plus.

Optimal State Estimation

The fully automated estimation of the 6 degrees of freedom camera motion and the imaged 3D scenario using as the only input the pictures taken by the camera has been a long term aim in the computer vision community. The associated line of research has been known as Structure from Motion (SfM). An intense research effort during the latest decades has produced spectacular advances; the topic has reached a consistent state of maturity and most of its aspects are well known nowadays. 3D vision has immediate applications in many and diverse fields like robotics, videogames and augmented reality; and technological transfer is starting to be a reality. This book describes one of the first systems for sparse point-based 3D reconstruction and egomotion estimation from an image sequence; able to run in real-time at video frame rate and assuming quite weak prior knowledge about camera calibration, motion or scene. Its chapters unify the current perspectives of the robotics and computer vision communities on the 3D vision topic: As usual in robotics sensing, the explicit estimation and propagation of the uncertainty hold a central role in the sequential video processing and is shown to boost the efficiency and performance of the 3D estimation. On the other hand, some of the most relevant topics discussed in SfM by the computer vision scientists are addressed under this probabilistic filtering scheme; namely projective models, spurious rejection, model selection and self-calibration.
This unified treatment of linear and nonlinear filtering theory presents material previously available only in journals, and in terms accessible to engineering students. Its sole prerequisites are advanced calculus, the theory of ordinary differential equations, and matrix analysis. Although theory is emphasized, the text discusses numerous practical applications as well.

Taking the state-space approach to filtering, this text models dynamical systems by finite-dimensional Markov processes, outputs of stochastic difference, and differential equations.

Starting with background material on probability theory and stochastic processes, the author introduces and defines the problems of filtering, prediction, and smoothing. He presents the mathematical solutions to nonlinear filtering problems, and he specializes the nonlinear theory to linear problems. The final chapters deal with applications, addressing the development of approximate nonlinear filters, and presenting a critical analysis of their performance.

Numerical Methods for Engineers and Scientists

Offering an up-to-date account of the strategies utilized in state estimation of electric power systems, this text provides a broad overview of power system operation and the role of state estimation in overall energy management. It uses an abundance of examples, models, tables, and guidelines to clearly examine new aspects of state estimation, the testing of network observability, and methods to assure computational efficiency. Includes numerous tutorial examples that fully analyze problems posed by the inclusion of current measurements in existing state estimators and illustrate practical solutions to these challenges. Written by two expert researchers in the field, Power System State Estimation extensively details topics never before covered in depth in any other text, including novel robust state estimation methods, estimation of parameter and topology errors, and the use of ampere measurements for state estimation. It introduces various methods and computational issues involved in the formulation and implementation of the weighted least squares (WLS) approach, presents statistical tests for the detection and identification of bad data in system measurements, and reveals alternative topological and numerical formulations for the network observability problem.

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