# Neural Network Based State Estimation Of Nonlinear Systems Application To Fault Detection And Isolation Lecture Notes In Control And Information Sciences

In this book, the stability analysis and estimator design problems are discussed for delayed discrete-time memristive neural networks. In each chapter, the analysis problems are firstly considered, where the stability, synchronization and other performances (e.g., robustness, disturbances attenuation level) are investigated within a unified theoretical framework. In this stage, some novel notions are put forward to reflect the engineering practice. Then, the estimator design issues are discussed where sufficient conditions are derived to ensure the existence of the desired estimators with guaranteed performances. Finally, the theories and techniques developed in previous parts are applied to deal with some issues in several emerging research areas. The book Unifies existing and emerging concepts concerning delayed discrete memristive neural networks with an emphasis on a variety of network-induced phenomena Captures recent advances of theories, techniques, and applications of delayed discrete memristive neural networks from a network-oriented perspective Provides a series of latest results in two

popular yet interrelated areas, stability analysis and state estimation of neural networks Exploits a unified framework for analysis and synthesis by designing new tools and techniques in combination with conventional theories of systems science, control engineering and signal processing Gives simulation examples in each chapter to reflect the engineering practice

This contributed volume provides the state-of-the-art development on security and privacy for cyber-physical systems (CPS) and industrial Internet of Things (IIoT). More specifically, this book discusses the security challenges in CPS and IIoT systems as well as how Artificial Intelligence (AI) and Machine Learning (ML) can be used to address these challenges. Furthermore, this book proposes various defence strategies, including intelligent cyber-attack and anomaly detection algorithms for different IIoT applications. Each chapter corresponds to an important snapshot including an overview of the opportunities and challenges of realizing the AI in IIoT environments, issues related to data security, privacy and application of blockchain technology in the IIoT environment. This book also examines more advanced and specific topics in AI-based solutions developed for efficient anomaly detection in IIoT environments. Different AI/ML techniques including deep representation learning, Snapshot Ensemble Deep Neural Network (SEDNN), federated learning

and multi-stage learning are discussed and analysed as well. Researchers and professionals working in computer security with an emphasis on the scientific foundations and engineering techniques for securing IIoT systems and their underlying computing and communicating systems will find this book useful as a reference. The content of this book will be particularly useful for advanced-level students studying computer science, computer technology, cyber security, and information systems. It also applies to advanced-level students studying electrical engineering and system engineering, who would benefit from the case studies.

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 Góra, the Silesian University of Technology in Gliwice, and the Technical University of Rzeszów. 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.
This two-volume set LNCS 11554 and 11555 constitutes the refereed proceedings of the 16th International Symposium on Neural Networks, ISNN 2019, held in Moscow, Russia, in July 2019. The 111 papers presented in the two volumes were carefully reviewed and selected from numerous submissions. The papers were organized in topical sections named: Learning System, Graph Model, and Adversarial Learning; Time Series Analysis, Dynamic Prediction, and Uncertain Estimation; Model Optimization, Bayesian Learning, and Clustering; Game Theory, Stability Analysis, and Control Method; Signal Processing, Industrial

Application, and Data Generation; Image Recognition, Scene Understanding, and Video Analysis; Bio-signal, Biomedical Engineering, and Hardware.

Exploration of stochastic control theory in terms of analysis, parametric optimization, and optimal stochastic control. Limited to linear systems with quadratic criteria; covers discrete time and continuous time systems. 1970 edition.

The theory of switched systems is related to the study of hybrid systems, which has gained attention from control theorists, computer scientists, and practicing engineers. This book examines switched systems from a control-theoretic perspective, focusing on stability analysis and control synthesis of systems that combine continuous dynamics with switching events. It includes a vast bibliography and a section of technical and historical notes.

The annual IEEE PES General Meeting will bring together over 2700 attendees for technical sessions, administrative sessions, super sessions, poster sessions, student programs, awards ceremonies, committee meetings, tutotials and more

"Neural Network-Based State Estimation of Nonlinear Systems" presents efficient, easy to implement neural network schemes for state estimation, system identification, and fault detection and Isolation with mathematical proof of stability, experimental evaluation, and Robustness against unmolded dynamics, external disturbances, and measurement noises.

Discrete-Time Neural Observers: Analysis and Applications presents recent advances in the theory of neural state estimation for discrete-time unknown nonlinear systems with multiple inputs and outputs. The book includes rigorous mathematical analyses, based on the Lyapunov approach, that guarantee their properties. In addition, for each chapter, simulation results are included to verify the successful performance of the corresponding proposed schemes. In order to complete the treatment of these schemes, the authors also present simulation and experimental results related to their application in meaningful areas, such as electric three phase induction motors and anaerobic process, which show the applicability of such designs. The proposed schemes can be employed for different applications beyond those presented. The book presents solutions for the state estimation problem of unknown nonlinear systems based on two schemes. For the first one, a full state estimation problem is considered; the second one considers the reduced order case with, and without, the presence of unknown delays. Both schemes are developed in discrete-time using recurrent high order neural networks in order to design the neural observers, and the online training of the respective neural networks is performed by Kalman Filtering. Presents online learning for Recurrent High Order Neural Networks (RHONN) using the Extended Kalman Filter (EKF) algorithm Contains full and reduced order neural observers for discrete-time unknown nonlinear systems, with and without delays Includes rigorous analyses of the proposed schemes, including the nonlinear system, the respective observer, and the Kalman filter learning Covers real-time implementation and simulation results for all the proposed schemes to meaningful applications

This book emphasizes the increasingly important role that Computational Intelligence (CI) methods are playing in

solving a myriad of entangled Wireless Sensor Networks (WSN) related problems. The book serves as a guide for surveying several state-of-the-art WSN scenarios in which CI approaches have been employed. The reader finds in this book how CI has contributed to solve a wide range of challenging problems, ranging from balancing the cost and accuracy of heterogeneous sensor deployments to recovering from real-time sensor failures to detecting attacks launched by malicious sensor nodes and enacting CI-based security schemes. Network managers, industry experts, academicians and practitioners alike (mostly in computer engineering, computer science or applied mathematics) benefit from th e spectrum of successful applications reported in this book. Senior undergraduate or graduate students may discover in this book some problems well suited for their own research endeavors.

This book deals with continuous time dynamic neural networks theory applied to the solution of basic problems in robust control theory, including identification, state space estimation (based on neuro-observers) and trajectory tracking. The plants to be identified and controlled are assumed to be a priori unknown but belonging to a given class containing internal unmodelled dynamics and external perturbations as well. The error stability analysis and the corresponding error bounds for different problems are presented. The effectiveness of the suggested approach is illustrated by its application to various controlled physical systems (robotic, chaotic, chemical, etc.).

This book is a tribute to 40 years of contributions by Professor Mo Jamshidi who is a well known and respected scholar, researcher, and educator. Mo Jamshidi has spent his professional career formalizing and extending the field of large-scale complex systems (LSS) engineering resulting in educating numerous graduates specifically, ethnic minorities.

He has made significant contributions in modeling, optimization, CAD, control and applications of large-scale systems leading to his current global role in formalizing system of systems engineering (SoSE), as a new field. His books on complex LSS and SoSE have filled a vacuum in cyber-physical systems literature for the 21st Century. His contributions to ethnic minority engineering education commenced with his work at the University of New Mexico (UNM, Tier-I Hispanic Serving Institution) in 1980 through a NASA JPL grant. Followed by several more major federal grants, he formalized a model for educating minorities, called VI-P Pyramid where K-12 students(bottom of pyramid) to doctoral (top of pyramid) students form a seamless group working on one project. Upper level students mentor lower ones on a sequential basis. Since 1980, he has graduated over 114 minority students consisting of 62 Hispanics, 34 African Americans., 15 Native Americans, and 3 Pacific Islanders. This book contains contributed chapters from colleagues, and former and current students of Professor Jamshidi. Areas of focus are: control systems, energy and system of systems, robotics and soft computing.

This book constitutes the refereed proceedings of the 21st International Conference on Runtime Verification, RV 2021, held virtually during October 11-14, 2021. The 11 regular papers and 7 short/tool/benchmark papers presented in this book were carefully reviewed and selected from 40 submissions. Also included is one tutorial paper. The RV conference is concerned with all aspects of monitoring and analysis of hardware, software and more general system executions.

"This book introduces Higher Order Neural Networks (HONNs) to computer scientists and computer engineers as an open box neural networks tool when compared to traditional artificial neural networks"--Provided by publisher.

The interest in neural network has been rapidly increasing in recent years. The neural network is applied in various fields and in engineering. The state estimation of electric power system is essential for security assessments and is an integral part of the automatic power system control. The weighted least square method and fast decoupled method have been widely used in state estimation of electric power system by utilities. The computation time is an important factor in security assessments and system controls. The improvement of the computational technique and time is always desired in any method of state estimation to obtain the information quickly and hence to increase the system performance. The computational time has been significantly reduced by the application of neural network. The recurrent type of neural network; Hopfield Neural Network (HNN) has been applied in state estimation because of its faster ability of computation and parallel architecture. In this approach, the weighted least square error function is used to identify the Lyapunov function which is mapped into the Hopfield circuit energy function. In this research, state estimator is designed which is an analogous circuit based on set of Hopfield networks. The designed estimator is developed for the general case of the system with arbitrary schemes of the measurements and the system dimensions. Algorithms developed have been tested on 5-bus and IEEE 30-bus system. Numeric experiments carried out have proved that the idea is feasible and improves estimator performance.

Artificial neural network research is one of the new

directions for new generation computers. Current research suggests that open box artificial higher order neural networks (HONNs) play an important role in this new direction. HONNs will challenge traditional artificial neural network products and change the research methodology that people are currently using in control and recognition areas for the control signal generating, pattern recognition, nonlinear recognition, classification, and prediction. Since HONNs are open box models, they can be easily accepted and used by individuals working in information science, information technology, management, economics, and business fields. Emerging Capabilities and Applications of Artificial Higher Order Neural Networks contains innovative research on how to use HONNs in control and recognition areas and explains why HONNs can approximate any nonlinear data to any degree of accuracy, their ease of use, and how they can have better nonlinear data recognition accuracy than SAS nonlinear procedures. Featuring coverage on a broad range of topics such as nonlinear regression, pattern recognition, and data prediction, this book is ideally designed for data analysists, IT specialists, engineers, researchers, academics, students, and professionals working in the fields of economics, business, modeling, simulation, control, recognition, computer science, and engineering research.

Proceedings of the European Control Conference 1991, July 2-5, 1991, Grenoble, France

This work addresses the monitoring and state estimation of electrical grids, especially at the distribution level. For

economic and technical reasons, grid monitoring cannot be implemented with a similarly high measurement density as in transmission grids. Two new monitoring methods, which are designed for low measurement density, are therefore presented for use in real-time grid operation. First, a heuristic monitoring method is presented, which does not require pseudo-measurements and estimates voltage magnitudes and line loadings. Second, a monitoring method based on artificial neural networks is presented. With appropriate training, the method can estimate grid variables, e.g., voltage magnitudes or line loadings, with high accuracy. The methods are tested on thousands of test scenarios using a comprehensive evaluation methodology. For measurement infrastructure planning, a concept is presented to determine suitable measurement locations for the use of one of the monitoring methods. After optimization, several possible measurement configurations are presented with their average and maximum errors and the projected capital expenditures.
Theincreasingcomplexityofspacevehiclessuchassatellites ,andthecostreduction measures that have affected satellite operators are increasingly driving the need for more autonomy in satellite diagnostics and control systems. Current methods for detecting and correcting anomalies onboard the spacecraft as well as on the ground are primarily manual and labor intensive, and therefore, tend to be slow. Operators inspect telemetry data to determine the current satellite health. They use various statisticaltechniques andmodels,buttheanalysisandevaluation

ofthelargevolume of data still require extensive human intervention and expertise that is prone to error. Furthermore, for spacecraft and most of these satellites, there can be potentially unduly long delays in round-trip communications between the ground station and the satellite. In this context, it is desirable to have onboard fault-diagnosis system that is capable of detecting, isolating, identifying or classifying faults in the system wit houttheinvolvementandinterventionofoperators.Towardthi send,theprinciple goal here is to improve the ef?ciency, accuracy, and reliability of the trend analysis and diagnostics techniques through utilization of intelligent-based and hybrid-based methodologies.

Terrain relative navigation can improve the precision of a spacecraft's state estimate by providing supplementary measurements to correct for drift in the inertial navigation system. This thesis presents a crater detector, LunaNet, that uses a convolutional neural network and image processing methods to detect craters from imagery taken by a spacecraft's on-board camera. These detections are matched with known lunar craters, and these matches can be used as features that are input to a extended Kalman filter. Our results show that, on average, LunaNet detects approximately twice the number of craters in an intensity image as two other successful intensity image-based crater detectors, and detects more accurate crater centers and diameters than the other two detectors as well. One of the challenges of using cameras for this task is that they can generate imagery with differences in image qualities and noise levels. These differences can occur for reasons such as

changes in irradiance of the lunar surface, heating of camera electronic elements, or the inherent fluctuation of discrete photons. These image noise effects are difficult to compensate for, making it important for a crater detector to be robust to noise. When trained on diverse data, convolutional neural networks are able to generalize over varied imagery. Similarly, LunaNet is shown to be robust to four types of image manipulation that result in changes to image qualities and noise levels of the input imagery. LunaNet also produces more repeatable crater detections from frame to frame throughout a trajectory, and that enables more reliable state estimation over a trajectory. A LunaNet-based EKF experiences fewer spikes in estimation error and has lower average estimation error than EKFs using other successful crater detectors.

With the steady stream of new web based information technologies being introduced to organizations, the need for network and communication technologies to provide an easy integration of knowledge and information sharing is essential. Network and Communication Technology Innovations for Web and IT Advancement presents studies on trends, developments, and methods on information technology advancements through network and communication technology. This collection brings together integrated approaches for communication technology and usage for web and IT advancements.

The book features selected high-quality papers presented at the International Conference on Computing, Power and Communication Technologies 2019 (GUCON

2019), organized by Galgotias University, India, in September 2019. Divided into three sections, the book discusses various topics in the fields of power electronics and control engineering, power and energy systems, and machines and renewable energy. This interesting compilation is a valuable resource for researchers, engineers and students.

Provides comprehensive treatment of the theory of both static and dynamic neural networks. * Theoretical concepts are illustrated by reference to practical examples Includes end-of-chapter exercises and end-of-chapter exercises. *An Instructor Support FTP site is available from the Wiley editorial department.

The focus of this book is the application of artificial neural networks in uncertain dynamical systems. It explains how to use neural networks in concert with adaptive techniques for system identification, state estimation, and control problems. The authors begin with a brief historical overview of adaptive control, followed by a review of mathematical preliminaries. In the subsequent chapters, they present several neural network-based control schemes. Each chapter starts with a concise introduction to the problem under study, and a neural network-based control strategy is designed for the simplest case scenario. After these designs are discussed, different practical limitations (i.e., saturation constraints and unavailability of all system states) are gradually added, and other control schemes are developed based on the primary scenario. Through these exercises, the authors present structures that not only provide mathematical tools for navigating control

problems, but also supply solutions that are pertinent to real-life systems.

This book summarizes the application of linear algebra-based controllers (LABC) for trajectory tracking for practitioners and students across a range of engineering disciplines. It clarifies the necessary steps to apply this straight-forward technique to a non-linear multivariable system, dealing with continuous or discrete time models, and outlines the steps to implement such controllers. In this book, the authors present an approach of the trajectory tracking problem in systems with dead time and in the presence of additive uncertainties and environmental disturbances. Examples of applications of LABC to systems in real operating conditions (mobile robots, marine vessels, quadrotor and pvtol aircraft, chemical reactors and First Order Plus Dead Time systems) illustrate the controller design in such a way that the reader attains an understanding of LABC.

A practical introduction to intelligent computer vision theory, design, implementation, and technology The past decade has witnessed epic growth in image processing and intelligent computer vision technology. Advancements in machine learning methods—especially among adaboost varieties and particle filtering methods—have made machine learning in intelligent computer vision more accurate and reliable than ever before. The need for expert coverage of the state of the art in this burgeoning field has never been greater, and this book satisfies that need. Fully updated and extensively revised, this 2nd Edition of the popular guide provides designers, data analysts, researchers and

advanced post-graduates with a fundamental yet wholly practical introduction to intelligent computer vision. The authors walk you through the basics of computer vision, past and present, and they explore the more subtle intricacies of intelligent computer vision, with an emphasis on intelligent measurement systems. Using many timely, real-world examples, they explain and vividly demonstrate the latest developments in image and video processing techniques and technologies for machine learning in computer vision systems, including: PRTools5 software for MATLAB—especially the latest representation and generalization software toolbox for PRTools5 Machine learning applications for computer vision, with detailed discussions of contemporary state estimation techniques vs older content of particle filter methods The latest techniques for classification and supervised learning, with an emphasis on Neural Network, Genetic State Estimation and other particle filter and AI state estimation methods All new coverage of the Adaboost and its implementation in PRTools5. A valuable working resource for professionals and an excellent introduction for advanced-level students, this 2nd Edition features a wealth of illustrative examples, ranging from basic techniques to advanced intelligent computer vision system implementations. Additional examples and tutorials, as well as a question and solution forum, can be found on a companion website. Neural Networks for Control brings together examples of all the most important paradigms for the application of neural networks to robotics and control. Primarily concerned with engineering problems and approaches to

their solution through neurocomputing systems, the book is divided into three sections: general principles, motion control, and applications domains (with evaluations of the possible applications by experts in the applications areas.) Special emphasis is placed on designs based on optimization or reinforcement, which will become increasingly important as researchers address more complex engineering challenges or real biological-control problems.A Bradford Book. Neural Network Modeling and Connectionism series

This open access book presents papers displayed in the 2nd International Conference on Energy and Sustainable Futures (ICESF 2020), co-organised by the University of Hertfordshire and the University Alliance DTA for Energy. The research included in this book covers a wide range of topics in the areas of energy and sustainability including: • ICT and control of energy; • conventional energy sources; • energy governance; • materials in energy research; • renewable energy; and • energy storage. The book offers a holistic view of topics related to energy and sustainability, making it of interest to experts in the field, from industry and academia.

27th European Symposium on Computer Aided Process Engineering, Volume 40 contains the papers presented at the 27th European Society of Computer-Aided Process Engineering (ESCAPE) event held in Barcelona, October 1-5, 2017. It is a valuable resource for chemical engineers, chemical process engineers, researchers in industry and academia, students, and consultants for chemical industries. Presents findings and discussions from the 27th European Society of Computer-Aided

Process Engineering (ESCAPE) event

Artificial Neural Networks (ANNs) is a powerful computational tool to mimic the learning process of the mammalian brain. This book gives a comprehensive overview of ANNs including an introduction to the topic, classifications of single neurons and neural networks, model predictive control and a review of ANNs used in food processing. Also, examples of ANNs in food processing applications such as pasteurization control are illustrated.

This book deals with continuous time dynamic neural networks theory applied to the solution of basic problems in robust control theory, including identification, state space estimation (based on neuro-observers) and trajectory tracking. The plants to be identified and controlled are assumed to be a priori unknown but belonging to a given class containing internal unmodelled dynamics and external perturbations as well. The error stability analysis and the corresponding error bounds for different problems are presented. The effectiveness of the suggested approach is illustrated by its application to various controlled physical systems (robotic, chaotic, chemical, etc.). Contents:Theoretical Study:Neural Networks StructuresNonlinear System Identification: Differential LearningSliding Mode Identification: Algebraic LearningNeural State EstimationPassivation via Neuro ControlNeuro Trajectory TrackingNeurocontrol Applications:Neural Control for ChaosNeuro Control for Robot ManipulatorsIdentification of Chemical ProcessesNeuro Control for Distillation ColumnGeneral Conclusions and Future

WorkAppendices:Some Useful Mathematical FactsElements of Qualitative Theory of ODELocally Optimal Control and Optimization Readership: Graduate students, researchers, academics/lecturers and industrialists in neural networks. Keywords:Dynamic Neural Networks;System Identification;State Estimation;Adaptive Control;Robust Control;Sliding Mode;Chaos Identification and Control;Chemical Process;Lyapunov Method;StabilityReviews:“This book is the result of many years of research and publications by the authors. Overall, it is a good one that could benefit the researchers and practitioners in the field of intelligent nonlinear control systems. Design methods and analytical results are well presented and substantiated by closely-related simulation examples and engineering applications. It is a very good addition to the libraries of those interested in the subject. It is also qualified to be used as a postgraduate-level reference.”International Journal of Adaptive Control and Signal Processing 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.