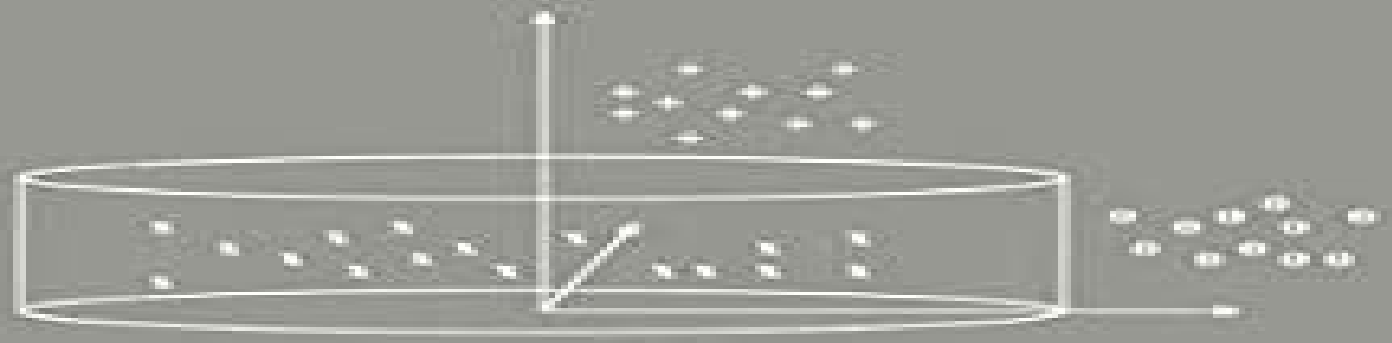
Evan L. Russell, Leo H. Chiang
and Richard D. Braatz

DATA-DRIVEN TECHNIQUES FOR FAULT DETECTION AND DIAGNOSIS IN CHEMICAL PROCESSES



Advances in Industrial Control

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Data Driven Methods For Fault Detection And Diagnosis In Chemical Processes Advances In Industrial Control

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Data-driven Methods for Fault Detection and Diagnosis in Chemical Processes Evan L. Russell,Leo H. Chiang,Richard D. Braatz,2012-11-01 Early and accurate fault detection and diagnosis for modern chemical plants can minimise downtime increase the safety of plant operations and reduce manufacturing costs The process monitoring techniques that have been most effective in practice are based on models constructed almost entirely from process data The goal of the book is to present the theoretical background and practical techniques for data driven process monitoring Process monitoring techniques presented include Principal component analysis Fisher discriminant analysis Partial least squares Canonical variate analysis The text demonstrates the application of all of the data driven process monitoring techniques to the Tennessee Eastman plant simulator demonstrating the strengths and weaknesses of each approach in detail This aids the reader in selecting the right method for his process application Plant simulator and homework problems in which students apply the process monitoring techniques to a nontrivial simulated process and can compare their performance with that obtained in the case studies in the text are included A number of additional homework problems encourage the reader to implement and obtain a deeper understanding of the techniques The reader will obtain a background in data driven techniques for fault detection and diagnosis including the ability to implement the techniques and to know how to select the right technique for a particular application Data-driven Methods for Fault Detection and Diagnosis in Chemical Processes Evan L. Russell,Leo H. Chiang,Richard D. Braatz,2012-12-06 Early and accurate fault detection and diagnosis for modern chemical plants can minimise downtime increase the safety of plant operations and reduce manufacturing costs The process monitoring techniques that have been most effective in practice are based on models constructed almost entirely from process data The goal of the book is to present the theoretical background and practical techniques for data driven process monitoring Process monitoring techniques presented include Principal component analysis Fisher discriminant analysis Partial least squares Canonical variate analysis The text demonstrates the application of all of the data driven process monitoring techniques to the Tennessee Eastman plant simulator demonstrating the strengths and weaknesses of each approach in detail This aids the reader in selecting the right method for his process application Plant simulator and homework problems in which students apply the process monitoring techniques to a nontrivial simulated process and can compare their performance with that obtained in the case studies in the text are included A number of additional homework problems encourage the reader to implement and obtain a deeper understanding of the techniques The reader will obtain a background in data driven techniques for fault detection and diagnosis including the ability to implement the techniques and to know how to select the right technique for a particular application **Fault Detection and Diagnosis in Industrial Systems** L.H. Chiang,E.L. Russell,R.D. Braatz,2012-12-06 Early and accurate fault detection and diagnosis for modern chemical plants can minimise downtime increase the safety of plant operations and reduce manufacturing costs The process

monitoring techniques that have been most effective in practice are based on models constructed almost entirely from process data The goal of the book is to present the theoretical background and practical techniques for data driven process monitoring Process monitoring techniques presented include Data driven methods principal component analysis Fisher discriminant analysis partial least squares and canonical variate analysis Analytical Methods parameter estimation observer based methods and parity relations Knowledge based methods causal analysis expert systems and pattern recognition The text demonstrates the application of all of the data driven process monitoring techniques to the Tennessee Eastman plant simulator demonstrating the strengths and weaknesses of each approach in detail This aids the reader in selecting the right method for his process application Plant simulator and homework problems in which students apply the process monitoring techniques to a non trivial simulated process and can compare their performance with that obtained in the case studies in the text are included A number of additional homework problems encourage the reader to implement and obtain a deeper understanding of the techniques The reader will obtain a background in data driven techniques for fault detection and diagnosis including the ability to implement the techniques and to know how to select the right technique for a particular application **Data-driven Design of Fault Diagnosis and Fault-tolerant Control Systems** Steven X. Ding,2014-04-12 Data driven Design of Fault Diagnosis and Fault tolerant Control Systems presents basic statistical process monitoring fault diagnosis and control methods and introduces advanced data driven schemes for the design of fault diagnosis and fault tolerant control systems catering to the needs of dynamic industrial processes With ever increasing demands for reliability availability and safety in technical processes and assets process monitoring and fault tolerance have become important issues surrounding the design of automatic control systems This text shows the reader how thanks to the rapid development of information technology key techniques of data driven and statistical process monitoring and control can now become widely used in industrial practice to address these issues To allow for self contained study and facilitate implementation in real applications important mathematical and control theoretical knowledge and tools are included in this book Major schemes are presented in algorithm form and demonstrated on industrial case systems Data driven Design of Fault Diagnosis and Fault tolerant Control Systems will be of interest to process and control engineers engineering students and researchers with a control engineering background **Advanced methods for fault diagnosis and fault-tolerant control** Steven X. Ding,2020-11-24 The major objective of this book is to introduce advanced design and online optimization methods for fault diagnosis and fault tolerant control from different aspects Under the aspect of system types fault diagnosis and fault tolerant issues are dealt with for linear time invariant and time varying systems as well as for nonlinear and distributed including networked systems From the methodological point of view both model based and data driven schemes are investigated To allow for a self contained study and enable an easy implementation in real applications the necessary knowledge as well as tools in mathematics and control theory are included in this book The main results with the fault diagnosis and fault tolerant

schemes are presented in form of algorithms and demonstrated by means of benchmark case studies The intended audience of this book are process and control engineers engineering students and researchers with control engineering background

Fault Diagnosis of Dynamic Systems Teresa Escobet,Anibal Bregon,Belarmino Pulido,Vicenç Puig,2019-06-22 Fault Diagnosis of Dynamic Systems provides readers with a glimpse into the fundamental issues and techniques of fault diagnosis used by Automatic Control FDI and Artificial Intelligence DX research communities The book reviews the standard techniques and approaches widely used in both communities It also contains benchmark examples and case studies that demonstrate how the same problem can be solved using the presented approaches The book also introduces advanced fault diagnosis approaches that are currently still being researched including methods for non linear hybrid discrete event and software business systems as well as an introduction to prognosis Fault Diagnosis of Dynamic Systems is valuable source of information for researchers and engineers starting to work on fault diagnosis and willing to have a reference guide on the main concepts and standard approaches on fault diagnosis Readers with experience on one of the two main communities will also find it useful to learn the fundamental concepts of the other community and the synergies between them The book is also open to researchers or academics who are already familiar with the standard approaches since they will find a collection of advanced approaches with more specific and advanced topics or with application to different domains Finally engineers and researchers looking for transferable fault diagnosis methods will also find useful insights in the book **Methods in Chemical Process Safety** ,2020-06-26 Methods in Chemical Process Safety Volume Four focuses on the process of learning from experience including elements of process safety management human factors in the chemical process industries and the regulation of chemical process safety including current approaches Users will find this book to be an informative tool and user manual for process safety for a variety of professionals with this new release focusing on Advanced Methods of Risk Assessment and Management Logic Based Methods for Dynamic Risk Assessment Bayesian Methods for Dynamic Risk Assessment Data Driven Methods Rare Event Risk Assessment Risk Management and Multi Criteria and much more Helps acquaint the reader researcher with the fundamentals of process safety Provides the most recent advancements and contributions on the topic from a practical point of view Presents users with the views opinions of experts in each topic Includes a selection of authors who are leading researchers and or practitioners for each given topic Frontiers in Statistical Quality Control 8 Hans-Joachim Lenz,Peter-Theodor Wilrich,2006-08-08 In Canada acceptance sampling has been used in legal metrology applications for nearly four decades One of its principal uses has been in the quality control of utility meters that measure electricity or natural gas supplied to consumers By law such meters must be inspected for conformance to specification requirements prior to use and be periodically inspected while huse With few exceptions due to the numerous utility companies in the country and their varied practices the meters exist in the form of isolated lots for inspection purposes The proportion of nonconforming meters in a lot has traditionally defined lot quality for utility meter sampling inspection

purposes Another principal application of acceptance sampling has been in the quality control of the net contents of packaged products sold in the marketplace Such products include those sold on the basis of such measures as weight volume length and area In this particular application products are also usually inspected on an isolated lot basis for regulatory purposes However lot quality is usually measured on the basis of two criteria for such products the proportion of nonc forming packages in the lot and the lot mean quantity This section reviews Canadian quality control practices in these two areas of application highlighting some of the deficiencies and issues Three class s pling plans are proposed as a possible solution to some of these deficiencies and issues **Model-based Fault Diagnosis in Dynamic Systems Using Identification Techniques** Silvio Simani,Cesare Fantuzzi,Ron J. Patton,2013-11-11 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 **Plug-and-Play Monitoring and Performance Optimization for Industrial Automation Processes** Hao Luo,2016-10-07 Dr Ing Hao Luo demonstrates the developments of advanced plug and play PnP process monitoring and control systems for industrial automation processes With aid of the so called Youla parameterization a novel PnP process monitoring and control architecture PnP PMCA with modularized components is proposed To validate the developments a case study on an industrial rolling mill benchmark is performed and the real time implementation on a laboratory brushless DC motor is presented

AI in Chemical Engineering José A. Romagnoli,Luis Briceño-Mena,Vidhyadhar Manee,2024-12-31 Industry 4 0 is revolutionizing chemical manufacturing Today s chemical companies are swiftly embracing the digital era recognizing the significant benefits of interconnected products production equipment and personnel As technology advances and production volumes grow there is an increasing need for new computational tools and innovative solutions to address everyday challenges AI in Chemical Engineering Unlocking the Power Within Data introduces readers to the essential concepts of machine learning and their application in the chemical and process industries aiming to enhance efficiency adaptability and profitability This work delves into the transformation of traditional plant operations into integrated and intelligent systems providing readers with a foundation for developing and understanding the tools necessary for data collection and analysis thereby gaining valuable insights and practical applications Introduces the principles and applications of unsupervised

learning and discusses the role of machine learning in extracting information from plant data and transforming it into knowledge Conveys the concepts principles and applications of supervised learning setting the stage for developing advanced monitoring systems complex predictive models and advanced computer vision applications Explores implementation of reinforced learning ideas for chemical process control and optimization investigating various model structures and discussing their practical implementation in both simulation and experimental units Incorporates sample code examples in Python to illustrate key concepts Includes real life case studies in the context of chemical engineering and covers a wide variety of chemical engineering applications from oil and gas to bioengineering and electrochemistry Clearly defines types of problems in chemical engineering subject to AI solutions and relates them to subfields of AI This practical text designed for advanced chemical engineering students and industry practitioners introduces concepts and theories in a logical and sequential manner It serves as an essential resource helping readers understand both current and emerging developments in this important and evolving field **Statistical Process Monitoring Using Advanced Data-Driven and Deep Learning Approaches** Fouzi Harrou,Ying Sun,Amanda S. Hering,Muddu Madakyaru,abdelkader Dairi,2020-07-03 Statistical Process Monitoring Using Advanced Data Driven and Deep Learning Approaches tackles multivariate challenges in process monitoring by merging the advantages of univariate and traditional multivariate techniques to enhance their performance and widen their practical applicability The book proceeds with merging the desirable properties of shallow learning approaches such as a one class support vector machine and k nearest neighbours and unsupervised deep learning approaches to develop more sophisticated and efficient monitoring techniques Finally the developed approaches are applied to monitor many processes such as waste water treatment plants detection of obstacles in driving environments for autonomous robots and vehicles robot swarm chemical processes continuous stirred tank reactor plug flow rector and distillation columns ozone pollution road traffic congestion and solar photovoltaic systems Uses a data driven based approach to fault detection and attribution Provides an in depth understanding of fault detection and attribution in complex and multivariate systems Familiarises you with the most suitable data driven based techniques including multivariate statistical techniques and deep learning based methods Includes case studies and comparison of different methods *Fault Detection, Supervision and Safety of Technical Processes 2003 (SAFEPROCESS 2003)* Marcel Staroswiecki,Eva Wu,2004-02-27 A three volume work bringing together papers presented at SAFEPROCESS 2003 including four plenary papers on statistical physical model based and logical model based approaches to fault detection and diagnosis as well as 178 regular papers

Data-Driven Fault Detection for Industrial Processes Zhiwen Chen,2017-01-02 Zhiwen Chen aims to develop advanced fault detection FD methods for the monitoring of industrial processes With the ever increasing demands on reliability and safety in industrial processes fault detection has become an important issue Although the model based fault detection theory has been well studied in the past decades its applications are limited to large scale industrial processes

because it is difficult to build accurate models Furthermore motivated by the limitations of existing data driven FD methods novel canonical correlation analysis CCA and projection based methods are proposed from the perspectives of process input and output data less engineering effort and wide application scope For performance evaluation of FD methods a new index is also developed *Injection Molding Process Control, Monitoring, and Optimization* Yi Yang,Xi Chen,Ningyun Lu,Furong Gao,2017-04-10 Improvement of injection molding processes remains a topic of great interest in both industry and research institutions This book introduces the analysis of the molding process from a systems technology point of view It is divided into four parts the first part provides general background to introduce the injection molding process the second covers the control of the process the third is on the monitoring technology and the fourth is concerned with the optimization of the process Most the results within are from real engineering implementations and experimental tests **Advances of Computational Intelligence in Industrial Systems** Ying Liu,Aixin Sun,Han Tong Loh,Wen Feng Lu,Ee-Peng Lim,2008-05-23 Computational Intelligence CI has emerged as a rapidly growing field over the past decade This volume reports the exploration of CI frontiers with an emphasis on a broad spectrum of real world applications Such a collection of chapters has presented the state of the art of CI applications in industry and will be an essential resource for professionals and researchers who wish to learn and spot the opportunities in applying CI techniques to their particular problems

Active Fault-Tolerant Control Systems Tushar Jain,Joseph J. Yamé,Dominique Sauter,2017-10-20 The book introduces novel algorithms for designing fault tolerant control FTC systems using the behavioral system theoretic approach and presents a demonstration of successful novel FTC mechanisms on several benchmark examples The authors also discuss a new transient management scheme which is an essential requirement for the implementation of active FTC systems and two data driven methodologies that are broadly classified as active FTC systems the projection based approach and the online redesign approach These algorithms do not require much a priori information about the plant in real time and in addition this novel implementation of active FTC systems circumvents various weaknesses induced by using a diagnostic module in real time The book provides graduate students taking masters and doctoral courses in mathematics control and electrical engineering an excellent stepping stone for their research It also appeals to practitioners interested to apply innovative fail safe control techniques **Methods to Assess and Manage Process Safety in Digitalized Process System** Faisal Khan,2022-07-06 Methods to Assess and Manage Process Safety in Digitalized Process System Volume Six the latest release in the Methods in Chemical Process Safety series highlights new advances in the field with this new volume presenting interesting chapters written by an international board of authors Provides the authority and expertise of leading contributors from an international board of authors Presents the latest release in the Methods in Chemical Process Safety series Provides the authority and expertise of leading contributors from an international board of authors Advances in Human Factors in Robots and Unmanned Systems Jessie Chen,2017-06-30 This book focuses on the importance of human factors in the

development of safe and reliable unmanned systems It discusses current challenges such as how to improve the perceptual and cognitive abilities of robots develop suitable synthetic vision systems cope with degraded reliability in unmanned systems predict robotic behavior in case of a loss of communication the vision for future soldier robot teams human agent teaming real world implications for human robot interaction and approaches to standardize both the display and control of technologies across unmanned systems Based on the AHFE 2017 International Conference on Human Factors in Robots and Unmanned Systems held on July 17 21 in Los Angeles California USA this book is expected to foster new discussion and stimulate new advances in the development of more reliable safer and highly functional devices for carrying out automated and concurrent tasks Applied Predictive Control Sunan Huang,Tong Heng Lee,2013-03-09 The series Advances in Industrial Control aims to report and encourage technology transfer in control engineering The rapid development of control technology has an impact on all areas of the control discipline New theory new controllers actuators sensors new industrial processes computer methods new applications new philosophies new challenges Much of this development work resides in industrial reports feasibility study papers and the reports of advanced collaborative projects The series offers an opportunity for researchers to present an extended exposition of such new work in all aspects of industrial control for wider and rapid dissemination The Advances in Industrial Control series promotes control techniques which are used by industry The series has useful volumes in various aspects of proportional integral derivative PID control because of the widespread use of PID in applications Predictive control is another technique that quickly became essential in some sectors of the petro chemical and process control industries It was the ability of the method to incorporate operational constraints that lead to this take up by industry The wider industrial applications of predictive control has been slower to develop indeed some practitioners might argue that this technology transfer step is still active or had only just begun in some industrial sectors

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