

Performance Assessment of Control Loops

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Abstract: The main concern of this thesis is to assess control loop performance using minimum variance control by FCOR algorithm in a convenient way by using only routine operating data and comparing the outcomes with an existing algorithm (named PINDEN). Only by determining a performance factor of the feed-back control loop the controller performance could be assessed, even from thousands of control loops in process industries. Minimum variance is the benchmark which indicates attainable minimum variance against the actual variance of the control error. A performance index has been defined as the ratio of minimum variance to actual variance. Where, a performance index value close to 1 indicates good control a value close to 0 indicates poor control. The performance index is always bounded between 0 to 1. The performance index calculation algorithm was implemented using MATLAB. A dynamic simulation study was performed using Aspen HYSYS for generating process data and also by SIMULINK. Various cases such as noise corruption, stiction and oscillation were introduced and the aftermath was studied and analyzed. Industrial data from an Ammonia plant (SAFCO) was also analyzed. All the results are compared with previously developed algorithm. This thesis will help to outline a very simple but effective way to detect performance of the controller in process systems.

Keywords: FCOR, SISO, Performance Index, Feed-back Controlling.

1. Introduction

In any chemical complex the foremost endeavor for any chemical engineer is to make money save money. In process controlling it is very indispensable to get some quick idea that all the controller in control loops working satisfactorily or not. If this checking upon collection of process data could be done within a very short time then the frequency of online checking could be enhanced. So it is very important to take decision about replacing any existing controller or keeping it in accordance with its performance factor. As a relevance to this pragmatic demand, the main objective is to assess control loops performance by applying minimum variance control law, using closed loop process data. According to minimum variance controlling minimum variance is the benchmark which indicates attainable minimum variance against the actual variance of the control error. A performance index has been defined as the ratio of minimum variance to actual variance of the control loop. Thus performance index value close to 1 indicates good control while value close to 0 indicates poor control. The performance index value is always bounded between 0 to 1. For performance index evaluation, algorithm implemented using MATLAB.

2. About Methodology

A controller performance assessment technique has been developed using the routine operating data for univariate control loops, assuming that control objective is to reduce process variance; this conventional approach is termed as Minimum Variance Control. It is used naturally as the benchmark standard against which

current control loop performance is assessed. It has been acknowledged that a system with time delay d , a portion of output variance is feedback control invariant and can be estimated from routine operating data. This portion of output variance equals the variance achieved under minimum variance control; thus the method for the estimation of the minimum variance from routine operating data is established. Observed minimum variance for any system means theoretically achievable absolute lower bound of output variance to assess control loop performance. Using minimum variance control as the benchmark does not mean that one has to implement such a controller on the actual process. This benchmark control may or may not be achievable in practice depending on several physical constraints. However, as a benchmark, it provides useful information such as how well the current controller and how much potential there is to improve controller performance further. If the controller indicates a good performance measure relative to minimum variance control, further tuning or re-designing of the control algorithm is neither necessary nor helpful. In this case, if further reduction of process variation is desired, implementation of other strategies such as feed forward control or re-engineering of the process itself may be necessary. On the other hand, if the controller indicates a poor performance measure, further analysis, such as model analysis, robustness analysis, constraint analysis etc may be necessary.

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Anthony S. Fauci



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Performance Assessment of Control Loops Biao Huang, Sirish L. Shah, 2012-12-06 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 Benchmarking is a technique first applied by Rank Xerox in the late 1970s for business processes As a subject in the commercial arena benchmarking thrives with for example a European Benchmarking Forum It has taken rather longer for benchmarking to make the transfer to the technical domain and even now the subject is making a slow headway A key research step in this direction was taken by Harris 1989 who used minimum variance control as a benchmark for controller loop assessment This contribution opened up the area and a significant specialist literature has now developed Significant support for the methodology was given by Honeywell who have controller assessment routines in their process control applications software therefore it is timely to welcome a first monograph on controller performance assessment by Biao Huang and Sirish Shah to the Advances in Industrial Control series [On performance assessment of feedback control loops](#) Byung-su Ko, 2000 **Control Performance Management in Industrial Automation** Mohieddine Jelali, 2012-10-31 Control Performance Management in Industrial Automation provides a coherent and self contained treatment of a group of methods and applications of burgeoning importance to the detection and solution of problems with control loops that are vital in maintaining product quality operational safety and efficiency of material and energy consumption in the process industries The monograph deals with all aspects of control performance management CPM from controller assessment minimum variance control based and advanced methods to detection and diagnosis of control loop problems process non linearities oscillations actuator faults to the improvement of control performance maintenance re design of loop components automatic controller re tuning It provides a contribution towards the development and application of completely self contained and automatic methodologies in the field Moreover within this work many CPM tools have been developed that goes far beyond available CPM packages Control Performance Management in Industrial Automation presents a comprehensive review of control performance assessment methods develops methods and procedures for the detection and diagnosis of the root causes of poor performance in complex control loops covers important issues that arise when applying these assessment and diagnosis methods recommends new approaches and techniques for the optimization of control loop performance based on the results of the control performance stage and offers illustrative examples and industrial case studies drawn from chemicals building mining pulp and paper mineral and metal processing industries This book will be of interest to academic

and industrial staff working on control systems design maintenance or optimisation in all process industries *Control Loop Performance Assessment with Closed-loop Subspace Identification* Nima Danesh Pour,2009 **Frequency and Time-domain Techniques for Control Loop Performance Assessment** Anand Vishnubhotla,1997 **Intelligent Decision Technologies** R. Neves-Silva,J. Watada,G.E. Phillips-Wren,2013-06-13 The field of intelligent decision technologies is interdisciplinary in nature bridging computer science with its development of artificial intelligence information systems with its development of decision support systems and engineering with its development of systems This book presents the 45 papers accepted for presentation at the 5th KES International Conference on Intelligent Decision Technologies KES IDT 2013 held in Sesimbra Portugal in June 2013 The conference consists of keynote talks oral and poster presentations invited sessions and workshops on the applications and theory of intelligent decision systems and related areas The conference provides an opportunity for the presentation and discussion of interesting new research results promoting knowledge transfer and the generation of new ideas The book will be of interest to all those whose work involves the development and application of intelligent decision systems **Emerging Electronics and Automation** Peter Han Joo Chong,Akhtar Kalam,Antonio Pascoal,Manas Kumar Bera,2022-11-09 This book constitutes peer reviewed proceedings of the International Conference on Emerging Electronics and Automation E2A 2021 The book presents new ideas research findings and novel techniques in the fields of sensors and instrumentation automation and control artificial intelligence MEMS sensors soft computing signal processing and communication It includes contributions received from both academia and industry The proceedings will be helpful for beginners as well as advanced researchers in the area of automation and other allied fields Automation in Mining, Mineral and Metal Processing 2004 Dominique Sauter,D. Theilliol,2006-02-21 Approx 482 pages *Profit Maximization Techniques for Operating Chemical Plants* Sandip K. Lahiri,2020-05-01 A systematic approach to profit optimization utilizing strategic solutions and methodologies for the chemical process industry In the ongoing battle to reduce the cost of production and increase profit margin within the chemical process industry leaders are searching for new ways to deploy profit optimization strategies Profit Maximization Techniques For Operating Chemical Plants defines strategic planning and implementation techniques for managers senior executives and technical service consultants to help increase profit margins The book provides in depth insight and practical tools to help readers find new and unique opportunities to implement profit optimization strategies From identifying where the large profit improvement projects are to increasing plant capacity and pushing plant operations towards multiple constraints while maintaining continuous improvements there is a plethora of information to help keep plant operations on budget The book also includes information on Take away methods and techniques for identifying and exploiting potential areas to improve profit within the plant Focus on latest Artificial Intelligence based modeling knowledge discovery and optimization strategies to maximize profit in running plant Describes procedure to develop advance process monitoring and fault diagnosis in running plant Thoughts on engineering

design best practices and monitoring to sustain profit improvements Step by step guides to identifying building and deploying improvement applications For leaders and technologists in the industry who want to maximize profit margins this text provides basic concepts guidelines and step by step guides specifically for the chemical plant sector *Performance*

Assessment and Root Cause Analysis of Multivariable PID Control Loops Mehmet Yağcı,2016 **Control Performance**

Assessment: Theoretical Analyses and Industrial Practice Paweł D. Domański,2019-09-01 This book presents a comprehensive review of currently available Control Performance Assessment methods It covers a broad range of classical and modern methods with a main focus on assessment practice and is intended to help practitioners learn and properly perform control assessment in the industrial reality Further it offers an educational guide for control engineers who are currently in high demand in the industry The book consists of three main parts Firstly a comprehensive review of available approaches is presented and discussed The classical canon methods are extended with a discussion of nonlinear and complex alternative measures using non Gaussian statistics persistence and fractional calculations Secondly the methods applicability aspects are visualized with the aid of computer simulations covering the most popular control philosophies used in the process industry Lastly a critical review of the methods discussed on the basis of real world industrial examples rounds out the coverage *IEE Seminar Control Loop Performance Assessment* , *Performance Evaluation, Prediction and*

Visualization of Parallel Systems Xingfu Wu,1999-02-28 *Performance Evaluation Prediction and Visualization in Parallel Systems* presents a comprehensive and systematic discussion of theoretics methods techniques and tools for performance evaluation prediction and visualization of parallel systems Chapter 1 gives a short overview of performance degradation of parallel systems and presents a general discussion on the importance of performance evaluation prediction and visualization of parallel systems Chapter 2 analyzes and defines several kinds of serial and parallel runtime points out some of the weaknesses of parallel speedup metrics and discusses how to improve and generalize them Chapter 3 describes formal definitions of scalability addresses the basic metrics affecting the scalability of parallel systems discusses scalability of parallel systems from three aspects parallel architecture parallel algorithm and parallel algorithm architecture combinations and analyzes the relations of scalability and speedup Chapter 4 discusses the methodology of performance measurement describes the benchmark oriented performance test and analysis and how to measure speedup and scalability in practice Chapter 5 analyzes the difficulties in performance prediction discusses application oriented and architecture oriented performance prediction and how to predict speedup and scalability in practice Chapter 6 discusses performance visualization techniques and tools for parallel systems from three stages performance data collection performance data filtering and performance data visualization and classifies the existing performance visualization tools Chapter 7 describes parallel compiling based search based and knowledge based performance debugging which assists programmers to optimize the strategy or algorithm in their parallel programs and presents visual programming based performance debugging to help

programmers identify the location and cause of the performance problem It also provides concrete suggestions on how to modify their parallel program to improve the performance Chapter 8 gives an overview of current interconnection networks for parallel systems analyzes the scalability of interconnection networks and discusses how to measure and improve network performances Performance Evaluation Prediction and Visualization in Parallel Systems serves as an excellent reference for researchers and may be used as a text for advanced courses on the topic **Bendix Technical Journal** ,1968

Multivariate Statistical Methods for Control Loop Performance Assessment Biao Huang,1997 **The Canadian Journal of Chemical Engineering** ,2007-08 **AIChE Symposium Series** American Institute of Chemical Engineers,1997 *Control Loop Performance Assessment and Oscillation Detection [microform]* Lahoucine Ettaleb,1999

Advanced Research on Information Science, Automation and Material System Helen Zhang,Gang Shen,David Jin,2011-03-28 Selected peer reviewed papers from the 2011 International Conference on Information Science Automation and Material System ISAM 2011 May 21 22 2011 Zhengzhou China *Tuning and Control Loop Performance, Fourth Edition* Gregory K. McMillan,2014-12-18 Tuning and Control Loop Performance Fourth Edition provides the knowledge to eliminate the misunderstandings realize the difference between theoretical and industrial application of PID control address practical difficulties improve field automation system design use the latest PID features and ultimately get the best tuning settings that enables the PID to achieve its full potential The proportional integral derivative PID controller is the heart of every control system in the process industry Given the proper setup and tuning the PID has proven to have the capability and flexibility needed to meet nearly all of industry s basic control requirements However the information to support the best use of these features has fallen behind the progress of improved functionality Additionally there is considerable disagreement on the tuning rules that largely stems from a misunderstanding of how tuning rules have evolved and the lack of recognition of the effect of automation system dynamics and the incredible spectrum of process responses disturbances and performance objectives

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