SENSITIVITY ANALYSIS APPLIED TO REACTIVE SYSTEMS FOR IMPROVING CONTROL PERFORMANCE

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Abstract. This paper is devoted to sensitivity analysis for nonlinear multivariable processes, particularly applied to chemical reactive systems. The presence of uncertainties or shift in the system's behavior has been investigated, based on deterministic models and also by direct application of the disturbance or uncertainty in the model. Such an approach describes the behavior of sensitivity, and since a reduction of sensitivity is desired, it can reveal how the minimum of sensitivity can be obtained. If the principal aim is concerned with process control, the results can also provide a strategy for improving performance, using the idea of fictitious smoothing reactors, meaning a partition and scheduling of variables of interest. Such a strategy can be inserted into software for process control, without additional cost or appreciable computational load.

Keywords: modeling, reactive system, sensitivity analysis, nonlinear PI

1- Introduction

Despite there being a new class of advanced controller, the PI or PID controller is still widely used in more than 95% of all control requirements for most industrial control systems. Their well-known qualities such as robustness in a wide range of industrial process with satisfactory performance, the simplicity of their structure and the low cost of implementation and maintenance are the reasons for such a long life. Due to the linear structure of PID, this class of feedback controllers cannot yield satisfactory results for some application in the industrial environment since chemical real-world processes have some degree of nonlinearity. However, to enable a controller such as this to deal with nonlinearity, efforts have been made to overcome the difficulties, using strategies which can include models of the process (Manzi and Odloak, 1998) and consequently to reduce the degrees of freedom of the system (Rivera et al., 1986), or even to implement the process control in such a way as to reduce dynamically sensitivity to disturbance.

Reactive systems have embodied structures of advanced control techniques for solving problems especially those associated with their nonlinearities, but, in practice, in view of the need to have qualified staff and the consequently increase in the cost of production, such control systems are not yet ordinarily used.

It can also be observed in industrial practice that the results obtained with the PID controller applied mainly to neutralization processes can be improved or its performance further justified, as in the case of temperature control, when sensitivity analysis is considered as a tool which can provide a better understanding of how the process responds in the presence of perturbations in the variables. For a neutralization system it is common to use a typical control strategy known as smoothing tanks. However, such a practice may not be reasonable either from the technical or economic point of view, since it can affect the plant configuration or compromise some operational conditions or the sanitary stability of the process. In this case, sensitivity analysis can contribute to improving the control performance, providing valuable insights and alternative control configurations.

For reaction temperature control, sensitivity analysis can reveal that the use of the so-called smoothing reactor is unnecessary. Such a procedure is already ordinarily applied in practice.

A review of the literature shows a widespread interest in stability analysis but relatively little has appeared on sensitivity, especially with regard to nonlinear systems. Skinskey (1973) presented a sensitivity analysis for cyclic variations in the influent pH, which does not reflect the fundamental details of the sensitivity. Other

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Sensitivity Methods In Control Theory

IM Harris

Sensitivity Methods In Control Theory:

   Sensitivity Methods in Control Theory L. Radanović,2014-06-28 Sensitivity Methods in Control Theory is a collection of manuscripts presented as the Third International Symposium of Sensitivity Analysis held at Dubrovnik Yugoslavia on August 31 September 5 1964 sponsored by The Theory Committee of International Federation of Automatic Control Sensitivity theory or sensitivity analysis concerns the solution of problems associated with parameter variations within the general scope of control theory This book is organized into five parts encompassing 30 chapters Part I presents some basic approaches of sensitivity analysis such the Lyapunov s theory of stability invariant imbedding nonlinear sampled data and linear time varying systems This part also looks into the preliminary steps towards the development of game theory and some general applications of sensitivity analysis Part II treats the problem of accuracy reliability self adjustment and optimization of sensitivity of automatic control systems while Part III deals with the functional derivative technique of sensitivity analysis and its applications for designing self adjusting control systems Part IV describes the task of synthesizing control systems for linear plants with variable parameters satisfying specified performance criteria Part V considers the association between sensitivity and optimality in various control systems This book will prove useful to design and other specialized fields in engineering   Sensitivity Methods in Control Theory International Federation of Automatic Control. Technical Committee on Theory,1966   **Sensitivity Methods in Control Theory** L. Radanovic,Yugoslav Committee for Electronics and Automation,International Federation of Automatic Control. Technical Committee on Theory,1968   Sensitivity Methods in Control Theory; Proceedings. Edited by L. Radanovié L. Radanovié (ed),International Federation of Automatic Control. Technical Committee on Theory,Yugoslav Committee for Electronics and Automation,1966   *Sensitivity Methods in Control Theory* Yugoslav Committee for Electronics and Automation,International Federation of Automatic Control. Technical Committee on Theory,1966   **Force Control Theory and Method of Human Load Carrying Exoskeleton Suit** Zhiyong Yang,Wenjin Gu,Jing Zhang,Lihua Gui,2017-04-06 This book reports on the latest advances in concepts and further development of principal component analysis PCA discussing in detail a number of open problems related to dimensional reduction techniques and their extensions It brings together research findings previously scattered throughout many scientific journal papers worldwide and presents them in a methodologically unified form Offering vital insights into the subject matter in self contained chapters that balance the theory and concrete applications and focusing on open problems it is essential reading for all researchers and practitioners with an interest in PCA   **Sensitivity Methods in Control Theory. Proceedings of an International Symposium Held at Dubrovnik, August 31-September 5, 1964** Yugoslav Committee for Electronics and Automation (Yugoslavia),1966   optimization in control theory and practice ,   **Sensitivity Methods In Control Theory (proc.Of An Int.Symp.) Dubrovnik, Aug.31-sept.5,1964** L. Radanovic,   **Control Theory Methods in Economics** Jati Sengupta,Phillip Fanchon,2012-12-06 Control theory methods in economics have historically

developed over three phases The first involved basically the feedback control rules in a deterministic framework which were applied in macrodynamic models for analyzing stabilization policies The second phase raised the issues of various types of inconsistencies in deterministic optimal control models due to changing information and other aspects of stochasticity Rational expectations models have been extensively used in this plan to resolve some of the inconsistency problems The third phase has recently focused on the various aspects of adaptive control where stochasticity and information adaptivity are introduced in diverse ways e g risk adjustment and risk sensitivity of optimal control recursive updating rules via Kalman filtering and weighted recursive least squares and variable structure control methods in nonlinear framework Problems of efficient econometric estimation of optimal control models have now acquired significant importance This monograph provides an integrated view of control theory methods synthesizing the three phases from feedback control to stochastic control and from stochastic control to adaptive control Aspects of econometric estimation are strongly emphasized here since these are very important in empirical applications in economics **Sensitivity methods in control theory** L. Radanović,1966 **Sensitivity of Automatic Control Systems** Efim Rozenwasser,Rafael Yusupov,2019-04-30 Although it arose much earlier in a variety of contexts sensitivity theory became an independent branch of science in the sixties Since then researchers from around the world have continued to make great strides in both the theory and its applications However much of the work of Russian scientific schools and specialists remain unknown in the West Sensitivity of Control Systems summarizes the results of the authors and their disciples in sensitivity theory addressing the basic notions of the theory and the problem of selecting technical parameters of systems The authors formulate problems for actual technical systems and their models and establish relations between sensitivity theory and classical stability problems They offer a significant general theory for investigating the sensitivity of boundary problems and use elements of this theory for sensitivity analysis of solutions to nonlinear programming and variational calculus problems as well as oscillatory processes The book also presents general investigation methods for discontinuous systems including those described by operator models Full of powerful new methods and results this book offers a unique opportunity for those in theoretical investigation and in the design testing and exploitation of various control systems to explore the work of Russia s leading researchers in sensitivity theory Furthermore its techniques for parametric perturbation investigation Sensitivity of Control Systems will prove useful in fields outside of control theory including oscillation theory motion dynamics and mathematical economy

Optimization of Large Structural Systems George I. N. Rozvany,2013-11-21 G I N Rozvany ASI Director Professor of Structural Design FB 10 Essen University Essen Germany Structural optimization deals with the optimal design of all systems that consist at least partially of solids and are subject to stresses and deformations This inte grated discipline plays an increasingly important role in all branches of technology including aerospace structural mechanical civil and chemical engineering as well as energy generation and building technology In fact the design of most man made objects ranging from

space ships and long span bridges to tennis rackets and artificial organs can be improved considerably if human intuition is enhanced by means of computer aided systematic decisions In analysing highly complex structural systems in practice discretization is un avoidable because closed form analytical solutions are only available for relatively simple idealized problems To keep discretization errors to a minimum it is de sirable to use a relatively large number of elements Modern computer technology enables us to analyse systems with many thousand degrees of freedom In the optimization of structural systems however most currently available methods are restricted to at most a few hundred variables or a few hundred active constraints   System-specific PI Control Theory for Fluid and Motion Systems Kalman I. Krakow,2006 A system specific feedback control theory for fluid process control and for motion control has been developed to enable analytical tuning The system specific theory enables the determination of the coefficients required to implement i e tune a proportional integral PI control system analytically from physical characteristics of the fluid or motion system PI control is essentially PID control with the derivative D coefficient set equal to zero A derivative coefficient is not essential and may have a detrimental effect on system response characteristics System specific theory based on the fundamental algorithm for PID control systems was developed from a back to basics perspective considering digital not analog control of fluid systems and motion systems independently For additional information visit www control innovation com ControlProblems is an application containing numerical system models corresponding to the problems presented in Chapters 23 though 27 of this book The problems represent typical systems that may be analyzed with system specific PI control theory The application enables validation of proportional integral PI coefficient calculations as well as investigation of system response characteristics with various PI coefficients Numerical data for the problems is presented in the ControlProblems application This data may be changed by the user to simulate different PI coefficients modulated capacities complete response intervals signal update intervals loads etc Suitability of user specified PI coefficients may be evaluated from simulated system response characteristics System response characteristic for default PI coefficients may be used for comparison The application is designed for computers running a Windows 98 or later operating system The download is a zip file ControlProblems zip containing the application in a file titled ControlProblems exe files required to run the exe file and files required to install and remove the application The following download and setup procedure is required The download should be saved in its own folder e g C ControlProblems or C Temp The files contained in the zip file should be extracted to the same folder Run setup exe to install the application Download ControlProblems zip file name 1581129211_extra_material zip approximately 500 KB ControlProblems   Synthesis of Flight Control Systems Subject to Vehicle Parameter Variations Eliezer Kreindler,1967 The main objective of this report is to investigate the potentials of adding sensitivity terms into the performance index to be optimized in order to achieve a reduction in sensitivity to plant parameter deviations The secondary objective is to survey the literature on methods of sensitivity reduction and on sensitivity in optimal control theory   **Progress In Astronautics and**

Aeronautics Manohar P. Kamat,1993   **Stochastic Theory and Control** Bozenna Pasik-Duncan,2003-07-01 This volume contains almost all of the papers that were presented at the Workshop on Stochastic Theory and Control that was held at the Univ sity of Kansas 18 20 October 2001 This three day event gathered a group of leading scholars in the eld of stochastic theory and control to discuss leading edge topics of stochastic control which include risk sensitive control adaptive control mathematics of nance estimation identi cation optimal control nonlinear ltering stochastic di erential equations stochastic p tial di erential equations and stochastic theory and its applications The workshop provided an opportunity for many stochastic control researchers to network and discuss cutting edge technologies and applications teaching and future directions of stochastic control Furthermore the workshop focused on promoting control theory in particular stochastic control and it promoted collaborative initiatives in stochastic theory and control and stochastic c trol education The lecture on Adaptation of Real Time Seizure Detection Algorithm was videotaped by the PBS Participants of the workshop have been involved in contributing to the documentary being lmed by PBS which highlights the extraordinary work on Math Medicine and the Mind Discovering Tre ments for Epilepsy that examines the e orts of the multidisciplinary team on which several of the participants of the workshop have been working for many years to solve one of the world s most dramatic neurological conditions Invited high school teachers of Math and Science were among the part ipants of this professional meeting

    Biology and Control Theory: Current Challenges Isabelle Queinnec,Sophie Tarbouriech,Germain Garcia,Silviu-Iulian Niculescu,2007-08-07 Creating some links between control feedback and biology modeling communities based on similarities in modeling observing and perceiving alive structures and analyzing interconnections between biological structures and subsystems was the main objective of this volume In this context biology systems need appropriate analysis tools due to their structure and hierarchy complexity and environment interference and we believe that these aspects may generate interesting research topics in control area Indeed several works raising the potential impact of control developments to bring some beginning of answers in the context of biological systems have been published in the recent years The idea of this book was conceived in the context mentioned above with the objective to help in claiming many of the problems for control researchers starting discussions and opening interactive debates between the control and biology communities and finally to alert graduate students to the many interesting ideas at the frontier between control feedback theory and biology

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