

Multivariable Control System Design for Quadruple Tank Process using Quantitative Feedback Theory (QFT)

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Abstract— This paper focus on design of multivariable controller for Quadruple Tank Process, a two input two output system with large plant uncertainty using QFT methodology. In the present work, a new approach using Quantitative Feedback Theory (QFT) is formulated for design of a robust two degree of freedom controller for Quadruple Tank Process. The design is done in frequency domain. This paper presents a design method for a 2 x 2 multiple input multiple output system. The plant uncertainties are transformed into equivalent external disturbance sets, and the design problem becomes one of the external disturbance attenuation. The objective is to find compensator functions which guarantee that the system performance bounds are satisfied over the range of plant uncertainty. The methodology is successfully applied to design a two degree of freedom compensator Quadruple Tank Process.

Keywords — Quadruple Tank Process, Robust Control, QFT, MIMO, EDA.

I. INTRODUCTION

Many practical applications are multi-input multi-output (MIMO) systems. MIMO system is composed of several interacting control loops and numbers of alternative configurations of control loops are very large. Interaction produces several undesirable effects. The design method proposed in this paper consists of design of multivariable controller to have desired response from the plant in the presence of plant uncertainties and external disturbances. The quadruple tank process is a multivariable laboratory process developed by K.H. Johansson[7]. This process consists of four interconnected water tanks and two pumps as shown in figure 1. Here objective to control the level in the lower two tank with two pump.

The Quantitative Feedback Theory (QFT) is a control method in frequency domain which uses the Nichols chart [1]. It is an engineering science devoted to the design problem with quantitative bounds on the plant parameters and quantitative tolerances on the acceptable closed-loop system response. The objective is to find compensator functions which guarantee that the system performance bounds are satisfied over the range of plant uncertainty.

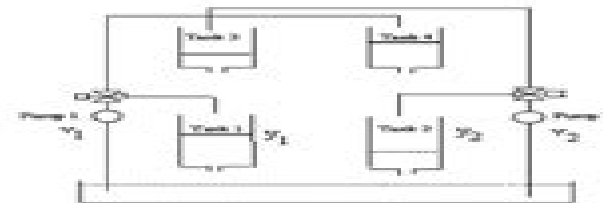


Figure 1: Quadruple tank system.

In this work, we propose a QFT based methodology to design a robust two degree of freedom MIMO compensator for quadruple tank process in the presence of parametric uncertainty. The plant uncertainties are transformed into equivalent external disturbance sets and thus the design problem becomes one of external disturbance attenuation (EDA). The method has been proven rigorous by means of Schauder's fixed point theorem [2]. The design technique is successfully applied to design a two degree of freedom compensator for quadruple tank process.

The present paper is organized as follows: Section II deals with the problem definition for a 2 x 2 MIMO design problem. Basic concepts are discussed in section III. Design equations used in the synthesis of controller for quadruple tank process is given in section IV. Section V deals with the design procedure to design controller and prefilter. In section VI, the methodology is applied to design a compensator for quadruple tank process. Conclusions are drawn in section VII.

II. A 2X2 MIMO DESIGN PROBLEM

The two degree of freedom controller structure used for the design of two input and two output quadruple tank process is shown in figure 2.

Multivariable Feedback Control Solution Manual

Christian G. Meyer



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the flexibility to include advanced topics **Robust Control of Linear Systems and Nonlinear Control** M. A. Kaashoek, J. H. van Schuppen, A. C. M. Ran, 2013-03-07 This volume is the second of the three volume publication containing the proceedings of the 1989 International Symposium on the Mathematical Theory of Networks and Systems MTNS 89 which was held in Amsterdam The Netherlands June 19 23 1989 The International Symposia MTNS focus attention on problems from system and control theory circuit theory and signal processing which in general require application of sophisticated mathematical tools such as from function and operator theory linear algebra and matrix theory differential and algebraic geometry The interaction between advanced mathematical methods and practical engineering problems of circuits systems and control which is typical for MTNS turns out to be most effective and is as these proceedings show a continuing source of exciting advances The second volume contains invited papers and a large selection of other symposium presentations in the vast area of robust and nonlinear control Modern developments in robust control and H infinity theory for finite as well as for infinite dimensional systems are presented A large part of the volume is devoted to nonlinear control Special attention is paid to problems in robotics Also the general theory of nonlinear and infinite dimensional systems is discussed A couple of papers deal with problems of stochastic control and filtering vi Preface The titles of the two other volumes are Realization and Modelling in System Theory volume 1 and Signal Processing Scattering and Operator Theory and Numerical Methods volume 3 Scientific and Technical Aerospace Reports ,1991 Lists citations with abstracts for aerospace related reports obtained from world wide sources and announces documents that have recently been entered into the NASA Scientific and Technical Information Database *Remote Techniques for Nuclear Plant* ,1993 This volume covers the practical application of remote technology to all types of nuclear plant both experimental and commercial It concentrates on the remote inspection refurbishment and decommissioning of reactor pressure vessels reactor internal components primary circuits boiler and steam generators PIE and fuel routes reprocessing plant and radioactive waste storage The emphasis is on equipment currently in use and it also covers equipment under consideration and development Consisting of 44 papers these proceedings draw on the experience of nuclear engineers from around the world to form a substantial reference work on remote techniques for the inspection and refurbishment of nuclear plant **Nuclear Science Abstracts** ,1972 Government Reports Annual Index ,1982 Sections 1 2 Keyword Index Section 3 Personal author index Section 4 Corporate author index Section 5 Contract grant number index NTIS order report number index 1 E Section 6 NTIS order report number index F Z **Proceedings of the ... American Control Conference** ,1988 Software for Computer Control 1986 D. Florian, V. Haase, 2014-05-23 This volume studies the advances of software for computers their development applications and management Topics covered include software project management real time languages and their uses and computer aided design techniques The book also discusses how far artificial intelligence is integrated with business and industry to give a complete overview of the role of computer systems today *Proceedings of the 1988 American Control*

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