

Robust Controller Design using Quantitative Feedback Theory (QFT)

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ABSTRACT

Most of the practical systems are characterized by high uncertainty which makes it difficult to maintain good stability margins and performance properties for closed loop system. In case of conventional control, if plant parameter changes we cannot assure about the system performance hence it is necessary to design robust control for uncertain plant. Among the various strategies proposed to tackle this problem, Quantitative Feedback Theory (QFT) has proved its superiority especially in the face of significant parametric uncertainty. The feature of QFT is that it can take care of large parametric uncertainty along with phase information. For the purpose of QFT, the feedback system is normally described by the two-degrees-of freedom structure. A chemical system common to many chemical processing plants, known as a continuous stirred tank reactor (CSTR). For an isothermal CSTR the product concentration can be controlled by manipulating the feed flow rate, which changes the residence time.

Keywords—

Robust Control, PID Control, Continuous stirred tank reactor, Quantitative Feedback Theory (QFT).

1.INTRODUCTION

PID controllers have dominated the process control industry over the decades owing to its associated simplicity and easiness in implementation. The needs for better control strategies for process control in order to achieve better performance have always motivated research interests. The design of PID controllers, tuning involves selecting the amounts of Proportional, Integral and Derivative components required at the output of the controller. Since the design of PID controllers involves obtaining the P, I and D components, there always occur a compromise in the design. The design of the optimum values for the PID controller parameters has always been challenging. Many new tuning techniques have been developed for the design of PID controllers, however there still exists a scope for better tuning method. Various control strategies are used for design of control system depending on plant model [1].

If the design performs well for substantial variations in the dynamics of the plant from the design values, then the design is robust. Robust control deals explicitly with uncertainty in its approach to controller design. Quantitative Feedback Theory (QFT) is robust control method which deals with the effects of uncertainty systematically. QFT is a graphical loop shaping procedure used for the control design of either SISO (Single Input Single Output) or MIMO (Multiple Input Multiple Output) uncertain systems including the nonlinear

And time varying cases. QFT [5],[17] developed by Isaac Horowitz is a frequency domain technique utilizing the Nichols chart (NC)

in order to achieve a desired robust design over a specified region of plant uncertainty. In comparison to other robust control methods, QFT offers a number of advantages. For the purpose of QFT, the feedback system is normally described by the two-degrees-of freedom structure. A proportional-integral-derivative controller (PID controller) is a generic control loop feedback mechanism widely used in industrial control systems. A PID controller attempts to correct the error between a measured process variable and a desired set-point by calculating and then outputting a corrective action that can adjust the process accordingly. A chemical system common to many chemical processing plants, known as a continuous stirred tank reactor (CSTR) for an isothermal CSTR the product concentration can be controlled by manipulating the feed flow rate, which changes the residence time.

2. BASICS OF PID CONTROL SYSTEM

A PID controller consists of the three terms: proportional (P), integral (I), and derivative (D). Its behavior can be roughly interpreted as the sum of the three term actions. The P term gives a rapid control response and a possible steady state error, the I term eliminates the steady state error and the D term improves the behavior of the control system during transients.

2.1 Parallel Form

It can be seen that P, I and D channels react on the error signal and that they are unbundled [3],[4].

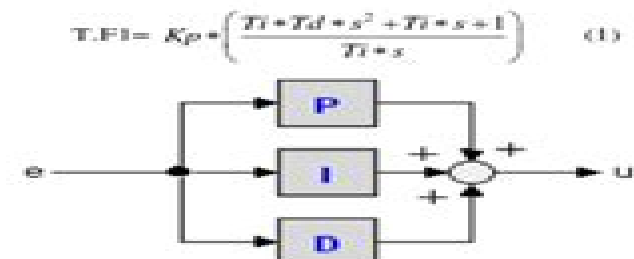


Fig.1: parallel form of PID

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