Closed-Loop Tuning of the PID Controller by Using MOMI Method

Damir Vrančić, Đani Juričić, Stanko Strmčnik, and Raymond Hanus*

J. Stefan Institute, Jamova 39, 1000 Ljubljana, Slovenia

tel.: 061-1773-732, FAX: 061-219-385, e-mail: *damir.vrancic@ijs.si; http://www-e2.ijs.si/Damir.Vrancic*

* Control Engineering & System Analysis Department, Free University of Brussels, Brussels, Belgium

Abstract

A simple procedure for tuning PID controllers in the closed-loop is presented. It employs multiple integration of process input and output signals obtained during the change of the process steady-state. It is shown that the resulting controller parameters are exactly the same as those calculated from the process open-loop step response.

1. Introduction

Tuning of PID controllers has been attracting interest for almost six decades. Numerous methods suggested so far try to accomplish the task by making use of different representations of the essential aspects of the process behaviour.

In tuning, like in other decision-making tasks, cognitive aspects are very important, particularly the question of minimum of information about the process we need to have at disposal in order to accomplish the task. Achieving maximal performance at minimal requested knowledge is the key motive for most of the tuning methods.

The essence of the new tuning method developed recently in [5, 6, 7] is a tricky way of accomplishing the magnitude optimum criterion (defined in the frequency domain) [1, 2, 3] by only making use of process open-loop step response. The novelty of the approach is that *all* the information, which is required to satisfy the magnitude optimum criterion, is contained in multiple integrals of the process output caused by step input [4]. This assessment allows direct tuning on the basis of straightforward integration of process response so that no identification is required. The algorithm has proved to result in good closed-loop responses with PI and PID controllers even for high-order, non-minimum phase and delayed processes.

Unfortunately, in a number of applications it is not possible to apply step changes. At best, one is allowed to use input signals of limited rate. Nonethless, numerous processes *must* operate under feedback all the time for security reasons. In such a case the open-loop experiments are simply impossible.

The purpose of this paper is to show that the elegant tuning procedure derived in [5, 6, 7] can still be used to tune the PI(D) controller under closed-loop operating conditions. A mild modification of the original tuning formulae is presented. What is still important is that one does not need demanding excitations of the control loop. This makes the whole procedure extremely attractive for practice.

2. Calculation of PID controller parameters

2.1 MOMI tuning method

The Magnitude-Optimum-Multiple-Integration (MOMI) tuning method is based on magnitude optimum criterion [2, 3] defined in the frequency domain. It finds such a controller that results in magnitude response flat and close to unity for as large bandwidth as possible (see Fig. 1). This technique results in a fast and non-oscillatory closed-loop response for a large class of processes.

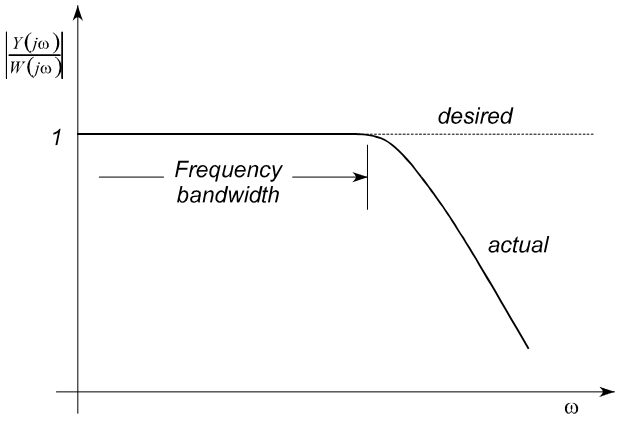

Fig. 1. Magnitude optimum criterion.