Automatic Tuning of the Flexible Smith Predictor Controller

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Abstract

The paper presents an extension of the Modified Smith Predictor controller referred to as the Flexible Smith Predictor control scheme. The tuning procedure is based on the multiple integration method and requires only the process open-loop step response to calculate the parameters of the Flexible Smith Predictor. The desired trade-off between robustness and the closed-loop performance can be achieved by means of only one free parameter.

1. Introduction

A new tuning method for PI and PID controllers which combines the magnitude optimum criterion [2, 4, 5] and the multiple integration method [7] has recently been developed [9, 10, 11]. These works show that a quite demanding frequency criterion (magnitude optimum) can be achieved from the process open-loop step response without explicit process identification. The underlying tuning procedure was applied to a number of processes resulting in high quality performance even in cases of high-order, non-minimal phase and moderately delayed processes.

In case of highly delayed processes several authors make use of the Smith Predictor (SP) control scheme instead of pure PI(D) controllers [3, 8] (c.f. Fig. 1). Unfortunately, the classical SP lacks robustness with respect to variations in process parameters. A way to alleviate this drawback is suggested in [1, 6] in terms of the Modified Smith Predictor (MSP) scheme shown in Fig. 2. One of the advantages of the MSP scheme is that two PI controllers (see Fig. 2) decouple the reference-tracking from load disturbance rejection. Unfortunately, the original SP controller still outperforms the MSP scheme with regard to disturbance rejection.

In order to improve disturbance rejection, additional network was added to the MSP as shown in Fig. 3. This new control scheme will be denoted as Flexible Smith Predictor (FSP) scheme.
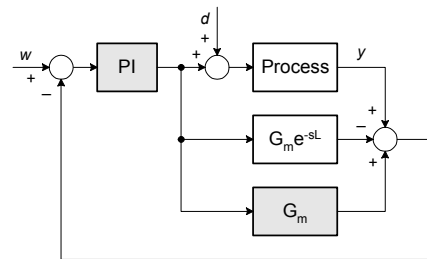

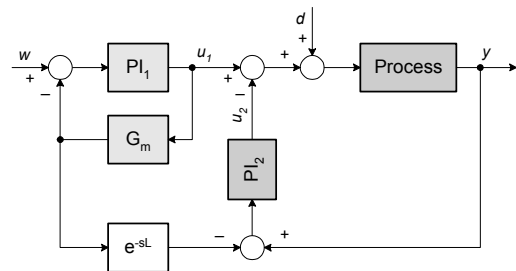Fig. 1. The original Smith-Predictor (SP) control scheme.

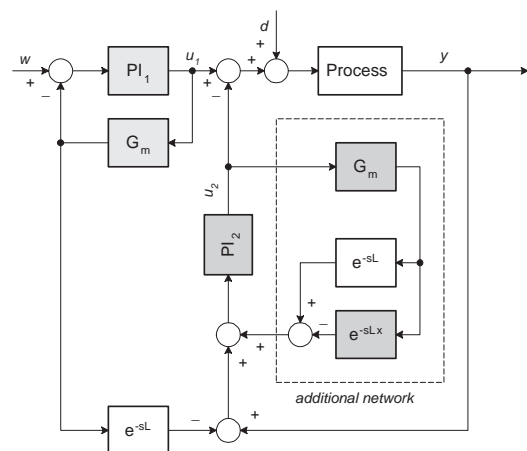Fig. 2. The Modified Smith-Predictor (MSP) control scheme.

Fig. 3. The Flexible Smith-Predictor (FSP) control scheme.