MAGNITUDE OPTIMUM TUNING USING NON-PARAMETRIC DATA IN THE FREQUENCY DOMAIN

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Abstract: Tuning the parameters of PID controllers requires reliable process identification (parametric or non-parametric). Recently, a new tuning method has been developed, based on the magnitude optimum, which requires the process open or closed-loop time response. However, the method requires an accurate estimation of the process final steady-state. In the present paper, a modified tuning method, based on non-parametric identification of the process in the frequency domain, is proposed. The proposed method can be less sensitive to noise than the original Magnitude-Optimum-Multiple-Integration method at the cost of more demanding experimentation on the process.

Keywords: PID control, Magnitude Optimum, Optimisation, Frequency Response, Controller Tuning

1. INTRODUCTION

The tuning of PID controllers has been attracting interest for almost six decades. Several tuning methods have been proposed so far. Recently, the Magnitude-Optimum-Multiple-Integration (MOMI) method has been developed (Vrančić et al., 1999a, b). This method has several advantages. The most important one is that it performs only a simple experiment on the process in the time-domain (e.g. process step-response) in order to obtain controller parameters. The parameters are calculated so as to achieve relatively demanding tuning criterion (Magnitude Optimum). Moreover, the calculation of the controller parameters remains quite simple and can be performed recursively (Vrančić et al., 1999a).

However, the MOMI tuning method exhibits certain drawbacks. In particular, it requires relatively accurate estimation of the process steady-state for reliable tuning (Vrančić et al., 1999b). When the noise levels are not so high or the noise cut-off frequency is relatively high compared to the process cut-off frequency, the tuning results obtained are quite good (Vrančić et al., 1999b). However, if this is not the case, the quality of the closed-loop performance may be degraded.

Further, it is known that system identification using non-periodic signals (e.g. step-response) is feasible only in cases of a relatively high signal-to-noise ratio (Rake, 1980). On the other hand, the problem of significant noise and/or process nonlinearity can be handled relatively easily by employing cross-correlation techniques (Rake, 1980).

Besides pure cross-correlation techniques, several methods for non-parametric identification of the process in the frequency domain have recently been proposed (Park and Lee, 1999; Tsang et al., 1998; Wang et al., 1997). According to results of identification, the proposed tuning methods estimate the process transfer functions relatively well even when the noise-to-signal ratio is relatively high.

In order to improve the robustness of the MOMI tuning method to process noise, the method was suitably modified so as to use the process non-parametric data in the frequency- instead of in the time-domain.