Closed-Loop Identification of the First Order Inertial System with Astatism and Time Delay

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Keywords: experimental identification, first order inertial system with astatism, time-delay, closed-loop system identification

Abstract. The mathematical model that accurately represents the dynamics of the industrial process is crucial for the efficient synthesis of control algorithm in industrial applications [1]. The mathematical model can be obtained using identification procedures, either in an open-loop or closed-loop configuration of the automatic control system. Identification methods in open-loop configuration are well known and typically yield accurate approximations of the process dynamics. However, in the closed-loop configuration, the presence of feedback in the system makes impossible to apply open-loop identification techniques directly. As a result, there are required specialized techniques and methods to accurately mathematical model estimation under closed-loop conditions [2-3].

This paper proposes an approach for closed-loop experimental identification, which involves approximating the process with model of object with inertia first order, time delay and astatism:

$$H(s) = \frac{ke^{-\tau s}}{s(Ts+1)} = \frac{B(s)}{A(s)},$$

where T is time constant, k is transfer coefficient, τ is time delay.

he value of time constant T is calculated based on: the critical transfer coefficient - k_{cr}, time delay – τ, natural frequency - ω_n and oscillations period

T_{cr} of the underdamped step response of the closed-loop system with P controller, when system achieves the limit of stability:

$T = f(\tau, \omega_n, k_{cr}, k)$.

Value of natural frequency is calculated according to the expression:

$$\omega_n = \frac{2\pi}{T_{cr}}.$$

According to the identification procedure presented in [4], the following expression is obtained for calculating the value of the time constant:

$$T = \frac{k_{cr} k \cos(\tau \omega_n)}{\omega_n^2}.$$

The obtained results are verified by computer simulation using software package MATLAB. The results demonstrate that the proposed control identification approach of first order inertial system with time delay and astatism offer good results in model estimation.

Acknowledgment. This work was supported by the project 23.70105.5007.13T Research and synthesis of efficient attitude control algorithms for nanosatellites.

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