Control-Relevant Identification of the First-Order Inertial Systems with Time-Delay

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Abstract. In this paper is proposed an approach of control-relevant identification of the inertial systems with time delay. The experimental identification is performed in the closed-loop and the control object is proposed to be approximated with transfer function with inertia first order and time delay:

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

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

This study contributes in enhancing of the understanding the closed-loop experimental identification process of the inertial systems with time delay, and provides effective strategies for synthesizing the PID control algorithm. According to the proposed approach of the closed-loop identification and synthesis the PID control algorithm, it is presented an algorithm for control-relevant identification:

1. Preliminary information gathering.
2. Ensuring the feedback control system with P controller.
3. Variation of the proportional tuning parameter $k_p > 0$ till it is achieved the undamped step response of the closed-loop system.
4. From the undamped step response of the closed-loop system determination the period of oscillations – T_{cr} and time delay - τ.
5. Calculation the value of natural frequency.

6. Estimation the parameters of the transfer function in conformity with expression:

$$T = \frac{k_{cr} k \sin(\tau \omega_n)}{\omega_n}.$$

7. Tunig the PID controller in conformity with expressions (14)-(15) and (17).

$$k_p = 2 \cdot k_d \cdot \frac{(\tau + 6a_0)}{2\tau a_0};\ k_i = \frac{e^{-\tau J}}{2k} \cdot \frac{\tau^2 - 36a_0^2}{4\tau^2 a_0} + \frac{k_p^2}{4k_d};\ k_d = \frac{e^{-\tau J}}{2k} \cdot \frac{\tau^2 + 8a_0^2}{8a_0}.$$

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 systems offers good results in model estimation and the control algorithm ensures good system performances.

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