Synthesis of the Typical Controllers to the Model of Objects with Advance-Delay and Time Delay for the Control System with Maximum Stability Degree

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***Abstract*—In this paper it is proposed to extend the maximum stability degree criterion method for synthesis of the typical controllers to the model of objects with advance-delay and time delay. There are elaborated the analytical algorithms for synthesis of the P, PI and PID controllers to the model of objects with second, third and fourth order delay and first, second and third order advance with time delay. It was analyzed the efficiency of the developed algorithms and some study cases are presented.**

***Keywords*—the advance-delayed object models; the typical control algorithms; the automatic control system with maximum stability degree; the synthesis methods; analytical algorithms for synthesis the controller**

I. Introduction

Because most of the technological processes, or technical systems have a high complexity, the dynamical complex systems became the subject of intensive research, regarding to the modeling and control of them. The complexity of the systems leads to difficulties encountered in the tasks of analyzing the systems and in the design and implementation of control algorithms and strategies. At the stage of identification of these processes, there are obtained the complex mathematical models based on the proprieties of inertia and time delay, which are highlighted and presented as the models of objects with advance-delay and time delay by the corresponding order [1-3]

$$H_F(s)=\frac{\exp(-\tau s)\prod_{j=1}^{l}(T_i^{'}s+1)}{\prod_{i=1}^{r}(T_is+1)}=\frac{\exp(-\tau s)(b_0s^l+b_1s^{l-1}+...+b_l)}{a_0s^r+a_1s^{r-1}+...+a_{r-1}s+a_r} \qquad (1)$$

where $T_j^{'}, j=\overline{1,l}$ are the time constants in advance; $T_i, i=\overline{1,r}$ - delay time constants; τ - time delay.

For synthesis of the P, PI, PID control algorithms to this model of objects can be applied different synthesis methods: frequency methods, the poles-zeros allocation method, the polynomial method etc. However, the use of these synthesis methods of the control algorithms imply the complex calculation and graphical representation [2-4].

In work [5] it is presented a new method for tuning of the typical controllers to the model of objects with inertia and time delay based on the maximum stability degree. This method ensures to the designed system the maximum stability degree, robustness at the variation of the object parameters and transient processes with low overshoot and high performance. In work [6], based on this method were developed analytical algorithms, in form of algebraic expressions, for synthesis the typical controllers P, PD, PI and PID to the model objects with any order inertia and time delay.

In this paper it is proposed to extend the maximum stability degree method for synthesis of the typical controllers to the model of objects with advance-delayed and time delay. It is analyzed the model of objects with second, third and fourth order delay and first, second and third order advance with time delay, for which are synthesized the analytical algorithms for the automatic control system with maximum stability degree.

II. Synthesis of the Typical Controllers to the Model of Objects with Advance-Delay and Time Delay

It is considered that is given the conventional structure of the control system (Fig. 1), which includes the model of control object $H_F(s)$ and controller $H_R(s)$.

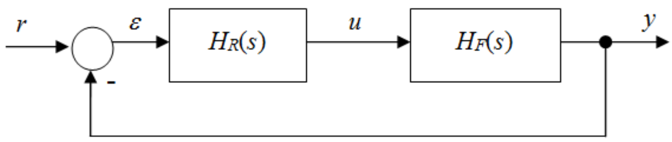

Fig. 1. The structural block scheme of the automatic control system.

It is assumed that the object model with advance-delay and time delay is represented by the following transfer function

$$H_F(s)=\frac{(T_1^{'}s+1)(T_2^{'}s+1)\exp(-\tau s)}{(T_1s+1)(T_2s+1)(T_3s+1)}=\frac{(b_0s^2+b_1s+b_2)\exp(-\tau s)}{a_0s^3+a_1s^2+a_2s+a_3}, \qquad (2)$$