Alternative optimality criteria in automatic control systems parametrical optimization

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The purpose of optimum parametrical synthesis of Systems of Automatic Control (SAC) consists in finding of such parameters of the actuation device (AD) at which the indicator of SAC quality chosen as criterion of an optimality accepts the best value. During parametrical optimization of AD value adjusting parameters of system, corresponding to an extremum of criterion of an optimality, are defined by their purposeful search. As it is known strategy of search is defined by algorithms of the optimizer. Thus it is important that the criterion of an optimality had an extremum in space of the optimized parameters. Integrated indicators of quality meet these requirements (excepting linear): the elementary, modular, square. Therefore they are often used as criteria of optimization.

Further the offered integrated indicator of quality which considers stability of technological process is given:

$$I_{St} = \int_0^{\infty} |St(t) - 1| dt \to 0; \tag{1}$$

$$y^{\alpha} \equiv y^* = \arg\min J_{St}; \tag{2}$$

Thus, optimization by the specified criterion is reduced to a choice as it is possible for the smallest area under the given curve:

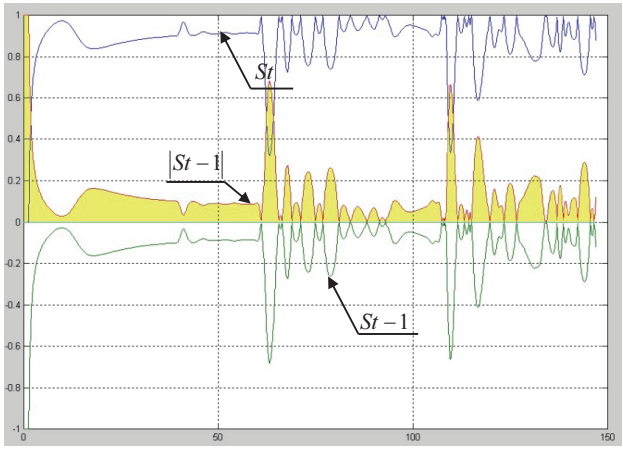

Fig.1. Visualization of integral from a formula calculation (1)

On integrally square, considering the size of speed of course of transition process indicator of quality and on offered integrated from stability parametrical optimization at the fixed values of parameters of object of management was performed.

Two sets of "optimum" values for PID – the regulator are as a result received (object static). Further an inspection on roughness of systems with the corresponding sets of

parameters of the regulator at dispersion of the parameters of ±20% was carried out (Fig. 2 – Fig. 3).

Fig.2. Set I_{St} dispersion of management object parameters +/- 20%

Fig.3. Set I_K dispersion of management object parameters +/- 20%

As we see from Fig. 2 and Fig. 3, the system with a set of the "optimum" settings of the regulator received by optimization by integrally square criterion considering the size of speed of course of transition process at essential dispersion of parameters of object of management is less steady in comparison with system with a set of the settings of the regulator received by optimization by integrated criterion from stability.

However when using of the offered criterion of an optimality in the course of optimization as search of a compromise in in advance mutually contradictory conditions (ensuring on the one hand high dynamic precision, and with other the demanded stability stock), the priority in this case is reduced to stability of controlled process that in turn is negatively reflected in the dynamic accuracy of a job of the got SAC.

Proceeding from above stated, more effective is use of the combined type of an integrated assessment in which restriction is imposed not only at a deviation size x and on deviation speed $\dot{x}$, but also and on stability deviation degree St has an appearance:

$$I_{KSt} = \int_0^{\infty} \left(\left(\Delta y(t)\right)^2 + \left(T_1 \Delta \dot{y}\right)^2 + \left(T_2 (St(t) - 1)\right)^2 \right) dt; \qquad (3)$$

where T_1 and T_2 - the weight coefficients which are bringing composed an indicator to one unit of measure and appropriately reflecting the size compromise degree between requirements of minimization of the area under $\Delta y^2(t)$, $\dot{y}^2(t)$ and under $\left(St(t) - 1\right)^2$.

CONCLUSIONS

As a result of the performed parametrical optimization at the fixed and variable values of parameters of object of management on integrally square, considering the size of speed of course of transition process indicator of quality and on an indicator of quality, integrated from stability, (1) the corresponding sets of values of parameters of the regulator for the elementary SAC were received. Check of work of system of automatic

control on a stability with conditional dispersion of parameters of object of management +/-30% for a set of values of the parameters of the regulator received as a result of optimization at the fixed parameters of object of management and conditional dispersion of parameters of object of management +/-40% for a set of values of the parameters of the regulator received as a result of optimization at variable parameters of object of management was executed. As a result of the specified check on a stability, big stability of work of SAC with values of the parameters of the regulator received as a result of optimization on a new quality indicator, integrated from stability, was revealed considerably.

Besides, the new combined type of an integrated assessment (3) in which restriction is imposed not only at a size of a deviation and on deviation speed is offered, but also and on stability deviation degree, which use allows to consider by parametrical optimization of SAC stability of process of change of a controlled variable, without endowing thus considerably the dynamic accuracy of work of SAC.

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Д И П Л О М А

**Програмният комитет на
Научната конференция РУ&СУ’15
награждава с КРИСТАЛЕН ПРИЗ
“THE BEST PAPER”
д-р ВИКТОР ЕГОРОВ
автор на доклада:
“Alternative optimality criteria in automatic control systems parametrical optimization”**

D I P L O M A

**The Programme Committee of
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to VICTOR YEGOROV, PhD
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