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INCREASE IN THE SPEED OF AUTOMATIC OPTIMIZERS ON SLIDING MODES

Temur Rigishbili[1], Besarion Shanshiashvili[2]

Georgian Technical University, Tbilisi, Georgia
[1]*sovbi@rambler.ru*, [2]*besoshan@yahoo.com*

It is known that one of the most essential parameters of any optimal system is the time of finding an extremum, especially if the exact kind of optimized functional and the functions that set constraints, is not known in advance and there is no biunique correspondence between its values and controlled variables.

For the construction of such systems and devices two approaches [1, 2, 3] are used most frequently. The first approach is the submission on the object input of any search signals with subsequent analysis of reaction on an output. As a result of this operation the vector grad f is estimated, which is used for the construction of the procedure providing an approach of y to y_{opt} [4]. At the second approach in one way or another a mode of oscillations is created in the closed automatic system of optimization, during which the average output of the object y approaches y_{opt} [1, 2]. These methods allow solving many applied problems, and on their basis a number of optimizers is constructed [5].

Let's consider some lacks that limit a scope for using such optimizers. First of all they are connected with purposive introduction in the system of oscillations, undesirable for most of real objects. Besides this there are fundamental difficulties of the account of limitations and dynamic properties of processes for such systems. The technical realization of corresponding devices is often connected with the use of the complex equipment.

In [6] it is offered, and in [7] another approach of construction of automatic optimization systems is developed. The optimized coordinate y is compared to driving influence, which is formed as the monotonously decreasing (increasing) function of time $g(t)$. If we track the influence of y on $g(t)$ in the tracking system $y(t)$ will monotonously decrease down to an extremum, repeating $g(t)$. Unlikely to the automatic optimizers [4], here are considered possible variants of change of a steepness of the extreme characteristic of the object and the speed of approaching an extremum are changed depending on a steepness of the extreme characteristic. Such approach allows increasing the rate of search at the great value of the factor $\frac{df}{dx}$ and slowing it down at the small value of $\frac{df}{dx}$.

Certainly, in such system it is not supposed the direct determination of $\frac{df}{dx}$. In offered optimizer the information on the size of $\frac{df}{dx}$ is contained in the average value of control u_{mv}, which is the an output of inertial element with a small constant of time (Fig. 1).

$$\tau\, \dot{u}_{mv} + \dot{u}_{mv} = u \,, \tag{1}$$

where, u – output variable of element 3 of formations reversing signal. Desirable character of dependence of searching speed of $\frac{df}{dx}$ will take place, if speed of decrease of driving influence is formulated as following:

$$\rho = \rho_0 \left(1 - \left|u_{mv}\right|\right). \tag{2}$$

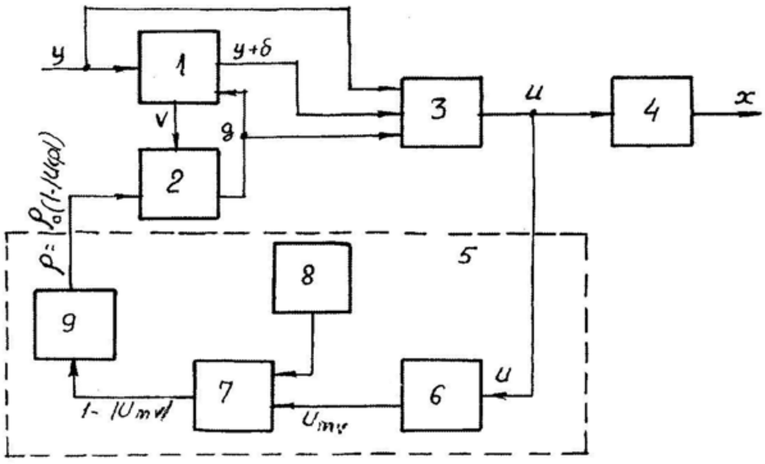

Fig. 1.

As an inertial element (1) filters a high-frequency component of the high frequency control function in a sliding mode, its output value will be equal to average value of control u_{mv}, that stands between $-u_0$ and $+u_0$ Movement in a sliding mode will be defined by this average control and because of it desirable character of dependence and speed of search from $\frac{df}{dx}$ will take place, if the speed of increase of driving influence is formed as following:

$$\dot{g} = \rho_0 \left(1 - |u_{mv}|\right) \tag{3}$$

where $\rho_0 > 0$ - a constant, any value which generates the sliding mode.

For realization of the specified dependence the block of nonlinear dynamic correction 5 [8] is used in the optimizer. From the aforesaid it is seen, that at change of a steepness of the extreme characteristic, for example at its increase, the frequency of switching of an operating signal *u* increases and accordingly the output value of an inertial element 6 decreases. However after adding up $|u_{mv}|$ in the adder 7 with the individual signal, submitted with element 8, the output value $1-|u_{mv}|$ increases and simultaneously the output signal $\rho = \rho_0 (1 - |u_{mv}|)$ of the block of multiplication on the constant coefficient 9 increases, where $\rho_0 > 0$. Thereof, the speed of driving influence $\dot{g} = \rho$ will increase, which as a result provides an increase in the speed of automatic optimizer.

The application of automatic optimizers by optimization of technological objects with small inertia is sometimes complicated because of quite high frequency of switching of the output signal, especially in a vicinity of an extremum. Executive mechanisms often do not maintain such frequency of switching, especially if this executive mechanism – membrane, besides that at frequent switching of the output signal, the speed of search of an extremum is not at its maximum.

These circumstances have led to the necessity of development new schemes of automatic optimizers [9, 10]. We will consider one of them, the block diagram of which is presented on fig. 2 and consists of block 1of control formation u, integrator 2 of driving influence *g* and the output integrator. The principle of work of optimizer consists in the following: The optimized value Y on an element 6 is compared to some variable z, equal to:

$$z = \begin{cases} g, & \text{when } g - (y - \Delta) > 0,\ g - (y - \Delta) < 0, \\ y - \Delta, & \text{when } g - (y - \Delta) < 0,\ g - (y - \Delta) > 0. \end{cases} \tag{4}$$

In (4) g - the output signal of the integrator 2 of driving influence formation and it is monotonously increasing function of time, $\rho_0 > 0$, Δ - small positive value which is adjusted by element 8.

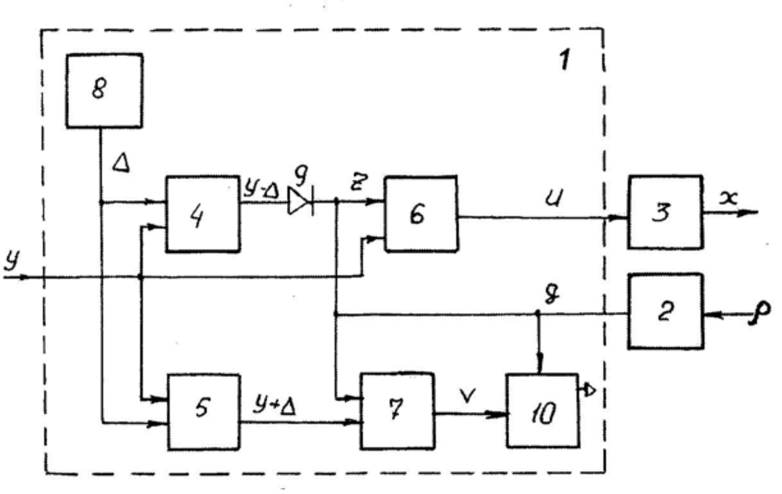

Fig.2.

The received signal of a mismatch $\varepsilon = z - y$ is used for formation of such operating signal *u*, equal to:

$$u = \begin{cases} 0, & \text{when } \varepsilon < 0, \\ y - \Delta, & \text{when } \varepsilon > 0, \end{cases} \tag{5}$$

which influences an input of the output integrator 3, reduces this mistake of a mismatch to zero and provides the further approach of y to an extremum. In a vicinity of the extremum point there will be a mode of oscillations, the amplitude of which defines an error of search. Using the signal v, equal to:

$$z = \begin{cases} 0, \text{when } z - (y + \Delta) < 0, \\ 1, \text{ when } z - (y + \Delta) > 0. \end{cases} \tag{6}$$

The system is stabilized in a vicinity of an extremum. At such circuit realization of optimizer, the value of y approaches an extremum with enough high speed without a reverser of effector. Increase in the speed of the automatic optimizer allows reducing the time of search of an extremum. Above described optimizers can be applied to optimization of rather low-inertial objects. They are simple in realization, reliable and convenient in exploitation.

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