The Adaptive Method of the Estimation of the Rheological Characteristics of the Objects of Measurement

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The development and improving of the methods and means of measuring are accompanied by the essential increasing of the quality of measuring parameters, rise of the require to the quality of the measuring devices, accuracy and reliability of the measuring results. It is essentially relative to the technical means of taking information which are working in a very difficult conditions and are under influence of the external and parametrical random noise. It is necessary to say for devices of the initial information that now are very wide borders of the measuring parameters. It makes more strong demands to the errors of the measuring. They should be as small as possible. One of the essential way to solve the problem of measuring of the parameters is the use of the adaptive methods of the parametrical identification. There are some ways of the practical realization. One of them is the way of the adaptive models which are following for the parametrical alteration of the objects. Another way dealt with the creation of the adaptive controllers which are compensate the parametrical deviation with the help of the contours of adaptation inside the system. In the report we discuss the new method of the synthesis of the structure of the generalize adjusted object of measuring (GAOM) and some examples of the adaptive controllers.

There are some methods of identification, which permit to restore the adequate model of the object of measuring (OM) and the vector of it parameters with definite accuracy. The tasks of identification of the unstationary objects and solutions of them when OM is observed uncompletely are especially difficult.

It is possible to find the solutions of such tasks as in the class of measuring systems with tuning models so in the class of adaptive systems with parametric, coordinate, or coordinate-parametric tuning. It will be interesting to find the technical means with the help of which it will be possible to solve the problem of adaptation in both cases.

Let us include the vector $\mu(t) = X(t) - Z(t)$ (1)

to the equation $\dot{X}(t) = A(t)X(t) + B(t)U(t) + D(t)\nu(t)$ (2)

of the object with full information about the state, where $A(t) = A_0 + \Delta A(t)$, $B(t) = B_0 + \Delta B(t)$, $D(t) = D_0 + \Delta D(t)$ – are matrixes with unknown parameters: $\nu(t)$ – the vector of disturbance; X(t)- full vector of the state, dimension n ; U(t)- vector of the input with the dimension - m; Z(t) - is the required vector of the object. It's value may be found as the solution of the equation:

$$\dot{Z}(t) = A_0 Z(t) + B_0 U(t) + D_0 \nu(t) + A_0 \mu(t) - \dot{\mu}(t) + F(t) \quad (3)$$

$$F(t) = \Delta A(t) X(t) + \Delta B(t) U(t) + \Delta D \nu(t)$$

From the equation (3) it may be found the structure of the compensating channel with equation

$$\dot{\mu}(t) = N_0 \mu(t) + \Delta N X(t) + \Delta R U(t) + \Delta K \nu(t) \quad (4)$$

where N_0 -(n x n) matrix of the constant coefficients; ΔN(t)-(n x n), Δ R(t)- (n x m) ΔK(t)- (n x r)- matrixes of the tuning coefficients.

The equation of the object of measuring became as next

$$\dot{Z}(t) = A_0 Z(t) + B_0 U(t) + D_0 \nu(t) + (\Delta A - \Delta N) X(t) + (\Delta B - \Delta R) U(t) + (\Delta D - \Delta K)\nu(t) \quad (5)$$

where $N_0 = A_0$.

The operator of the GAOM will be equal to the stationar one if the parameters of the matrixes K, R and N will be tuning to satisfied to equalities

$$\Delta N(t)=\Delta A(t);\ \Delta R(t)=\Delta B(t);\ \Delta K(t)=\Delta D(t). \quad (6)$$

Using the received structure of the GAOM we shall consider features of the synthesize of the TM and adaptive measuring converters (AMC) of parameters of the objects with incomplete information.

Let us synthesize the TM of the stochastic OM (1) where the matrixes $A(t) = A_0$; $B(t) = B_0$; $D(t) = D_0$ with constant but unknown coefficients and its output

$Y(t)=C\,X(t)+\eta(t)$,

where $M[\eta(t)]=0$.

The best estimation of the objects state for minimum of the functional

$$J[\varepsilon(t)] = M\{\varepsilon(t) \cdot \varepsilon^T(t)\} \quad (7)$$

where $\varepsilon(t) = \{X(t) - X_\mu(t)\}$

will be the estimation which is the solution of the equation

$$\dot{X}_\mu(t) = A_0 X_\mu(t) + B_0 U(t) + T_0[Y(t) - CX_\mu(t)];\ X_\mu(0) = 0, \quad (8)$$

where $T_0 = P_0 C^T \overline{W}$,

$$\dot{P}_0(t) = A_0 P_0(t) + P_0(t) A_0^T - P_0(t) C^T \overline{W} C P_0(t) + V;$$

The model of the OM we shall make on the base of the equation (5) with tuning coefficients

$$\dot{X}_\mu(t) = A_\mu X_\mu(t) + B_\mu U(t) + T_\mu[Y(t) - CX_\mu(t)];\ X_\mu(t_0) = 0, \quad (9)$$

where $A_\mu(t) = A_\mu + \Delta A_\mu(t)$, $B_\mu(t) = B_\mu + \Delta B_\mu(t)$, $T_\mu(t) = T_\mu + \Delta T_\mu(t)$.

Now we shall use new functional of the quality

$$J[\bar{\varepsilon}(t)] = M\{\bar{\varepsilon}(t) \cdot \bar{\varepsilon}^T(t)\}, \quad (10)$$

where $\bar{\varepsilon}(t) = \{Y(t) - CX_\mu(t)\}$, (11)

which is equivalent to the functional (7) for the OM with complete information about state.

The equation of the channel of compensation in this case will be such form, as follows

$$\dot{\mu}(t) = N_0 \mu(t) + \Delta N X_\mu(t) + \Delta R U(t) + \Delta K \bar{\varepsilon}(t) + \Delta M \mu(t), \quad (12)$$

where ΔN, ΔR, ΔK, ΔM are matrixes with tuning coefficients and the equation OM with respect to new coordinate Z(t) will have the form

$$\dot{Z}(t) = A_\mu^0 Z(t) + B_\mu^0 U(t) + T_\mu^0 \bar{\varepsilon}(t) + \delta r\, X(t) + \delta k\, \bar{\varepsilon}(t) + \delta m \mu(t), \quad (13)$$

where $\delta r = \Delta B_\mu - \Delta R$; $\delta k = \Delta T_\mu - \Delta K$; $\delta m = \Delta T_\mu C - \Delta M$ (14)

are tuning matrixes.

To minimize the error (11) there have been used the method of gradient.

And were sold the problem of stability of the contours of adaptation. The realization and experimental investigation of the measuring system showed a good accuracy and reliability of the process of identification.