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A STABLE SOLUTION TO THE ILL-DEFINED PROBLEM OF IDENTIFICATION OF A STOCHASTIC DYNAMIC SYSTEM

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A new method is suggested for parametric identification of the model of a stochastic dynamic system observed by a nonlinear noise-containing meter. The method takes the ill-defined formulation of identification problem into account, and allows for convergence of the computational algorithm in the case of identification of a high-dimensional vector of parameters.

It is known that an existing solution to the problem of identification of a stochastic dynamic system under parametric indeterminacy conditions (sometimes this problem is called the adaptive filtering problem) implies extending its state vector at the expense of m unknown parameters followed by estimating the whole extended vector [1, 2]. In this approach, dimensionality of the filter, with regard for symmetry of the covariance matrix, increases by $0.5m(2n + m + 3)$, where n is the initial dimension of the dynamic system. The awkwardness of the filters thus formed, when identifying the vector of parameters of high dimensionality ($m > n$), predetermines considerable, and insurmountable in some cases, difficulties of their practical implementation [1–3].

In [4] we considered treatment of the problem of parametric identification of the determinate model of dynamic system without the traditional extension of its dimensionality, but under the condition of precise observation of the state vector at finite time instants. Here we suggest the solution of a more general (in terms of its formulation) problem of parameter identification in the model of a stochastic dynamic system observed by a nonlinear meter characterized with some intrinsic noise.

In the case of identification of a high-dimension vector of parameters, the suggested method demands less computational expenditures against the known methods based on the theory of optimal estimation [1–3, 5]. Moreover, the method considers the incorrectness of identification problems and, owing to decomposition of the estimation-identification procedures, provides a rather easy "stability adjustment" of the computational algorithm. In this case, we use the concept of the reverse problem of the sensitivity theory and, accordingly, the main limitation of the approach developed consists in the assumption about existence of a known basic (non-perturbed) solution for nominal values of the vector to be identified [1]. A typical practical application of the proposed approach is, for example, a set of problems of identification of dynamic models of multiple air targets [5].

Decomposition of procedures of estimation and identification. In the general case, the models of a stochastic dynamic system and of observations are set by the following continuous equations [1, 2]:

$$\dot{x}(t) = f\big[x(t), p, t\big] + w(t), \tag{1}$$

$$z(t) = h\big[x(t), t\big] + v(t), \tag{2}$$

where $x(t)\,(x \in R^n)$ is the state vector of the system; $t \in [t_0, t_k]$ is the independent variable (time); $f[x(t), p, t]$ is the n-dimensional nonlinear vector function containing the unknown vector of parameters p ($p \in R^m$); $w(t)$ ($w \in R^n$) is the noise

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