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A NONLINEAR FILTERING ALGORITHM IMMUNE TO SINGULAR ERRORS

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The problem of linear discrete filtering is resolved for the case when the observation channel contains piecewise continuous interference having a finite number of the first-kind discontinuities on the whole observation segment and is described, within the continuity intervals, by power polynomials with random coefficients. An illustrative example is included.

It is well known [1, 2] that one of the promising lines of development of theory and practice of estimation and identification of random process parameters is the use of algorithms of optimal (suboptimal) filtering. The simplest technical decisions are based on linear filtering algorithms widely used in practice, particularly, in customer's equipment of GPS/GLONASS satellite navigation system [2]. These filters are effective when the measurement channel contains only a fluctuating error [3]. However, actual measurements may involve other types of errors, for example, dynamic errors with a known structure of their mathematical model and with unknown parameters (so-called singular errors) [4, 5]. A more complicated situation occurs when we deal with measurement errors, similar to above-mentioned ones but with a random change of structures belonging to some totality set a priori. An example of errors of this kind is piecewise continuous interference described, within the continuity intervals, by arbitrary generalized polynomials with random coefficients [3, 4].

In this paper we consider the basic theoretical statements used in treatment of the problem of discrete linear filtering applied to measurements in the presence of piecewise-power interference having a finite number of discontinuities over the whole interval of measurement.

Let the state vector $X(j) = X(t_j) = [x_s(j), s = \overline{1,q}]^T$ of the object under observation on the interval $[t_0, T]$ be described by the difference equation

$$X(j+1) = \Phi(j+1, j)X(j) + \Gamma(j+1, j)N_x(j), \; j = 0, 1, 2, \ldots, \quad (1)$$

while the observed random sequence be represented by equation

$$Y(j) = B(j)X(j) + H(j) + N_y(j), \; j = 0, 1, 2, \ldots, \quad (2)$$

where $\Phi(j+1, j) = [\varphi_{ls}(j), l, s = \overline{1,q}]$, $\Gamma(j+1, j) = [\gamma_{sk}(j), s = \overline{1,q}, k = \overline{1,m}]$, $B(j) = [b_{ks}(j), k = \overline{1,p}, s = \overline{1,q}]$ are known functional matrices, $Y(j) = [y_s(j), s = \overline{1,p}]^T$ is the vector of observation, $N_x(j) = [n_{xs}(j), s = \overline{1,m}]^T$, $N_y(j) = [n_{ys}(j), s = \overline{1,p}]^T$ correspond to the random noise of object (1) and of observation channel (2), respectively.

It is known that

$$M\{N_x(j)\} = 0, M\{N_y(j)\} = 0, \quad M\{N_x(j)N_x^T(k)\} = V_x(j)\delta(j-k),$$

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