JOINT FILTERING OF SIGNAL PARAMETERS HAVING CONTINUOUS AND DISCRETE STATES

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In works which consider the synthesis of algorithms for joint estimation of discrete and continuous signal-parameter states, decisions with regard to the discrete parameters are frequently adopted via threshold comparison of likelihood ratios conditioned by estimates of the continuous parameters. As a result, due to difficulties in obtaining separate estimates of the filtering performance for discrete and continuous parameters, the analysis and synthesis of complex radio-engineering aggregates is complicated and the possibility of unifying the implementation base of the mentioned algorithms is reduced. It is possible to overcome the indicated shortcomings while using a single device for representing and estimating discrete and continuous parameter states. The basis for this can be found in [1,2,3] where a description is given of discrete and continuous parameters using unified models in the form of stochastic difference (differential) equations.

Assume that at the receiver input we have time-discrete readings of signal-plus-noise

$$Y(k) = S(\lambda(k), k) + n(k), \qquad (1)$$

where $\lambda(k) = [\lambda_c(k) \mid \lambda_d(k)]^T$ is the vector representing the signal parameters; $\lambda_c(k)$ is the vector representing the parameters having a continuous state; $\lambda_d(k)$ is the vector representing the parameters having a discrete state; n(k) is a white-noise sequence with a zero average and a correlation function $M\{n(k) \times n(m)\} = V_n \delta(k-m)$; $\delta(\cdot)$ is the Kronecker symbol.

The equation of state for the vector for the continuous parameters which have a Gaussian character (see [3]) has the form

$$\lambda_c(k+1) = F_c(k)\lambda_c(k) + W_c(k), \qquad (2)$$

where

$$F_c(k) = \begin{Vmatrix} \exp(-\alpha_1 \cdot \Delta) \ldots & 0 \\ \cdots & \\ 0 & \exp(-\alpha_n \Delta) \end{Vmatrix},$$

α_j is the drift coefficient (the spectrum of the fluctuations) of the j-th component of $\lambda_c(k)$; Δ is the quantization interval; $W_c(k)$ is the vector sequence of white noises having a zero average and $M\{W_c(k) W_c^T(m)\} = V_s \delta(k-m)$

The vector $\lambda_d(k)$ describes the signal parameters having a discrete state which acquire a finite set of values. The state of the j-th component of $\lambda_d(k)$ may be represented by the vector-indicator $X^j(k)$ corresponding to the considered component; the dimensionality of this indicator is equal to the number of states of $\lambda_{dj}(k)$. The components of $X^j(k)$ are determined as follows:

$$[x_i^j(k)] = \begin{cases} 1, & \text{if } \lambda_{dj}(k) = i; \\ 0, & \text{otherwise.} \end{cases}$$

The vector $X^j(k)$ which indicates a Markovian chain the equation of state (see [1,2]) may be written in the form

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