INTEGRATION OF METERS WITH FAILURES

P. A. Evlanov and S. Ya. Zhuk

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Based on the device of mixed Markovian processes in discrete time, optimal and quasi-optimal algorithms for the integration of meters having failures have been synthesized and analyzed. A comparison of the derived quasi-optimal algorithms with known ones has been performed by the method of statistical simulation for the example of measurements with anomalous errors and for the case in which systematic measurement errors of unknown magnitude appear.

For operation under conditions of intense natural and artificial interferences, the probability of failures in meters is high, and therefore in order to increase the reliability of information processing the integration of such meters is especially effective. In the present paper it is proposed to use the device of mixed Markovian processes in discrete time (see [1]) to solve the problem of integrating meters with failures; this technique is adequate for the problem being solved when the synthesized algorithms are implemented on a computer, the derived filters applying to the class of devices with decision feedback.

In order to solve the problem posed, let us consider the model consisting of a multichannel measurement system with failures, which can be described by the equations

$$x(x) = F[x(k-1)] + w(k); \tag{1}$$

$$y(k) = H_{\Gamma(k)}[x(k)] + v_{\Gamma(k)}(k), \tag{2}$$

where x(k) is a continuous-valued vector including the parameters of target motion; $y^{\tau}(k) = \| y_1(k), \dots, y_L(k) \|$ is the combined vector for the measurements arriving from L channels; $H^{\tau}_{\Gamma(k)}\ [x(k)] = \| h_{1j}\ [x(k)], \dots,\ h_{Lm}\ [x\ (k)] \|$, j, m = 1...M is the combined matrix for the measurements; $F[\cdot]$, $h_{lj}[\cdot]$, $l = 1 \dots L$, j = 1...M are vector-valued functions; $\Gamma^{\tau}(k) = \| \gamma_{1j}\ (k), \dots, \gamma_{Lm}\ (k) \|$ is an extended Markovian chain; w(k) is an uncorrelated Gaussian sequence $E[w(k)] = 0$, $E[w(k) w^{\tau}(k)] = Q(k)$; $v_{\Gamma(k)}\ (k)$ is the combined vector of the Gaussian noises of the measurements $E[v_{\Gamma(k)}(k)] = 0$, $E[v_{\Gamma(k)}(k) v^{\tau}_{\Gamma(k)}(k)] = R_{1j \dots Lm}(k) = \mathrm{diag} \| R_{1j}\ (k), \dots,\ R_{Lm}$ (k) $\|$. The initial vector of state is Gaussian $E[x(0)] = \hat{x}\ (0)$, $E\ [(x(0) - \hat{x}\ (0))\ (x(0) - \hat{x}\ (0))^{\tau}] = \hat{P}\ (0)$

The character of the failures in the l-th measurement channel can be described by the Markovian chain $\gamma_{lj}(k)$, l = 1...L having the transition-probability matrix $\Pi^{l}_{ij}\ (k,\ k-1)$, $i,\ j = 1 \dots M$ and the initial probabilities $p^{l}_{j}(0)$.

Equations (1), (2) describe a mixed Markovian process in discrete time (see [1]), the quasi-optimal algorithm for joint filtering of the vector of state x(k) and the Markovian chains Γ(k) being described by the relationships

$$W^{*}_{j \dots m}(k) = \sum\nolimits_{i=1}^{M} \cdots \sum\nolimits_{n=1}^{M} \prod\nolimits_{ij}^{1}(k, k-1) \dots \prod\nolimits_{nm}^{L}(k, k-1)\, W_{i \dots n}(k-1); \tag{3}$$

$$\begin{gathered} x^{*}_{j \dots m}(k) = \sum\nolimits_{i=1}^{M} \cdots \sum\nolimits_{n=1}^{M} \prod\nolimits_{ij}^{1}(k, k-1) \dots \prod\nolimits_{nm}^{L}(k, k-1)\, W_{i \dots n}(k-1) \times \\ \times F[\hat{x}_{i \dots n}(k-1)] / W^{*}_{j \dots m}(k); \end{gathered} \tag{4}$$

$$\overline{P^{*}_{j \dots m}}(k) = \sum\nolimits_{i=1}^{M} \cdots \sum\nolimits_{n=1}^{M} \prod\nolimits_{ij}^{1}(k, k-1) \dots \prod\nolimits_{nm}^{L}(k, k-1)\, W_{i \dots n}(k-1) \times \tag{5}$$

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