OPTIMIZATION OF SYSTEMS FOR PARAMETRIC MONITORING OF THE RELIABILITY OF RADIOELECTRONIC DEVICES

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Izvestiya VUZ. Radioelektronika,
Vol. 33, No. 7, pp. 44-49, 1990

UDC 621.391.1

Parametric monitoring of the reliability of a radioelectronic device has been presented as a problem in recognition of two multidimensional normal ensembles. Analytic expressions have been derived for the monitoring-error probabilities. A procedure has been proposed for selecting the most informative parameters. The problem of optimizing the monitoring system according to the number of measurements required for monitoring in the presence of restriction on the error probabilities has been solved. An example has been given.

Nondestructive monitoring of the reliability of a radioelectronic device (RED), which is performed from the results of measurements of the values of the vector corresponding to the monitored electrical parameters $X = (x_1, ..., x_p)$, can as a rule be reduced to an image recognition problem (see [1]). Due to fluctuations of the technological process, the parameters indicated are random quantities. All fabricated samples can be divided into two classes: reliable (S_2) and potentially unreliable (S_1). Both classes are characterized by their distribution functions of the vector representing the monitored parameters; these distribution functions may frequently be approximated by normal distributions N_1, N_2 (see [2]). In group reliability monitoring, n monitored items are chosen from the batch of products; for each of these items the vectors of the monitored parameters are measured, and it is determined whether the monitoring sample $X^1, ..., X^n$ consisting of these measurements belongs to one of the multidimensional normal distributions introduced above. Most frequently, the monitored parameters may be chosen in such a way that they are weakly correlated (a correlation coefficient below 0.2; see [3]). In practice, such correlation may be neglected, since the error probability under these conditions changes insignificantly, and it may be assumed that the monitored parameters are uncorrelated; if the normality of their distribution is taken into account, they may also be assumed independent. In this case, the covariational matrices of the vector of the monitored parameters will be diagonal with variances along the diagonal for both classes. The average values a_{ij} and variances σ^2_{ij} of the monitored parameters are a priori unknown for both classes. Therefore, the problem of parametric reliability monitoring of RED can be reduced to the recognition of two multidimensional normal ensembles $N_1(a_1, D_1)$ and $N_2(a_2, D_2)$ in accordance with the monitoring sample $X^1, ..., X^n$ (see [2]).

The purpose of this work is to derive analytic expressions for the error probabilities of parametric monitoring of the reliability of RED, then using these as the basis for choosing the most informative monitored parameters and optimizing the monitoring system for a priori stipulated constraints on the error probability.

The problem of recognizing two multidimensional normal ensembles N_1 and N_2 according to the monitoring sample $X^1, ..., X^n$ resides in comparing of the logarithm of the likelihood ratio v with the threshold l; in this ratio, the unknown averages a_{ij} and variances σ^2_{ij} are replaced by their estimates (i = 1, 2; j = 1...p)

$$\hat{a_{ij}} = \left(\sum\nolimits_{k=1}^{m_i} x_{ij}^k\right)/m_i; \qquad (\sigma^2_{ij})\hat{} = \left[\sum\nolimits_{k=1}^{m_i} (x_{ij}^k - \hat{a_{ij}})^2\right]/(m_i - 1) = \\ = \sigma^2_{ij} w_{ij}/(m_i - 1),$$

obtained from the training samples $X_i^1, \dots, X_i^{m_i}$, where m_i are their sizes (see [2]). In other words, for fulfillment of the inequality

$$v = \sum\nolimits_{j=1}^{p} \{(m_1 - 1) \sum\nolimits_{k=1}^{n} (x_j^k - \hat{a_{1j}})^2/w_{1j}\sigma^2_{1j} - (m_2 - 1) \sum\nolimits_{k=1}^{n} (x_j^k - \hat{a_{2j}})^2/ \\ /w_{2j}\sigma^2_{2j} + n \ln [w_{1j}\sigma^2_{1j} (m_2 - 1)/w_{2j}\sigma^2_{2j} (m_1 - 1)]\} \geqslant 2l \tag{1}$$

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23 December 1988