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ANALYSIS AND OPTIMIZATION OF MULTIFREQUENCY SIGNAL PROCESSING SYSTEMS

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The paper is devoted to analysis of detection characteristics of systems of invariant processing of multifrequency signals against passive interference background. Dependencies of the threshold signal-to-noise ratio on the number of frequency channels, and on parameters of signal, passive interference, and noise are determined. Analysis of these dependencies is used for optimization of systems of multifrequency signal processing as a function of the number of frequency channels. Comparison of different types of multifrequency signal processing is included.

An alternative to single-frequency systems of moving target selection (MTS) is usage of multifrequency systems, permitting to overcome the main difficulty arising at designing the single-frequency systems — the blind speeds in the operation range of target's velocities. However, in deciding on a particular MTS system or when designing such systems, there arises a problem of comparative analysis of the systems of invariant processing of multifrequency signals, and determination of optimal number of frequency channels, which are necessary for the MTS system realization. Resolution of these issues is possible through analysis of detection characteristics at different number of frequency channels and at various parameters of the signal, interference and noise arriving at the input of the multifrequency MTS system.

Statistical description of multifrequency signals and interference. The input data of the lth frequency channel, where the data represent an additive mixture of legitimate signal, interference, and noise

$$U^{(l)} = U_{\mathrm{s}}^{(l)} + U_{\mathrm{int}}^{(l)} + U_{\mathrm{n}}^{(l)} \tag{1}$$

can be represented as a sequence of N samples of complex envelopes $U_j^{(l)} = x_j^{(l)} + \mathrm{i}y_j^{(l)}$ arriving with the repetition period T and forming, in the lth frequency channel, a column vector $\boldsymbol{U}_l = \{U_j^l\}^{\mathrm{T}},\ j = \overline{1,N},\ l = \overline{1,L}$.

Provided the legitimate signal and interference are Gaussian random processes, the simultaneous distribution of the values at the input of the lth frequency channel can be represented in the form

$$P(\boldsymbol{U}_l) = (2\pi)^{-N} \left(\det \boldsymbol{R}_l\right)^{-1} \exp\left(-\frac{1}{2} \boldsymbol{U}_l^{*\mathrm{T}} \boldsymbol{W}_l \boldsymbol{U}_l\right) \tag{2}$$

where $\boldsymbol{R}_l = \left\| R_{jk}^{(l)} \right\|$ is the N-order correlation matrix of the received samples for the lth frequency channel, and $\boldsymbol{W}_l = \left\| W_{jk}^{(l)} \right\|$ is the matrix inverse to the correlation matrix $\boldsymbol{R}_l$.

The elements of the correlation matrix of the received samples are defined by expression

$$R_{jk}^{(l)} = \frac{1}{2} \overline{U_j^{(l)} U_k^{(l)*}}.$$

Then, with regard for (1), the expression for determination of the correlation matrix entries may be written in the form

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