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A DEVICE FOR STABILIZATION OF FALSE ALARM PROBABILITY USING A LINEAR COMBINATION OF ORDER STATISTICS

F. M. Andreyev, A. N. Kurbet, and R. E. Pashchenko

Kharkov Military University, Ukraine

The authors suggest a new structure of the device for stabilization of false alarm probability using a linear combination of order statistics to estimate the unknown variance of interference. The work also includes estimation of the quality criteria of detection by the device in the presence of nonstationary interference.

The process of radar detection of targets includes a comparison of the received signal amplitude with some threshold. To ensure the fixed probability of false alarm in the event of unknown noise (interference) power, devices with adaptive control of the threshold must be used. These devices, called stabilizers of false alarm probability (SFAP) [1], are usually built on the "sliding window" principle, with subsequent estimation of the unknown variance of the interference background σ_{ib}^2.

As shown in [2], in the clutter and multiple target situations the most efficient method consists of calculation of the interference background variance with the use of order statistics. The number K of the order statistic is recommended to be chosen as $K = 3N/4$, where N is the "sliding window" dimension. In such SFAP we use the value (amplitude) of the Kth order statistic X_K as an estimate of interference variance σ_{ib}^2 taking part in generating the required threshold value [2]

$$U_{\text{thr}} = T_{\text{tc}}\ \sigma_{\text{ib}}^2 = T_{\text{tc}} X_K \tag{1}$$

where T_{tc} is a threshold constant defined by the false alarm probability value P_F.

The purpose of this work is to consider the structure of SFAP, where, instead of isolated order statistics we use their linear combination as an estimate of the unknown interference variance σ_{ib}^2. Another purpose consists in analyzing the detection quality of SFAP. By a linear combination of order statistics (LCOS) is meant a weighted sum of a sample (containing more than one element) consisting of the ordered (after ranging) numerical values of signal amplitudes.

The efficient operation of SFAP with LCOS, under nonstationary interference conditions, can be attained using the weighted sum of order statistics with their ordinal numbers from $0.5N + 1$ to K.

The detector will be assumed quadratic. Then, in the event of Gaussian interference, the interference amplitude distribution law is exponential [4]. For a sample composed of elements with exponential rule of propagation and truncated from the left and from the right, the optimal estimate of interference variance has the form [3]

$$\sigma_{\text{ib}}^2 = \frac{1}{G}\left[\left(\frac{L}{d} - (N - r1)\right) X_{(r1+1)} + r2\, X_{(N-r2)} + \sum_{i=r1+1}^{N-r2} X_{(i)}\right] \tag{2}$$

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