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AN ADAPTIVE DETECTOR OF MULTIPLE TARGETS

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The structure of a new adaptive detector is developed based on order statistics. The device ensures stabilization of the false alarm probability in the case of nonstationary interference background. The paper gives comparative estimation of detection quality indices of the new and the classical devices working on the order statistics principles. Advantages of the new device at detecting multiple objects are discussed.

Processing of radar information for adaptive detection of targets is performed, as a rule, with the use of special parametric detectors built on the “sliding window” principle, followed by estimating the unknown variance of the clutter background. Such detectors ensure a constant level of false alarms (CFAL) and are often called CFAL-processors. Depending on the method of calculation of the clutter unknown variance, four classes of CFAL-processors are available [1]: with averaging of the power of samples within the “window” elements; with the use of different logic on the “window” elements; based on order statistics (OS-CFAL-processors); and the devices, which are adaptive to the parameters of non-Rayleigh’s distributions of clutter amplitudes.

When dealing with a multiple-target situation and in the presence of nonstationary interference, the OS-CFAL-processors are most efficient [1, 2]. In such a device, for the estimate of the clutter variance Z used for generation of a required threshold value U_{thr} we work with the value of the Kth order statistic $X_{(K)}$, i.e.,

$$U_{\text{thr}} = T_{\text{thc}} \cdot Z = T_{\text{thc}} \cdot X_{(K)} \tag{1}$$

where T_{thc} is some threshold constant defined by the required false alarm probability (FAP) P_F.

In what follows such a device will be called classical. The sampling of the input process is performed with a frequency F_{sam} that ensures noncorrelatedness of samples in the “sliding window”. Thus, when the radar channel of echo-signal processing contains a matched filter with a passband $\Delta f_{\text{mf}} \approx 1/\tau_{\text{s}}$, where τ_{s} is the sounding signal duration, the sampling frequency must be selected equal to $f_{\text{sam}} \approx \Delta f_{\text{mf}}$. The duration of the matched filter response τ_{resp} at the zero level, i.e., $\tau_{\text{resp}} \approx 2\tau_{\text{s}}$. It means that after time sampling the echo-signal may occupy two samples in the “sliding window”. This is the reason why we have to exclude from our consideration the cells (elements) of the “sliding window” located on the right and on the left from the central cell (the sample element X_0 to be analyzed) put through the threshold test [2]. If the time sampling is performed in accordance with Kotelnikov’s theorem then $f_{\text{sam}} \approx 2\Delta f_{\text{mf}}$, and the number of cells of the “sliding window” occupied by the echo signals may amount up to 3–4.

Denote by $< n_{\text{s}} >$ the average number of cells occupied by the echo, and by N — the dimension of the sample used for evaluation of the clutter variance. In the event of detection of a multiple target with resolvable elements, the quantity $(< n_{\text{s}} > + l)/ < n_{\text{s}} > = q_{\text{sp}}^{\text{min}}$ defines “sparseness” of the target elements, where l is the discrete spacing between the signals from the neighboring elements. At given N, K, and $< n_{\text{s}} >$ the classical OS-CFAL-processor is able to detect multiple targets in which the sparseness of elements is no less than

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