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MAXIMUM ATTAINABLE QUALITY OF DETECTION AND RESOLUTION OF SIGNALS IN THE DETECTOR BASED ON A MATCHED PROJECTOR

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The paper is devoted to assessment of maximum attainable efficiency of a new method of signal processing providing high resolution of correlated and uncorrelated signals.

The possibility of application of known properties of projectors for attaining high resolution of correlated and uncorrelated signals has been considered in [1]. The paper below presents results of quantitative assessment of maximum achievable quality of detection and resolution of signals in radar detectors based on matrix filters-projectors.

When estimating detector's efficiency, the following assumptions are introduced: the sounding signal of the radar is narrow-band in space and frequency; the receiving antenna of the radar is an equidistant digital linear antenna array (DLAA) with the distance between reception elements equal to half-length of the working wave; the intrinsic noise of the reception channels is distributed by the normal law; the correlation matrix (CM) of the intrinsic noise of the reception channels is represented as $\mathbf{R}_{\mathrm{n}} = p_{\mathrm{n1}} \cdot \mathbf{I}$ (here p_{n1} is the power of intrinsic noise of a single receiving channel in DLAA, and $\mathbf{I}$ is the identity matrix).

By a matrix-type filter-projector (MFP) is meant a matrix filter with its transfer function $\mathbf{Pr}_n = \mathbf{V} \cdot \left(\mathbf{V}^{\mathrm{H}} \cdot \mathbf{V}\right)^{-1} \cdot \mathbf{V}^{\mathrm{H}}$, where $\mathbf{V} = \left[\mathbf{v}_1\, \mathbf{v}_2 \ldots \mathbf{v}_n\right]$ is an $N \times n$ matrix; N is the number of reception channels in DLAA if we deal with spatial filtering, or the number of taps of the digital delay line (DDL) — in the case of Doppler's filtration; n is the number of columns in the matrix $\mathbf{V}$; $\mathbf{v}_i$ is the N-dimensional column vector characterizing the amplitude-phase distribution (APD) created by the ith target falling in the radar pulse volume; and H denotes Hermitian conjugation.

The MFP dimensionality will be defined by the number of columns of the matrix $\mathbf{V}$. In what follows, the subscript at the symbol, corresponding to the characteristic of the filter-projector, is indicative of the projector dimensionality for every particular case.

The projector is called matched if: the projector dimensionality n coincides with the number of targets M in the radar pulse volume, i.e., $n = M$; and the columns of the matrix $\mathbf{V}$ coincide with the column vectors characterizing the APD, created by targets' signals, in the DLAA reception elements. The purpose of this paper consists in quantitative estimation of quality of detection and resolution of targets' signals in radar detectors based on matrix-type filter-projectors.

Let us estimate the detection quality in detectors using the matrix filter-projectors. When the number of targets in the pulse volume of the radar is known, the detection algorithm has the form [2]:

$$z_M = \mathbf{Y}^{\mathrm{H}} \cdot \mathbf{Pr}_M \cdot \mathbf{Y} \geq z_{\mathrm{thr}\ M}, \qquad (1)$$

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