Radioelectronics and Communications Systems
Vol. 47, No. 2, pp. 25–29, 2004

Izvestiya VUZ. Radioelektronika
Vol. 47, No. 2, pp. 34–41, 2004
UDC 621.396.677

COMPARATIVE ESTIMATION OF EFFECTIVENESS OF NOISE SIGNAL DETECTORS REALIZED WITH THE AID OF KEYPONE'S ALGORITHM AND THE OPTIMAL ALGORITHM

B. F. Bondarenko, I. N. Sashchuk, and V. Yu. Tymchuk

Kiev, Ukraine

The paper is devoted to the estimation of the quality of noise signal detection in the output signal processing system of an equidistant linear antenna array realized with the aid of an algorithm of high resolution known as Keypone's algorithm. The obtained results are compared with the respective parameters of an optimal detector of noise signals.

In spite of repeated inquiries in high-resolution algorithms, particularly, in that proposed by Keypone [1, 2], the issue of signal detection quality estimation, when the number of signal samples used in the algorithm for estimating the correlation matrix (CM) is limited, remains open. However, without answer to this question we hardly can give any substantiated recommendations on usage of the Keypone algorithm in the problems occurring in radar and communications. The purpose of this paper is to fill the gap.

The Keypone algorithm is one of widely known high-resolution algorithms [1]. It assumes calculation of the function of output signals from a digital linear antenna array (DLAA) of the type

$$F(\theta) = 1/[\vec{v}_0^H(\theta)\cdot(R^*)^{-1}\cdot\vec{v}_0(\theta)] \tag{1}$$

where $R^* = 1/n_1 \cdot \sum_{i=1}^{n_1} Y_i \cdot Y_i^H$ is the estimating CM of output signals of the DLAA; Y_i is the N-dimensional column vector of discrete samples of the DLAA output signals; $v_0^H(\theta) = [1\ \ \mathrm{e}^{-\mathrm{j}\varphi}\ \ \mathrm{e}^{-2\mathrm{j}\varphi}\ \ldots\ \mathrm{e}^{-\mathrm{j}(N-1)\varphi}]$ is the estimating row vector; N is the number of reception channels of the DLAA; $n_1 \geq N$ is the number of signal samples employed in the CM estimation; $\varphi = \pi\cdot\sin\theta$, provided that the distance between the DLAA receiving elements is equal to a half wavelength of the oscillations radiated by the signal source (SS); $\theta \in [\theta_{min}, \theta_{max}]$ is a possible value of the SS angular coordinate; $(\theta_{max} - \theta_{min})$ is the range of possible θ values; and H denotes Hermitian conjugation.

Provided that

$$F(\theta) \geq h_0 \tag{2}$$

where h_0 is the detection threshold dictated by a prescribed false alarm probability, for the estimate θ^* of the parameter θ to be measured we take the θ value corresponding to $\theta^* = \arg\max_{\theta} F(\theta)$.

For brevity sake, in the relations containing $\vec{v}_0$ or F, the argument θ will be omitted. With all other things being the same, the signal detector effectiveness can be characterized by the detection probability. In order to estimate the probability of signal detection at functional transformation of the DLAA output signals, corresponding to the Keypone algorithm, we must know the probability distribution density of the function defined by (1).

REFERENCES

1. J. Keypone, Proc. IEEE [Russian edition], Vol. 66, No. 1, pp. 60–96, 1978.
2. D. I. Lekhovitskii, P. M. Flekser, D. V. Atamanskii, and I. G. Kirillov, Antenny, No. 2(45), pp. 23–39, 2000.
3. S. R. Rao, Linear Statistical Methods and Their Applications [Russian translation], Nauka, Moscow, 1968.
4. B. P. Levin, Theoretical Foundations of Statistical Radio-Engineering. Book 1 [in Russian], Sov. Radio, Moscow, 1974.
5. I. S. Gradshtein and I. M. Ryzhik, Table of Integrals, Sums, Series, and Products [in Russian], Nauka, Moscow, 1971.
6. Yu. G. Sosulin, Theory of Detection and Estimation of Stochastic Signals [in Russian], Sov. Radio, Moscow, 1978.
7. V. V. Voyevodin and Yu. A. Kuznetsov, Matrices and Computations [in Russian], Nauka, Moscow, 1984.

23 April 2003