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A METHOD FOR ESTIMATION OF MANY-DIMENSIONAL IMAGES WITH SUPER-RAYLEIGH RESOLUTION IN PROCESSING OF ECHO SIGNALS AT COHERENT SOUNDING

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A new method called NOSE (nonorthogonal signals estimation) is suggested for assessment of many-dimensional (time-space-Doppler type) amplitude-phase images, particularly, multiple lumped targets. When using this method, the maximum possible resolving capacity of the radar system is limited only by the signal-to-noise ratio. An analytical expression of the correlation matrix of noise in image is deduced. The soundness of the method at typical signal-to-noise ratios is confirmed by the mathematical simulation method.

In many fields of human activity we often face the problems of processing of signals (or modulated waves) of different physical nature — with the purpose of extracting some useful information. These are systems of radio- or acousto-location (ultrasonic diagnostics in particular), systems of communications, data transmission and telecommunication, navigation, management of sea, air, and space traffic, etc. The intensive development of contemporary technologies of signal processing makes it possible to use more intelligent algorithms, permitting to get a maximum of information embedded in the signals under processing.

In practical situations, there often arises the problem of assessment of the number of available and informative parameters of a mixture of some signals received against the background of additive noise-like interference. At the present time, the solutions to this problem are rather deeply investigated for the cases when the realization to be processed is formed by a single signal known with an accuracy of its amplitude and some other parameters (the trivial case), or when the signals comprising the input mixture are orthogonal.

The orthogonality condition, which reduces the problem to the trivial case, is satisfied if we can separate signals in time, or when other signal parameters (the frequency, phase, space parameters, etc.) correspond to their orthogonaluty (meaning that the signals are resolved in time, frequency, or space).

For traditional methods of signal processing the orthogonaluty condition is a limitation of sorts. In the cases when the signal mixture components are essentially nonorthogonal, we call these signals non-resolvable. The known Woodword and Rayleigh criteria characterize the permissible rate of non-resolvability of the components in radio- and acousto-location, and in optoelectronic equipment. In the end, these and similar criteria dictate the domain of application of traditional methods of signal processing. At the same time, the practical application of signal processing systems shows that the above limitation lowers their potentialities and, moreover, narrows their sphere of application considerably.

The latter assertion can be illustrated by several examples (our considerations concern mainly the radar systems, but they can be extended to acousto-location systems as well).

It is well known that in radar stations of traditional structure the range resolution of two or several targets is unambiguously related to the width of sounding signal spectrum. Hence, in order to attain the required resolution of a radar

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