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Estimation of the Connectedness Parameter of Narrow-Band Interferences Described by Markov Model in Applied Problems of Detecting Radar Signals

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Abstract—An adaptive selection algorithm of the order of filter for the suppression of correlated interferences described by the *m*-order Markov models has been considered. The specified algorithm based on estimating the order of connectedness was analyzed in terms of the structure of inverse correlation matrix of the clutter (interference). This algorithm was compared with the algorithm based on calculating the Akaike information criterion. In addition the relationships of the threshold value used in making a decision on the order of connectedness as a function of the relative spectrum width of interference and the noise-to-clatter ratio were also obtained.

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INTRODUCTION

The problems dealing with the synthesis and performance analysis of wireless devices in radiolocation and communications involve the need of taking into account the effect of different kinds of external and internal noises and interferences. In the majority of cases their physical nature makes it possible to consider these interfering inputs as stationary normal random processes with probability density function

$$w_N(\mathbf{X}) = (2\pi)^{-N/2}[\det(\Sigma)]^{-1}\exp\left\{-\frac{1}{2}(\mathbf{X}-\mathbf{M})^{\mathrm{T}}\Sigma^{-1}(\mathbf{X}-\mathbf{M})\right\},$$

where $\mathbf{M}$ and Σ are the mathematical expectation vector and the covariance matrix of discrete process having N measurements, respectively.

Markov models (chains) are commonly used for the description of such processes [1]. One of the Markov model parameters determining the statistical dependence of the ith realization of the random process on m previous realizations is the so-called connectedness m of the chain. The problems of detecting radar signals against the background of narrow-band interferences involve the approximation of the latter by using an m-order Markov sequence. Such approximation makes it possible to synthesize the practically implementable devices for primary processing of signals. Hence optimal operations for the detection of signal against the background of correlated Markov interference with a priori known connectedness at the ultimate narrowing of the spectrum width of interference fluctuations are performed by using a two-stage procedure including the whitening of interference with subsequent coherent addition of a useful signal [2]. The corresponding structure of the n-pulse signal processing system represents a tandem connection of the mth order rejection filter and the multichannel $(n - m - 1)$-order accumulation filter. Given the a priori uncertainty of the connectedness parameter m, the order and parameters of the filters become indeterminate that implies the need of adaptation on the basis of estimating the order of Markov chain. It should be noted that the issues of adaptation based on estimating the order of Markov chain have received insufficient attention in the available literature.

The purpose of this study is to estimate the order of connectedness of narrow-band radar interferences having the spectral-correlation properties that are described by using the m-order Markov models.