ISSN 0735-2727, Radioelectronics and Communications Systems, 2016, Vol. 59, No. 8, pp. 362–368. © Allerton Press, Inc., 2016.
Original Russian Text © A.A. Kolchev, A.E. Nedopekin, 2016, published in Izvestiya Vysshikh Uchebnykh Zavedenii, Radioelektronika, 2016, Vol. 59, No. 8, pp. 44–51.

Application of Model of Mixture of Probabilistic Distributions for Definition of the Signals of Radiophysical Probing

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Received in final form September 14, 2015

Abstract—The article describes a model representation of radar probing data in form of a mixture of background and target samples, which is the sum of two random variables with very different parameters. For model development we research the behavior of the central moments of the distribution mix without assuming the distribution law form. An example it is described the detection of the signal at the output of compression system of chirp ionosonde.

DOI: 10.3103/S0735272716080057

INTRODUCTION

The problem of detection of the useful signal at the output of radio receiving equipment is one of the main problems in case of radio probing data processing. The most of methods of the signal selection on a background of noise or interferences use the criteria, related to some known a priori assumption about signal and noise distribution [1, 2]. Usually there are approaches using assumption that signal-noise mixture at the output of the receiver is characterized by known distribution (Nakagami–Rice, Relay, etc.) [3].

Signals processing for solution of radio physical problems has essential specificity in compare to connected signal processing, since physical conditions are characterized by static instability, which is the researches object. This instability introduces natural a priori non-parametric uncertainty. Moreover, detection of known signal (by structure, statistic properties) is often main problem in radio physical researches. In [4] it is proposed a model of the mixture distribution for description of probabilistic model of the signal at the radio physical probing equipment output.

The purpose of the paper is research of the possibilities of application of such numerical characteristics of the mixture distribution, which are modified essentially in case of presence of useful signal in it.

1. PROBABILISTIC MODEL

Since the signals in current-technology devices are represented in digital form, then the output signal detection problem stated in following form.

Let it is obtained n samples $x_1, x_2, \ldots, x_n$, which are the results of some observations. It is supposed the digital samples are uncorrelated, and the samples, related to the signal exceed the rest samples. If the useful signal is absent, then all samples $x_1, x_2, \ldots, x_n$ are considered as the realization of independent equally distributed random values $X_1, X_2, \ldots, X_n$ with the distribution function $F(x)$ or there is n realizations of the random value X. In case of presence of the samples related to the signal we consider random values X_1, $X_2, \ldots, X_n$ are also independent. At that the samples $x_1, x_2, \ldots, x_m$ ($m < n$) are the realizations of the random value X with distribution $F(x)$, and the samples $x_{m+1}, \ldots, x_n$ are the realization of the random value Y with distribution function $G(x)$, which is shifted right regarding $F(x)$ (for example, $G(x) = F(x - A)$).

In this case all samples amount $x_1, x_2, \ldots, x_n$ can be considered as a set of realizations of the random value Z, which is a mixture of the random values X and Y. Random value X characterizes the background samples (noise, interferences), random value Y characterizes target samples, whose presence in the mixture Z must be determined.

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