

Analysis of Suboptimal Detection-Discrimination Algorithms of Compound Ultra-Wideband Signals in Multipath Channels with Undefined Structure

Yu. S. Radchenko and A. A. Zaitsev

Voronezh State University, Russia

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Abstract—Investigation results for suboptimal processing rule of a coded ultra-wideband signal with unknown arrival time at the output of multipath communication channel with undefined structure are presented. Characteristics of signal detection-discrimination from multiple users are calculated. Statistical modeling of suboptimal signals reception is performed.

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One of the new ways of wireless information systems efficiency enhancement is the use of ultra-wideband (UWB) signals without carrier [1]. Achievement of high characteristics for these systems may be obtained through the use of coded ultra-wideband signals with large base [2, 3] only. A main reception problem of UWB signals is multipath propagation in communication channel. Undefined beams number, unknown time position of multipath cluster, and random relative beam's position with unknown amplitudes characterizes the signal's multipath structure. Synthesis and analysis of optimal signal processing algorithms at the output of a similar channel appears to be a complex problem. Practical realization of such algorithms in ultra-wideband frequency range makes rather strict requirements to system's speed of operation. System detection-discrimination characteristics for simultaneous signals with undefined structure with the help of a device designed for a single-beam signal (suboptimal reception) are found in this article. The analysis of these characteristics allows estimating reasonability of complicating processing system at the output of channels with the specified structure during reception of ultra-wideband signals with code modulation from multiple users. The statistical modeling of suboptimal signals' detection-discrimination, which allows evaluating the accuracy of the produced expressions, is performed in this work.

SIGNAL'S MODEL

In a general case coded UWB signal can be written as

$$f(t) = \sum_{k=0}^K a_k f_0(t - (k + b_k \Delta)T_0 + \sigma g - \tau_0), \quad (1)$$

where $f_0(t)$ determines the elementary pulse's form of sequence, (T_0, τ_0) are the period and time position of pulse sequence. The binary code $g = \{1, -1\}$ provides modulation shift σ of UWB sequence. The signals consisting of the Gaussian monocycles of the first ($f_0(t) = (\alpha t) \exp(-(\alpha t)^2)$) and second ($f_0(t) = \exp(-(\alpha t)^2) (-\alpha t)^2$) orders are considered more often. In signal's model (1) the sequence period is modulated instead of time position of an elementary pulse within sequence as opposed to [1]. Thus, the signal has the additional information parameter increasing signals' space [2, 3] considerably.

PROCESSING ALGORITHM

Signal that passed through multipath channel can be written as