CONDITIONAL OPTIMIZATION OF SIGNALS FOR HIGH-SPEED NONLINEAR INERTIAL RADIO CHANNELS

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A new approach has been proposed to the solution of the problem of increasing the information efficiency of high-speed message transmission over nonlinear inertial channels; the technique is based on searching for the optimal ensembles of signals under the condition of their element-wise mutual-correlation reception.

In order to improve the quality of communication, it is conventional to perform optimization of the receiver for signals of the stipulated type in a specific signal-transmission channel. However, the applicability of this traditional approach to nonlinear inertial channels is substantially restricted by the significant difficulties in finding the functional for the likelihood ratio and the practical realization of the decision rules being synthesized. In this connection, it is of interest to examine an alternative approach to the indicated channels, which is based on the optimal selection of signals using a relatively simple algorithm for their element-wise mutual-correlation processing.

However, it is well known that the mentioned algorithm is, rigorously speaking, optimal only for linear stationary Gaussian channels with additive white noise. Likewise taking into account the greatest preference for a rectangular shape of the signals for nonlinear channels, the proposed approach can be reduced to the optimal selection of ensembles of signals according to the criterion of minimum total error probability p_0 for the condition that stationarity and Gaussianness of the signals utilized is ensured. Here it is essential that the given selection be performed in the class of signals which are invariant relative to any influence of their nonlinear dynamic distortions. The latter means the absence of any influence of terms of the second and higher orders $\sum_{q=2}^{\infty} y_q(\cdot)$ in the mathematical description of the output response $y(\cdot)$ of the considered nonlinear inertial channels by means of a functional Volterra series in the input $x(\cdot)$ (see [4]):

$$y(t) = y_1(t) + \sum_{q=2}^{\infty} y_q(t) = \int_{-\infty}^{\infty} h_1(\tau)\, x(t-\tau)\, d\tau + \sum_{q=2}^{\infty} \int_{-\infty}^{\infty} \cdots \int_{-\infty}^{\infty} h_q(\tau_1, \ldots, \tau_q) \prod_{i=1}^{q} x(t-\tau_i)\, d\tau_i, \tag{1}$$

where $h_g(\cdot)$ is the g-th order Volterra kernel of the investigated channel and $g \in [1, \infty)$. Then from the results of [1] it follows that the desired class is made up of sequentially transmitted discrete signals of equal power with a restricted base and a dynamic amplitude range. The requirement that the given signals $s(\cdot)$ have a narrow band relative to the center frequency ω_s of the spectrum gives rise (see [2]) to the possibility of their orthogonal projection

$$s(t) \sim A \sin[n(2\pi/T)t + \Phi] + B \sin[m(2\pi/T)t + \Psi] = s'(t) \tag{2}$$

from the Hilbert-space domain of the allowed realizations which is bounded by the conditions indicated above onto the four-dimensional Euclidean space that is "stretched" over the system of orthonormalized basis functions

$$\left\{ \begin{array}{ll} \lambda_1(t) = \sin n(2\pi/T)t; & \lambda_3(t) = \sin m(2\pi/T)t; \\ \lambda_2(t) = \cos n(2\pi/T)t; & \lambda_4(t) = \cos m(2\pi/T)t, \end{array} \right\} \tag{3}$$

REFERENCES

1. M. A. Ivanov, "Investigation of the effect of nonlinear distortion of discrete signals on the quality of their transmission," Izv. VUZ. Radioelektronika [Radioelectronics and Communications Systems], vol. 32, no. 7, pp. 10-16, 1989.

2. A .G. Zyuko, A. I. Fal'ko, I. P. Panfilov, et al., Interference Immunity and Efficiency of Information-Transmission Systems [in Russian], A. G. Zyuko (Editor), Radio i svyaz, Moscow, 1985.

3. M. A. Ivanov, "Distribution of the output response of narrow-band nonlinear systems of the Volterra type," Radiotekhnika, no. 11, pp. 52-54, 1987.

4. M. A. Ivanov and I. A. Yakovlev, "Probabilistic properties of the output signal of nonlinear inertial systems of the Volterra type," Radiotekhnika i elektronika, vol. 34, no. 3, pp. 653-656, 1989.

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