ESTIMATION OF SIGNAL DELAY WHEN THE PARAMETERS OF THE MODULATING INTERFERENCE ARE UNKNOWN

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The variances of the quasi-optimal estimate and of the maximum-likelihood estimate of the signal delay for reception on a background of white noise are obtained.

Consider the reception of the following pulse:

$$s(t, \tau_c) = \begin{cases} a_0 (1 + K_0 \xi_0 (t)), & |t - \tau_c| \leq \gamma/2; \\ 0, & |t - \tau_c| > \gamma/2, \end{cases}$$

(1)

distorted by modulating Gaussian interference $\xi_0 (t)$ on a background of Gaussian white noise $n(t)$ with single-sided spectral density $N_0$. Here $\xi_0 (t)$ is a dimensionless stationary random process, which describes the parasitic modulation of the signal, where $\langle \xi_0 (t) \rangle = 0$, $\langle \xi_0 (t) \xi_0 (t+\lambda) \rangle = K_0 (\lambda)$, $K_0 (0) = 1$, and $k$ is the parasitic modulation coefficient. The maximum-likelihood estimate of the delay $\tau$ of signal (1) was investigated in [1] for the case when the parameters $a$ and $k$ of the modulating interference are known a priori. We will assume that in addition to the delay $\tau_0$, which it is required to estimate, the true values $a_0$ and $k_0$ of the parameters of the modulating interference are also not known.

As in (1) we will assume that the duration of the pulse (1) is much greater than the correlation time of the process $\xi_0 (t)$, i.e.,

$$\mu \gg 1, \quad \mu = \gamma A f_g / 2; \quad A f_g = \int_{-\infty}^{\infty} G_0 (\omega) d\omega / 2 \pi \max G_0 (\omega);$$

(2)

$G_0 (\omega)$ is the power spectrum of the process $\xi_0 (t)$.

When (2) is satisfied, to estimate the delay of the signal (1) we will use the maximum-likelihood receiver synthesized in [1]. The estimate of the unknown signal delay $\hat{\tau}_1$ is defined in this case as the position of the absolute (the greatest) maximum of the function

$$M_1 (\tau) = \frac{1}{2} \int_{-\gamma/2}^{\gamma/2} [\rho^2 (t) + \frac{4a_1 x (t)}{N_0 (1 + a_1 k_1 \rho)}] dt.$$

(3)

Here $x(t)$ is a sample of the observed data, $y_1 (t) = \int_{-\infty}^{\infty} x(t') H_1 (t-t') dt'$, the spectrum of the function $H_1 (t)$ satisfies the relation $|H_1 (\omega)|^2 = 2a_1 k_1 r \times \rho (\omega) / N_0 (1 + a_1 k_1 \rho (\omega)); \rho (\omega) = G_0 (\omega) / \max G_0 (\omega), r = 2 \max G_0 (\omega) / N_0; \tau_0 = 2G_0 (0) / N_0$, while the quantities $a_1$ and $k_1$ are the assumed values of the parameters of the modulating interference, where, in general, $a_1 \neq a_0$, $k_1 \neq k_0$.

We will obtain the characteristics of the estimate $\hat{\tau}_1$. Introducing the dimensionless parameter $l = \tau_0 / \gamma$, we can represent (3) in the form of the sum [1] of the signal function and the noise function

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REFERENCES


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