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MODERNIZATION OF PEARSON'S DISTRIBUTIONS FOR APPROXIMATION OF EXPERIMENTAL DISTRIBUTIONS OF RADAR SIGNALS

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The paper describes a modernization of Pearson's method for approximation of experimental distribution of radar signals. The modified method permits us to facilitate the approximation procedure and to extend the field of application of the Pearson method.

Selection of some or other statistical models for an appropriate description of experimental distributions of radar signals may be based on known empirical methods, such as the application of Johnson's and Pearson's distributions, the expansion into Edgeworth's series, etc. [1–3]. The well-known system of Pearson's distributions satisfies the differential equation [1, 3]

$$\frac{\mathrm{d}p(x)}{\mathrm{d}x} = \frac{a_1 x - a_0}{b_2 x^2 + b_1 x + b_0} p(x) \tag{1}$$

where a_i and b_i are parameters of the distribution.

If the first primary moment $m_1 = 0$, then the parameters a_i and b_i can be determined by the formulas [1, 3]

$$a_0 = b_1 = a_1 \frac{\mu_3(\mu_4 + 3\mu_2^2)}{d}, \quad b_0 = a_1 \frac{\mu_2(4\mu_2\mu_4 - 3\mu_3^2)}{d}, \tag{2}$$

$$b_2 = a_1 \frac{2\mu_2\mu_4 - 6\mu_2^2 - 3\mu_3^2}{d},$$

where μ_n are the nth order central moments; $d = 18\mu_2^3 + 12\mu_3^2 - 10\mu_2\mu_4$. Here we assume that the parameter $a_1 = 1$.

Approximation of the experimental data by Pearson's empirical distributions includes the following steps:

– determine the first four selected moments used for calculating the asymmetricity coefficient β_1, peakedness coefficient β_2, and the coefficient k:

$$\hat{\beta}_1 = \hat{\mu}_3 / \hat{\mu}_2^{1,5}, \hat{\beta}_2 = \hat{\mu}_4 / \hat{\mu}_2^2, \hat{k} = \frac{\hat{\beta}_1^2(\hat{\beta}_2 + 3)^2}{4(2\hat{\beta}_2 - 3\hat{\beta}_1^2 - 6)(\hat{\beta}_2 - 3\hat{\beta}_1^2)};$$

– pick out the most appropriate distribution in the plane of variables β_1 and β_2;

– calculate the values of parameters a_0, b_0, b_1, and b_2 of differential equation (1) in conformity with (2);

– set up and resolve the system of equations to determine the parameters of Pearson's empiric distribution.

The main disadvantages of the Pearson method are as follows: (a) the estimation errors of the moments of experimental data grow together with so-called "tails" of empirical distributions; (b) we can perform an approximation of

REFERENCES

1. M. Kendall and A. Stewart, The Theory of Distributions [Russian translation], Nauka, Moscow, 1966.
2. G. Khan and S. Shapiro, Statistical Models in the Engineering Problems [Russian translation], Mir, Moscow, 1969.
3. V. I. Tikhonov, Statistical Radio Engineering [in Russian], Radio i Svyaz', Moscow, 1982.
4. A. N. Malakhov, Cumulant Analysis of Random Gaussian Processes and of Their Transforms [in Russian], Sov. Radio, Moscow, 1978.
5. I. G. Karpov, Radiotekhnika, No. 4, pp. 77–82, 2001.

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