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ESTIMATION OF AREA OF A NONUNIFORM VANISHING IMAGE AGAINST THE SPATIAL NOISE BACKGROUND*

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The paper considers a quasiprobable and a maximum probable algorithm of area estimation with regard to possible absence of an image in an observed realization of a random field. Exact expressions for characteristics of the area estimation algorithms are derived.

When processing an image recorded in the “picture” plane, it is often essential to assess its area. In [1] we dealt with estimation of the area of a nonuniform image against the spatial noise background when the presence of the image was known a priori. However, because of guidance errors, the random nature of the observed objects, beam deviations due to fluctuations of the propagation medium, and a number of other reasons, the legitimate signal at the input of the image-shaping device may appear with a probability less than unity [1]. In [1] the problem of area estimation of a uniform disappearing image was considered. In actual practice the image intensity is usually a function of coordinates, so that the image looks nonuniform. In this connection, the problem of estimation of nonuniform image areas, with regard to temporary disappearance of the signal used for shaping the image, is of great interest.

Let in some domain G a realization of some random field be accessible for processing, i.e.,

$$\xi(x, y) = \gamma_0 s(x, y; \chi_0) + n(x, y) \qquad (1)$$

where

$$s(x, y; \chi_0) = F(x, y) I(x, y; \chi_0) \qquad (2)$$

is a legitimate image with intensity $F(x, y)$ occupying an area χ_0. The shape of the domain $\Omega(\chi)$, with the area χ occupied by the image, can be described by the indicator $I(x, y; \chi) = 1$ for $x, y \in \Omega$ and $I(x, y; \chi) = 0$ for $x, y \notin \Omega$. In formula (1) $n(x, y)$ denotes the Gaussian spatial white noise with one-sided spectral density N_0, while the unknown area χ_0 of the image may take values within a priori interval $[\chi_{min}, \chi_{max}]$. Assume that the legitimate image is present in the realization of observed data (1) with some probability $p_1 < 1$, so that $\gamma_0 = 1$ with probability p_1, and $\gamma_0 = 0$ with probability $p_0 = 1 - p_1$. Thus, we have to estimate the image area χ_0 under the assumption that the discrete parameter γ_0 is uninformative [2].

The logarithm of the likelihood ratio functional (LRF) depends on γ and χ as [2]

$$L(\chi, \gamma) = \frac{2\gamma}{N_0} \iint_G \xi(x, y) s(x, y; \chi) \mathrm{d}x \mathrm{d}y - \frac{\gamma^2}{N_0} \iint_G s^2(x, y; \chi) \mathrm{d}x \mathrm{d}y. \qquad (3)$$

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