ISSN 0735-2727, Radioelectronics and Communications Systems, 2008, Vol. 51, No. 9, pp. 510–518. © Allerton Press, Inc., 2008.
Original Russian Text © A.P. Trifonov, R.V. Kutsov, 2008, published in Izv. Vyssh. Uchebn. Zaved., Radioelektron., 2008, Vol. 51, No. 9, pp. 70–80.

The Efficiency of Detecting an Image of Object Moving in the Unknown Direction[1]

A. P. Trifonov and R. V. Kutsov
Voronezh State University, Voronezh, Russia
Received in final form February 19, 2008

Abstract—The maximum likelihood algorithm for detecting a nonuniform image of the space-extended object moving in a priori unknown direction has been synthesized and analyzed with due regard for the background shading.

DOI: 10.3103/S0735272708090070

The need of detecting objects by their pictures generally occurs during processing of the results of remote viewing. Usually the objects are viewed on a certain underlying surface and the signal scattered by this surface forms a background radiation (background). High resolution of the state-of-the-art remote viewing systems makes it possible not only to separate a space-extended object (SEO) [1] in terms of the intensity drop at the object-background boundary, but also to distinguish irregularities of the intensity distribution of object image.

Paper [2] investigates potential possibilities of detecting SEO moving with the known speed in the specified direction. The case where the direction of the object motion is known, but its speed is not known was considered in papers [4, 5], while the efficiency of detecting SEO moving with unknown velocity vector was determined in paper [6]. However, using the results of paper [6] it is not feasible to obtain the detection characteristics of SEO moving with the specified speed in a priori unknown direction that does not allow us to estimate the impact of a priori lack of knowledge of the direction of object motion on the efficiency of its image detection.

The purpose of this study is to synthesize and analyze the maximum likelihood (ML) algorithm of detecting CEO, moving in the unknown direction, by its image.

Let the realization of Gaussian random field $\Xi(x, y, t)$ be available for observation in the two-dimensional domain Ω during the time interval $[0, T]$, where t is time, (x, y) are coordinates of a point belonging to domain Ω in the rectangular coordinate system XY. Let us assume that in the case of hypothesis H_1 field $\Xi(x, y, t)$ contains: image $s(x - V_0 t \cos \varphi_0, y - V_0 t \sin \varphi_0)$ of the object moving with known speed V_0 from the specified position in the a priori unknown direction forming angle φ_0 with axis X, stationary background $\nu(x, y)$, and the additive Gaussian space-time white noise $n(x, y, t)$ with one-sided spectral density N_0. In the case of hypothesis H_0 field $\Xi(x, y, t)$ contains background $\nu(x, y)$ and additive noise $n(x, y, t)$.

In accordance with the applicative model [1–5] taking into account the effects of shading of a part of the background by the object, we assume that the object image occupies part Ω_s of domain Ω, while the background occupies the remaining part of the domain of viewing. If the object is not present, the background occupies the total domain of viewing. We shall consider that the resolution of the viewing system is sufficiently high, and, therefore, the size of nonuniformities of the object and background are large with respect to dimensions of the resolution cell resulting in a significant dependence of the object image intensity on spatial coordinates. Then the following realization of image is available for viewing during time interval $[0, T]$

$$\Xi(x, y, t) = \gamma_0 s(x - V_0 t \cos\varphi_0, y - V_0 t \sin\varphi_0) I_s(x - V_0 t \cos\varphi_0, y - V_0 t \sin\varphi_0)$$

[1] The results presented were obtained with the assistance of RFFS (Projects 06–07–96301 and 07–01–00042).