Journal scientific and applied research, vol. 5, 2014
Association Scientific and Applied Research
International Journal

Original Contribution

ISSN 1314-6289

METHOD FOR IDENTIFICATION OF SIGNALS

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Abstract: *The paper to the research of particular objects from optic spectrum by means of optical-electronic devices is related. A mathematical model for identification of signals with two degrees of freedom is proposed. Object of research is a variant of discrete signal processing in the temporary area.*

Key words: *Bayesian Matrix, Gaussian noise, Identification of signals with two degrees of freedom.*

1. Introduction

In the research of particular objects from optic spectrum by means of optical-electronic devices the sensor registers a signal that is carrying useful information about the characteristics of the object [2, 4]. Determining the amounts upon registration of information signal [5] and determining the Gaussian noise [3] provide some clarity about the conditions for detection, identification and registration of studied objects [7].

2. Analysis of the problem

The task of research was to investigate the possibility of identifying signals with two degrees of freedom.

Signals with two degrees of freedom (2-DOF) are presented in the following form [1, 6]:

$$(1)\ S_t = \sum_{i=1}^{2} d_i \varphi_{it}, \quad t \in [O, T],$$

where: $\varphi_{1t}, \varphi_{2t}$ form a basis in the functional space φ;

α_1, α_2 - scalar coordinates for $S_t \text{в} \varphi$;

T - the time of the study.

Moreover coordinates α_1 and α_2 assume values from certain sets. The signal S_t may be determined by the value of these sets $L = L_1 . L_2$ for possible various states x_i, i= 1, L determined by <α_1 ,α_2>.

In particular, to the signal of a similar type relate signals with a combined amplitude-phase modulation. Therefore this application allows to be increased the transmission speed of information on the channels [2].

The Object of research was a variant of discrete signal processing $S_t(x_i)$ through monitoring the sequences $\{y_m\}$, m = 1, M, related to the signal.

$$y_m = s_m(x_i) + n_m, \quad m = 1,M, \; i = 1,L, \tag{2}$$

where: n_m - a sequence of uncorrelated Gaussian errors, characterized by the normal probability density $N\,[O, \sigma^2]$.

$S_m(x_i)$ is determined in accordance of expression (1):

$$S_m(x_i) = \sum_{i=1}^{2} d_ij\, \varphi_{jm}, \qquad m = 1, M, \qquad i = 1, L. \tag{3}$$

Expressing the set of equations (2) and (3) is obtained:

$$S_i = \sum_{i=1}^{2} d_ij\, \varphi_j, \tag{4}$$

$$Y = S_i + N, \tag{5}$$

where: the vectors S_i, φ_i, Y, N possess components $S_m(x_i)$, φ_{im},Y_m, n_m,by m = 1, M.

Solving the task with the Bayesian method for identification of signals as a result of the research of the vector Y is necessary to be accepted one of the mutually exclusive hypotheses $\Gamma i = x_i$, i=1,L. The belonging of G to this field of study vector Y needs to be broken on a set of subsets$\{G_i\}$, i=1,L, so that $G_i \cap G_j = \varphi$,

$$by\ i \neq j, \qquad \bigcup_{i=1}^{L} G_i = G\ and\ G_i = x_i\ by\ Y\ \in G_i.$$

On the assumption that the states x_i and x_j are a priori equally possible and the Bayesian Matrix $[C_ij]$, i, j= 1,L is simple, namely C_ij = 1 - δ_{ij}, where δ_{ij} -

Kronecker coefficient. Then the optimal Bayesian identifier is provided by the equality:

$$(6) \qquad N_{cp} \int_{G_g} W(Y / S_i)\ dy = N_{cp} \int_{G_g} W(Y / S_j)\ dy,\ i,j = 1L,$$

where: Ncp - the average number of signals;

$W(Y / S_i)$ conditional probability density of the vector Y for the state of the signal x_i.

As is clear from (5) Y is a normal vector with probability density $N(S_i, \sigma^2, I)$, where I is a single matrix.

Then equation (6) acquires the type:

$$(7) \quad N_{cp} \int_{G_g} exp\left\{-\frac{1}{2\alpha^2} d^2(y, S_i)\right\} dY = N_{cp} \int_{G_g} exp\left\{-\frac{1}{2\alpha^2} d^2(y, S_j)\right\} dy,$$

where: $d^2(y, S_i) = (y - S_i)_{(y,S_i)}$ is a distance between the vectors Y and S_i in the Euclidean space G;

$d_{min}(i) = d_{min}(G_j, S_i)$, $G_i = \{y_i d(Y, S_i) \leq d_{min}(i)\}$,

where: $d(G_i, S_i) = inf\, d(Y, S_i)$ - distance from S_i to the sets G_j;L (i), having a common boundary with y. Because $G_j' \subset G_i$, then equation (7) can be replaced from a system equations:

$$(8) \quad N_{cp} \int_{G_i'} exp\left[-\frac{1}{2\sigma^2} d \quad (Y, S_i)\right] dY = N_{cp} \int_{G_j} exp\left[-\frac{1}{2\alpha^2} d^2(Y, S_j)\right] dY,$$

$$(9) N_{cp} \int_{G_{i/G_j}} exp\left[-\frac{1}{2\sigma^2} d \quad (Y, S_i)\right] dY = N_{cp} \int_{G_j/G_j'} exp\left[-\frac{1}{2\alpha^2} d^2(Y, S_j)\right] dY,$$

where: G_j/G_j' - complement of the sets from G_j' and G_j.

The set G_i, $i = 1,L$ represents a hyper-sphere with radius $d_{min}(i)$, as an equality (8) will be done in:

$$(10) \qquad d_{min}(i) = d_{min}(j), i, j = 1,L \ and\ \mu(G_i) = \mu(G_j').$$

The integrals in (6) determine the probability of correctly identification of the signal S_i , $i = 1,L$, and by definition in $d(Y, S_i) > d_{min}(i)$, is possible an error by indentifying of S_i, and therefore in fact usually performed the following:

$$(11)\ N_{cp}\int_{G_i/G_j'} exp\left[-\frac{1}{2\sigma^2}d^2\,(Y,S_i)\right]dY \ll N_{cp}\int_{G_j'} exp\left[-\frac{1}{2\alpha^2}d^2(Y,S_i)\right]dY.$$

That allows to obtain an approximate assessment of the integral in (9), putting on $d(Y,S_i)$ in the integration of G_i/G_j' which is constant and equal to $d(Y,S_i)$ = $d_{min}(i)$ + Δ,$Y\in G_i/G_j'$, and therefore Δ is determined by the expression:

$$\Delta = \frac{1}{2L}\sum_{i=1}^{L}[d_{min}(i) + d_{max}(i)],$$

as $d_{max}(i) = maxd(S_j,S_i)$.

From (8) is determined the equivalent system:

$$(12)\qquad \begin{cases} d_{min}(i) = d_{min}(j), \\ \mu(G_i/G_j') = \mu\left(\frac{G_j{}'}{G\ j}\right),\ \ i,j = 1,L\,. \end{cases}$$

Combining (12) with (10) the searched rule for synthesis of quasi optimal Bayesian identifier was defined:

$$(13)\qquad d_{min}(i) = d_{min}(j),$$

$$(14)\qquad (G_i) = \mu\left(G_j\right),\quad i,j = 1,L\,.$$

Whereas, if condition (11) determines the shift of vectors S_i and G_i, then conditions (13) and (14) determine the necessity of simultaneously solving both the task for the synthesis by optimal identifying and the task of signal forming $S(x_i)$.

3. Conclusion

Of studies carried out could be done the following conclusion that the obtained correlations (13) and (14) a quasi optimal Bayesian identifying of signals with two degrees of freedom by simultaneously optimization allows to be synthesized.

Acknowledgements

This paper is supported by the Project BG051PO00l-3.3.06-0003 “Building and steady development of PhD students, post-PhD and young scientists in the areas of the natural, technical and mathematical sciences”. The Project is realized by the financial support of the Operative Program “Development of the human resources” of the European social found of the European Union.

References:

[1] Danailov B.S., Single strand signal transmission, Publishers. Связь, Moscow, 2004, 187 p.
[2] Mardirossian G., Aerospace methods in ecology and learning environment in, Acad. Press., prof. Marin Drinov, Sofia, 2003, 201 p.
[3] Stoyanov S., G. Mardirossian, Factor Analysis in the Process of Designing Complex Optical Schemes, Sixth Scientific Conference with International Participation SPACE, ECOLOGY, SAFETY, Sofia, 2010, 159 - 162 p.
[4] Getsov P., Mardirossian G., Hubenova Z., Tsekova V., Filipov F., Stoyanov S., Hristov I., Zhekov Zh., Influence molecular dissipation of light on the light protection characteristics of the optical devices, Proceedings of Naval Scientific forum, vol.3 N.Y. Vaptsarov Naval Academy, Varna, 2003, 91-94 p.
[5] Stoyanov S., G. Mardirossian, Research of the relationships between Light dispersion and contrast of the registered image at different background brightness, Aerospace Research in Bulgaria №24 Space Researc hand Technology Institute, 2012, 109–115 p.
[6] Ту Дж. Гожалес, Принципы разпознавания образов. Издат. Мир, Москва, 1998, 219 с (in Russian).
[7] Zhelyazov P., Zhekov Zh., Valchev K., Determining the sum of the registered optical signals and Gaussian noise, Proceedings of Technical University of Gabrovo, Bulgaria, 2004, 52 - 49 p.