*Radioelectronics and Communications Systems*
*Vol. 47, No. 12, pp. 19–23, 2004*

*Izvestiya VUZ. Radioelektronika*
*Vol. 47, No. 12, pp. 28–34, 2004*
*UDC 681.3.042:621.39*

# A VARIANT OF SOFT DECODING OF BINARY CODES

V. L. Seletkov

*National Academy of Security Service of Ukraine*

**A variant of soft decoding of a binary code is considered as treatment, by the least squares method, of the problem of nonlinear estimation of statistical parameters of the information symbols. Estimation of the ratios (logarithms of the ratios) of probabilities of information symbols' realizations is performed during the respective processing of levels of continuous signals at the output of a discriminator (demodulator) of the received signals with regard for the coding rule. Assessment of the effectiveness of soft decoding may be performed either analytically — based on the covariance matrix of a posteriori probability density of distribution of estimates of information symbols' parameters, or by the methods of statistical tests.**

One of the ways to improve the effectiveness of coding systems with error correction is the application of decoders of the "soft input — soft output" type. The use of statistical characteristics of continuous output signals from a demodulator (discriminator) of received signals $c(t)$ and $s(t)$, corresponding to the transmitted coded symbols, with regard for code structure (coding rule), permits to identify the information-bearing coded symbols based on the criterion of maximum of a posteriori probability [1]. However, the problem of soft decoding of a redundant binary code of an arbitrary structure is not resolved in full extent, and the assessment of effectiveness of soft decoding represents a rather intricate task.

Consider a variant of universal treatment of the soft decoding problem and of possible assessment of effectiveness of soft decoding of a redundant binary code.

In the general case, the vector $X$ of samples of an input signal $x(t)$ in the discriminator of signals $c(t)$ and $s(t)$ of a known shape against the background of Gaussian quasiwhite noise $n(t)$ can be represented in the form $X = C + N$ — in the event of reception of the signal $c(t)$, or $X = S + N$ — in the event of reception of the signal $s(t)$. Here $C$ and $S$ are the vectors of samples of signals $c(t)$ and $s(t)$, respectively, and $N$ is the vector of samples of the noise with its correlation matrix $R$.

Under the assumption of equiprobable arrival of the signals $c(t)$ and $s(t)$, the vector of samples $X$ of the input signal can be written as $X = \alpha C + (1 - \alpha)S + N$, where $\alpha$ is an indicative variable taking one of two values [0, 1]. For the considered case of Gaussian noise, estimation of maximum likelihood $\tilde{\alpha}$ of the parameter $\alpha$ can be obtained as a solution to the problem

$$\tilde{\alpha} = \arg\min_{\alpha} [X - \alpha C - (1-\alpha)S]^T R^{-1} [X - \alpha C - (1-\alpha)S].$$

The difficulties in obtaining the estimate $\tilde{\alpha}$ of the discrete parameter $\alpha$ can be avoided if the two-step procedure for the problem treatment is used. At the first step, we regard $\alpha$ as a continuous variable, for which the expression of maximum likelihood estimate $\hat{\alpha}$ has the form

$$\hat{\alpha} = [X - S]^T R^{-1} [C - S] / q_{\Delta}^2$$

**REFERENCES**

1. Bernard Sklyar, Digital Communications — Theoretical Foundations and Practical Applications [Russian translation], 2nd edition, Izd. Dom "Williams", Moscow, 2003.

14 April 2004