SYSTEM OF TWO-DIMENSIONAL BINARY SIGNALS WITH IDEAL PERIODIC CORRELATION FUNCTIONS

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The known strictly optimal ensembles of one-dimensional binary sequences (Gold's, Kasami's, sequences of bent functions) have an upper limit of the level of the periodic cross-correlation function (PCCF) considerably exceeding the zero value [1]. Therefore, of definite interest is a search for families of signals in other classes, in particular, in the case of two-dimensional binary signals, which can produce an improvement, other conditions being equal, of the upper level of the PCCF. A number of works [2-4] devoted to two-dimensional binary sequences have recently been published. However, it is necessary to note that the mathematical theory of the synthesis of such signals and systems is in the initial stage of development. A system of two-dimensional binary signals with single-level, equal to unity, PCCFs intended for use in parallel communication channels with multiple access was examined in [5]. A system with ideal, equal to zero, PCCFs is studied in the present report.

Let us examine a two-dimensional binary signal described by a rectangular matrix [5]

$$S_{NM} = \begin{bmatrix} s_{00} \cdots s_{0M-1} \\ \cdots\cdots\cdots\cdots \\ s_{N-10} \cdots s_{n-1M-1} \end{bmatrix}, \tag{1}$$

where $s_{ij} \in \{-1, 1\}$, $i = 0, ..., N-1$, $j = 0, ..., M-1$, is elements of the signal. The number N of rows of the signal matrix corresponds to the number of parallel channels.

Let there exist a two-dimensional binary signal S_{NM} of form (1) with a two-dimensional periodic correlation function (PCF) defined as [2]

$$R_{NM\Pi}(u, v) = \sum_{i=1}^{N-1} \sum_{j=0}^{M-1} s_{ij}\, s_{(i+u)\mathrm{mod}N(j+v)\mathrm{mod}M},$$

of a delta-like form

$$R_{NM\Pi}(u, v) = \begin{cases} NM & \text{for } u \equiv 0 \bmod N,\ v \equiv 0 \bmod M; \\ 0 & \text{for other u, v.} \end{cases} \tag{2}$$

For formation of the signals S^l_{NM} of the system ($l = 1, 2, ..., K$, K is the volume of the system), we will use signal S_{NM}, which we take as S^1_{NM}. We associate with each signal S^l_{NM} a row matrix $d_l = [d_{l0}, d_{l1}, ..., d_{lN-1}]$, where $d_{ij} \in \{0, 1, ..., N-1\}$ is an integer equal to the number of the row of the signal S^1_{NM}, which is substituted at the place of the j-th row S^l_{NM}. Thus the system of two-dimensional binary signals can be described by a code matrix

$$K_K = \begin{bmatrix} d_{10} \cdots d_{1N-1} \\ \cdots\cdots\cdots\cdots \\ d_{K0} \cdots d_{KN-1} \end{bmatrix}. \tag{3}$$

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