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METHODS FOR CONSTRUCTING COMPLETE FAMILIES OF 36-ELEMENT PERFECT BINARY ARRAYS

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A new algorithm is developed for synthesis of two families of 36-element perfect binary arrays (6×6 and 3×12), and the completeness of both families is proved. A method is derived for constructing PBA of the format $N/2\times 2N$ with the aid of basic PBA of the format $N\times N$ for any dimensionality $N = 3\cdot 2^n$.

With the advent of CDMA systems with multi-frequency carrier (MC-CDMA), there arises additional need in algorithms for construction of frequency-time signals with good auto- and cross-correlation properties. In this connection, of interest are perfect binary arrays (PBA), i.e., two-dimensional binary codes $N_1\times N_2$ with the ideal periodic autocorrelation function (PACF) in the form of delta function

$$R(0,0) = N_1 \times N_2, \qquad R(u,v) = \sum_{i=0}^{N_1-1}\sum_{j=0}^{N_2-1} e_{i+u}e_{j+v} = 0$$

at any other u and v, $e_{ij} \in \{+1, -1\}$.

One of fundamental properties of PBA is uniformity of their spectrum. Indeed, the two-dimensional discrete Fourier transform of the ideal PACF has the form

$$E_{kl}^2 = \sum_{u=0}^{N-1}\sum_{v=0}^{N-1} R(u,v)Z^{uk}Z^{vl} = \sum_{i,j=0}^{N-1}\sum e_{ij}Z^{-(ik+jl)}\sum_{u,v=0}^{N-1}\sum e_{uv}Z^{uk+vl)} = E_{kl}^{*}\cdot E_{kl} = N^2,$$

where $Z = Z_N = \exp(-2\pi j/N)$.

There is a proof of existence of PBA of formats $N\times N$ and $N/2\times 2N$ for dimensionality $N = 2^n$ and $N = 3\cdot 2^n$, where n is an integer [1, 2]. Procedures of construction of PBA for any N were deduced in [3], however, the method of synthesis of full classes of these arrays for $N = 2^n$ was suggested only after elapse of ten years [4]. In [5] we can find a consistent substantiation of the method for construction of rectangular PBA of the format $N/2\times 2N$ from $N\times N$ PBA.

In [6] the problem of synthesis of full classes of code sequences with length N and zero level of PACF at even shifts was handled based on alternation of pairs of complementary sequences of length $N/2$. It was natural to suggest a similar approach to synthesis of PBA from sets of four (quadruples) arrays with twice less dimensionality.

In [4] an $N\times N$ PBA **E** is formed by spatial alteration of elements α, β, γ, and δ of complementary $N/2\times 2N$ matrices **A**, **B**, **C**, and **D**, respectively, i.e.,

$$e_{2i,2j} = \alpha_{ij};\ e_{2i,2j+1} = \beta_{ij};\ e_{2i+1,2j} = \gamma_{ij};\ e_{2i+1,2j+1} = \delta_{ij},$$

or

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