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A MULTIUSER DEMODULATOR WITH REDUCED ENUMERATION

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A new algorithm of multiuser demodulation is suggested for the system with code division multiple access. The algorithm permits to raise demodulation efficiency with only a slight increase in computational complexity of known algorithms and, under certain conditions, to approach the optimal boundary.

At the present time, the digital communication systems, particularly, cellular mobile communication systems, make rapid strides. A promising technology, making it possible to expect an increase in traffic capacity of such systems, is Code Division Multiple Access (CDMA) [1]. However, in order to attain the potential traffic capacity of the CDMA system, new approaches to signal processing are necessary, one of which consists in using some algorithms for intrachannel clutter suppression. These algorithms are called multiuser demodulators (MUD), since they process users' signals with regard for correlation between these signals.

The present-day microprocessors permit to realize complex algorithms of signal digital processing, but the optimal MUD is hardly feasible in the event of a large number of users because of high computational complexity. Suboptimal algorithms are less efficient, and their implementation also demands considerable computational expenditure. Thus, it is necessary to develop a demodulation algorithm approaching the optimal as much as possible and requiring a minimum of computations.

Consider a CDMA system with many users. This situation may occur, for example, when several subscriber's stations are exchanging information with one basic station. The demodulator input is activated by a mixture of user's signals and additive white Gaussian noise (AWGN). The model of such system in discrete time can be described as [1]

$$y = G\theta + n, \quad G = SA, \qquad (1)$$

where $y = [y_1,... y_N]^T$ is the mixture of users' signals and AWGN; N is the base of the signals; $S = [s_1,..., s_K]$ is the matrix composed of users' coded sequences $s_k = [s_{1k},..., s_{Nk}]^T$, $k = \overline{1,K}$ is the number of users; $A = \text{diag}\ \{A_1,..., A_K\}$ is the matrix of amplitudes; $\theta = [\theta_1,..., \theta_K]^T$ is the vector of information symbols $\theta_k \in \{-1, +1\}$; $n = [n_1,..., n_N]^T$ is a Gaussian random vector with zero mean and correlation matrix $U = E[nn^T] = \sigma^2\ \mathbf{1}$; and σ^2 is AWGN variance.

In the traditional demodulator, mixture (1) is processed in the unit including the correlators or matched filters, which is equivalent to multiplication by the matrix G^T:

$$Y = G^T y = H\theta + z;\ H = G^T G,\ z = G^T n, \qquad (2)$$

where $Y = [y_1,... y_K]^T$ is the vector composed of output signals from K correlators; H is the matrix defined by correlations between users' signals and by their amplitudes, whose entries $h_{ij} = \rho_{ij} A_i A_j$, $\rho_{ij} = s_i^T s_j$, $i, j = \overline{1,K}$; $z = [z_1,..., z_K]^T$ is a Gaussian random vector with zero mean and correlation matrix $V = E[zz^T] = \sigma^2 H$. The estimate of the vector of information symbols arrives at the output of amplitude limiters

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