OPTIMUM MULTI-USER DETECTION IN GAUSSIAN NOISE IS NP-HARD

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Consider a Gaussian multiple-access channel shared by K users who transmit independent data streams by modulating asynchronously a set of assigned signal waveforms. The information transmitted by all users can be demodulated simultaneously by a Viterbi algorithm whose time-complexity is linear on the number of symbols transmitted by each user and exponential in the number of users. It is shown that the combinatorial problem of selecting the most likely transmitted sequence given the sufficient statistics (sequence of matched filter outputs), and the signal energies and crosscorrelations is non-deterministic polynomial-time hard (NP-hard) in the number of users. And it remains so even if the users are restricted to be synchronous.

The performance analysis of the multi-user detector in terms of the set of multi-user asymptotic efficiencies involves the computation of the minimum distance between any pair of distinct multi-user signals. This problem is also shown to be NP-hard.

APPLICATION OF ROTATIONAL SEARCH METHODS TO ADAPTIVE PISARENKO HARMONIC RETRIEVAL

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This paper will describe the application of the authors' rotational search algorithms to the problem at hand. These algorithms require approximately ⅓ the number of multiplications per iteration required by the algorithms of Reddy and Vaccaro. In terms of convergence and eigenfilter response, the success of these algorithms, and failure in certain instances, was similar to that described by Vaccaro.

One observation is of particular interest. The presence of higher noise levels actually increased the convergence rate of the algorithms, in the sense that the coefficient vectors converged to the true minimum eigenvector of the estimated covariance matrix much faster than the estimated covariance matrix converged to the true covariance matrix. This can be attributed to the spreading of the lower eigenvalues due to the noise. The result was either the 'noise-fitting' problem described by Vaccaro, or in some cases, completely erroneous filter responses.