MIMO detection for higher order QAM-Semidefinite programming relaxation approach for multiuser detection of QAM Signals
Introduction

- A semidefinite programming (SDP) relaxation approach is proposed to solve multiuser detection problems in systems with *M*-ary quadrature amplitude modulation (MQAM). In the proposed approach, the optimal *M*-ary maximum likelihood (ML) detection is carried out by converting the associated *M*-ary integer programming problem into a binary integer programming problem. Then a relaxation approach is adopted to convert the binary integer programming problem into an SDP problem. This relaxation process leads to a detector of much reduced complexity. A multistage approach is then proposed to improve the performance of the SDP relaxation based detectors. Computer simulations demonstrate that the symbol-error rate (SER) performance offered by the proposed multistage SDP relaxation based detectors outperforms that of several existing suboptimal detectors.
Problem statement

Maximum Likelihood Detection

Minimize $\|r - Cx\|^2$

Subject to $x_k \in \mathcal{A} = \{I_m + jQ_n\}$ for $k = 1, \ldots, K$;

\[ m = 1, \ldots, \hat{M} \; ; \quad n = 1, \ldots, \hat{N} \]

\[ \equiv \]

Minimize $x^H H x + \Re\{x^H p\}$ \hspace{1cm} (3a)

Subject to $x_k \in \mathcal{A} = \{I_m + jQ_n\}$ for $k = 1, \ldots, K$;

\[ m = 1, \ldots, \hat{M} \; ; \quad n = 1, \ldots, \hat{N} \]

\[ \equiv \]

Where $H = C^H C$, $p = -2C^H r$ and $x_k$ denotes the $k^{th}$ component of $x$. In general, an exhaustive search is required to obtain the solution to the problem (3), in which the computational complexity involved is $O(M^K)$. \[ \equiv \]
The method

- SDP relaxation approach
- Multistage SDP Relation Multiuser Detection
- Randomization
- Rank-one Approximation
- Maximal Ratio Combining detection
- Equal Gain Combining detection
Simulation results

We considered a four-user system using 8QAM as modulation scheme. The spreading codes of all users are of length fifteen. The SERs obtained by using the ML, the SDPR, the M-SDPR, the MRC and the EGC are plotted. The simulations show that the method of multistage SDP is the most closed to the ML detection. The performance of the SDPR is similar to the M-SDPR. However, the performance of MRC and EGC are not good enough.

compare the performance of rank one and randomization