Guaranteed Minimization of the Bit Error Ratio for Correlated MIMO Systems

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Abstract

Multiple-input multiple-output (MIMO) systems play an important role in modern engineering, with applications not only in wireless but also in wire line communications. Placing multiple antennas at the transmitter and receiver sides improves both the capacity and the integrity of a communication link. A frequency-flat MIMO link consisting of n_T transmitting and n_R receiving antennas can be described using the linear stochastic model

$$\vec{y} = H \cdot \vec{c} + \vec{n}, \qquad \vec{y}, \vec{n} \in \mathbf{C}^{n_R},\ \vec{c} \in \mathbf{C}^{n_T},\ H \in \mathbf{C}^{n_R \times n_T}\ ,$$

where $\vec{y}$ is the received data vector, $\vec{c}$ is the transmitted signal vector, $\vec{n}$ is the additive white Gaussian noise at the receiver side with the zero mean and the variance σ^2 in both real and imaginary parts, and H is the channel matrix. Singular value decomposition (SVD) eliminates the interference between different antennas' data streams (for an *ideal* H and its SVD) and transforms the MIMO link into a number of independent, weighted, frequency flat single-input single-output (SISO) links. Due to poor scattering conditions leading to antennas' correlation effect, the inequality in weights might be large, which makes bit and power allocation especially important (see Ahrens et al. (2016)). The goal of this contribution is to optimize such MIMO links using the criterion of the bit error ratio (BER).

The BER should be as small as possible for the whole link and can be described in the general form for a transmission layer i using the complement error function $\text{erfc}(\cdot)$ as $P_b^{(i)} = k_{i_1} \cdot \text{erfc}(k_{i_2} \cdot \lambda_i)$. Here, k_{i_1}, k_{i_2} are coefficients depending on the number of bits per symbol, the noise variance as well as the available transmit power per layer and λ_i is the singular value corresponding to the considered layer (also the weight of the layer). Usually, these characteristics are not given exactly but are influenced by a (numerical or/and measurement) error of known magnitude. That is, in the linear model described above, not only the stochastic but also the bounded uncertainty can be present, the major uncertainty source of the latter type being due to λ_i.

The focus of this contribution is on possibilities for (verified) minimization of BER under uncertainty in its parameters for MIMO links under poor scattering conditions from a formal point of view. Theoretical results are illustrated using close-to-life examples.

References

Ahrens, A.; Benavente-Peces, C.; Cano-Broncano, F.: Power Allocation in SVD- and GMD-assisted MIMO Systems. In: *Optimization and Engineering*, 17 (2016), no. 4, pp. 919–940.