
The Capacity of Gaussian MIMO Channels Under Total and Per-Antenna Power Constraints

Abstract:

The capacity of a fixed Gaussian multiple-input multiple-output (MIMO) channel and the optimal transmission strategy under the total power (TP) constraint and full channel state information are well known. This problem remains open in the general case under individual per-antenna (PA) power constraints, while some special cases have been solved. These include a full-rank solution for the MIMO channel and a general solution for the multiple-input single-output (MISO) channel. In this paper, the fixed Gaussian MISO channel is considered and its capacity and optimal transmission strategies are determined in a closed form under the joint total and PA power constraints in the general case. In particular, the optimal strategy is hybrid and includes two parts: first is equal-gain transmission and second is maximum-ratio transmission, which are responsible for the PA and TP constraints, respectively. The optimal beamforming vector is given in a closed form and an accurate yet simple approximation to the capacity is proposed. Finally, the above results are extended to the MIMO case by establishing the ergodic capacity of fading MIMO channels under the joint power constraints when the fading distribution is right unitary-invariant (of which i.i.d. and semi-correlated Rayleigh fading are special cases). Unlike the fixed MISO case, the optimal signaling is shown to be isotropic in this case.