EE4-65/EE9-SO27 Wireless Communications
Coursework 2: Link-level Performance Evaluation of MIMO

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1 Objective

- Compute analytically the capacity of simple MIMO channels.
- Evaluate the capacity of MIMO channels using Matlab.
- Evaluate the error rate performance (link-level evaluations) of basic MIMO transmission and reception schemes using Matlab.

2 Tasks

The following tasks should be performed:

1. Consider the transmission $\mathbf{y} = \mathbf{H}\mathbf{c}' + \mathbf{n}$ with perfect CSIT over a deterministic point to point MIMO channel. The input covariance matrix is given by $\mathbf{Q} = \mathcal{E}\left\{\mathbf{c}'\mathbf{c}'^H\right\}$ and is subject to the transmit power constraint $\mathrm{Tr}\left\{\mathbf{Q}\right\} \leq P$.
   - Compute analytically the capacity with perfect CSIT of the deterministic channel $\mathbf{H}_1 = \begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}$. Explain your reasoning.
   - Compute analytically the capacity with perfect CSIT of the deterministic channel $\mathbf{H}_2 = \begin{bmatrix} \sqrt{2} & 0 \\ 0 & \sqrt{2} \end{bmatrix}$. Explain your reasoning.
   - Which channel $\mathbf{H}_1$ or $\mathbf{H}_2$ leads to the largest capacity? Explain your reasoning and the observed behavior.
2. For SNR ranging from -10 dB till 20dB, simulate using Matlab the ergodic capacity of $n_r \times n_t = 2 \times 2$, 4×2 and 2×4 i.i.d. Rayleigh fading channels with full (CSIT) and partial (CDIT) knowledge at the transmitter. Explain the results.
3. For SNR ranging from 0 dB till 20dB, simulate using Matlab the bit error rate vs SNR performance of
   - Spatial Multiplexing with ML receiver and QPSK constellation over a 2×2 MIMO i.i.d. Rayleigh fading channel.

- Spatial Multiplexing with ZF receiver and QPSK constellation over a 2×2 MIMO i.i.d. Rayleigh fading channel.
- Spatial Multiplexing with unordered ZF SIC receiver and QPSK constellation over a 2×2 MIMO i.i.d. Rayleigh fading channel.

Explain the observed results and the achieved diversity gains.

3 Deliverables

The project is conducted **individually**. Each student is requested to submit (on Blackboard)

1. A pdf **report** detailing the results. Format: Font size 10 pt, maximum 5 pages, single-spacing. In your report, you should write the system model, contrast the simulation results with the theoretical results, and clarify whether your simulation results are inline with the theory. You should explain the rationale behind all the observations made.

2. **All Matlab files** with comments. The files should be self-explanatory and the examiner should be able to run the code and get the same results as those provided in the report. Explain how to run the code.

Deadline for report submission on Blackboard: **24 February 2019, 12:00 midnight** (London time).