Universität Rostock Traditio et Innovatio

FAKULTÄT FÜR INFORMATIK UND ELEKTROTECHNIK

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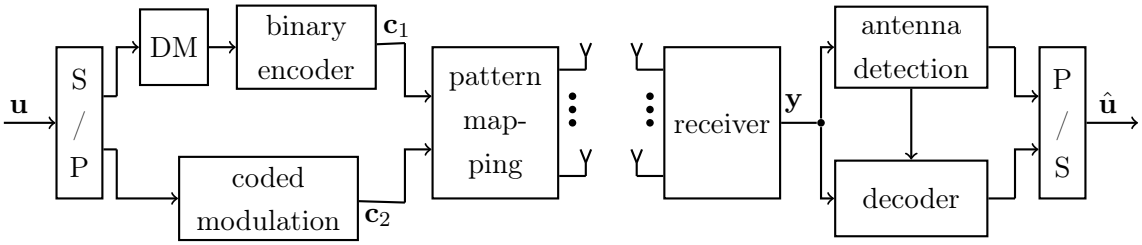
Master Thesis

Probabilistic Shaping for Multi-Level Trellis-Coded Generalized Spatial Modulation

Task Description

Multiple antennas at transmitter and receiver have boosted the performance of mobile radio communications. Since their introduction in UMTS, they became a well-established component in many state-of-the-art mobile communication systems like 4G, 5G and WIFI systems. Multiple antennas can be used in different ways. They can improve diversity and robustness against fading, they can increase the SNR by beamforming, and they can multiply data rates by spatial multiplexing. For the latter, as many receive as transmit antennas are required. Certainly, combinations of the aforementioned techniques can be derived. Current research focuses on massive MIMO systems with hundred or even more antennas at a base station.

A relatively new approach for increasing data rates and achieving high spectral efficiencies is spatial modulation. It uses only N_A out of N_T transmit antennas and delivers information by the choice of active antennas. Additionally, conventional data symbols can be transmitted over the activated antennas. While the original approach considers only one active antenna ($N_\mathrm{A} = 1$), generalized spatial modulation uses multiple active antennas ($N_\mathrm{A} > 1$). This allows much larger spectral efficiency, but encoding and decoding require higher computational complexity. The principal structure of the communication system is illustrated in the figure below.



In this master thesis, a multi-level coding approach splitting bits into two branches for antenna selection and data symbols shall be pursued. By appropriate probabilistic shaping of the information bits in the antenna selection branch (DM block), an average number of N_A active antennas from N_T antennas shall be selected. First, a literature research shall make familiar with the basics of spatial modulation. Next, a simulation environment containing all required components has to be implemented in Matlab or Python. With this environment,

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the following tasks have to be performed:

- Simulation of uncoded spatial modulation with maximum likelihood detection
- Development of probabilistic shaping for different convolutional codes to protect antenna selection bits against wrong detection
- Analysis of probabilistic shaping by information theoretic means
- Implementation of Viterbi algorithm with a priori information for decoding (antenna detection)
- Performance comparison of coded and uncoded generalized spatial modulation

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