Universität Rostock Traditio et Innovatio

FAKULTÄT FÜR INFORMATIK UND ELEKTROTECHNIK

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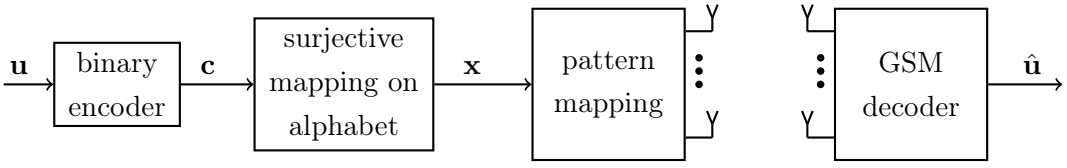
Master Thesis

Probabilistic Shaping for 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 transmit vector with an average number of N_A nonzero symbols (active antennas) from N_T symbols shall be generated by probabilistic shaping of the transmit sequence. Including the element zero in the modulation alphabet, an appropriate surjective mapping can generate nearly arbitrary symbol probabilities. This shaping allows the application of conventional FEC codes and does not require specific code designs. First, a literature research shall make familiar with the basics of spatial modulation. Next, a simulation environment containing all required components has to be set up in Matlab or Python. With this environment, the following tasks have to be performed:

- Simulation of uncoded spatial modulation with maximum likelihood detection

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- Development of surjective mappings on symbol alphabets to obtain Sparse transmit patterns
- Implementation of soft-output demapper to provide soft-information to FEC decoder
- Performance comparison of coded and uncoded generalized spatial modulation

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