

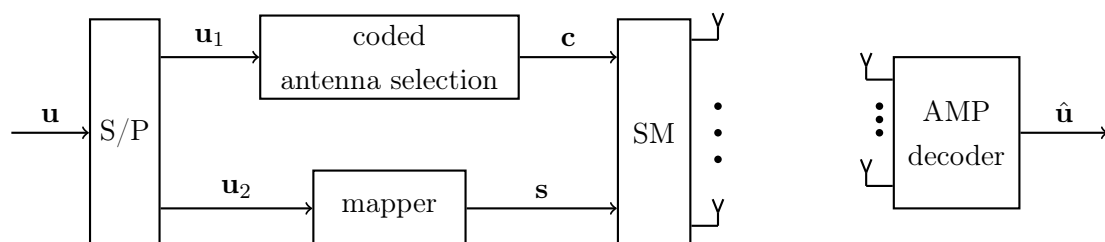
Master Thesis

Tree Codes for Spatial Modulation

Task Description

Multiple antennas at transmitter and receiver have boosted the performance of mobile radio communications. Since their introduction in 3G systems, 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 enhance data rates by spatial multiplexing. Current research focuses on massive [Multiple-Input Multiple-Output \(MIMO\)](#) systems with hundred or even more antennas at a base station.

A relatively new approach is [Spatial Modulation \(SM\)](#). [SM](#) 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. Particularly in massive [MIMO](#) systems, spatial modulation can achieve very large spectral efficiencies. The principal structure of the communication system is illustrated in the figure below. There is an interesting relationship of spatial modulation and [Sparse Regression Codes \(SPARCs\)](#). Both have the same mathematical structure and decoding can be performed with the same class of algorithms. [SPARCs](#) and [Approximate Message Passing \(AMP\)](#) decoding are proven to asymptotically achieve capacity.



This master thesis shall extend the simulation environment of a spatial modulation system by an outer coding scheme in order to increase the robustness and to improve detection. Candidates are conventional [Low Density Parity Check \(LDPC\)](#) codes and the rather new tree codes. The latter have been proposed for coding in unsourced random access systems but are particularly suited for the application in SM systems. First, they preserve the sparsity of transmit signals and second, they can be combined with [AMP](#) decoding.

For the master thesis, the following tasks have to be performed:



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- A literature study shall make familiar with the basics of spatial modulation, [AMP](#) decoding and tree codes.
- An existing [SM](#) simulation environment in Python has to be extended by outer [LDPC](#) and tree codes. This includes encoding and decoding algorithms.
- The performance of tree codes for the protection of antenna selection bits shall be investigated.
- The performance of tree codes and [LDPC](#) codes shall be compared.

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