Karlsruhe Institute of Technology

Communications Engineering Lab (CEL)
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Analysis and Implementation of Grassmannian Modulation for Non-Coherent MIMO Communications

Master's Thesis

Project

Current state-of-the-art MIMO systems apply pilot-based channel estimation and employ equalizers at the receiver to remove the effects of multi-path propagation and fading. Increased mobility of users in cellular networks and higher number of sending and receiver antennas present challenges for pilot-based communication systems in terms of overhead and interference.

Modulation formats to overcome the need for pilots in the presence of a multipath channel for MIMO systems are therefore of interest. One such format is Grassmannian Modulation. In this format the information carrying elements are not individual complex baseband symbols sent during a time frame T by M transmit antennas. Instead the M×T symbols describe an element from the Grassmannian manifold G(T,M). Transmission over a multipath channel and reception with M receive antennas results in M×T complex symbols. Now, distortions of the multipath channel can be observed on the complex symbols, but it has been shown that the elements in the reception matrix are still the same element of the G(T,M), but distorted by a unitary matrix.

Tasks

1. Literature research on Grassmannian manifolds and modulation
2. Physical layer simulation of non-coherent MIMO transmission
3. Machine learning to find a constellation of elements within G(T,M)

Requirements

- ✔ Interest to dive into topolgy and differential geometry
- ✔ A thorough understanding of modulation formats, MIMO and channels
- ✔ Interest and/or experience in physical layer simulations
- ✔ Languages/frameworks: Python, NumPy, PyTorch, TensorFlow

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