Abstract

Massive multiple input multiple output (MIMO) system refers to a communication system where a base station (BS) with a large number of antennas (typically hundreds) serves simultaneously a few mobile terminals (typically tens) in the same frequency band over the parallel spatial channels in each cell. Recently, an extensive research on massive MIMO systems has been carried out owing to its higher spectral efficiency, energy efficiency, and its ability to average out small scale fading and random noise. The potentials of this system have been shown by several channel measurement experiments and test benches. In spite of the great promises of massive MIMO systems, a few issues like channel modeling, channel estimation, and system design need to be addressed with a better research before this technology comes into practice. The existing channel models belong to two categories namely the correlation based stochastic channel models (CBSCMs) and the geometry based stochastic channel models (GBSCMs) that have their own limitations in terms of accuracy and complexity respectively. Therefore, there is a need of a new channel model which can accurately model the underlying propagation along with analytical tractability. The estimation of channel—an essential requirement for a massive MIMO system—also needs more research as the existing pilot based methods have an adverse effect on spectral efficiency and accuracy of channel estimation. On the other hand, the existing blind channel estimation methods have higher complexity and/or limitations on ranges of the system parameters. Therefore, an investigation on channel estimation for finding better techniques is needed. The allocation of resources in massive MIMO systems also needs more research. The inter-cell interference is a key factor in non-cooperative multi-cell setting, which needs to be controlled by a better resource allocation strategy.

This thesis is aimed at bringing the concept of massive MIMO systems a bit closer to the deployment by identifying the issues in the existing literature and bringing out the solutions for a few of them. The research work starts with the exploration of massive MIMO channel and development of a new channel model for a massive MIMO system with block fading channel. The new channel model is not only able to explain the underlying propagation (like GBSCMs) but also analytically tractable (like CBSCMs). After channel modeling, the issue of channel estimation for massive MIMO systems is addressed with the help of temporal correlation of the channel. In this sequence, a new channel estimation and tracking method is proposed which blindly estimates and tracks the channel. The proposed method has lower limitations on system parameters compared to state-of-the-art blind channel estimation methods for massive MIMO systems as well as it has a lower computational complexity compared to similar methods. The aforementioned estimation deals with instantaneous realizations of channels whereas the statistics of the channel is useful for a power-allocation strategy and analysis of the sum-rate of the system. In the same sequence, the next part in the thesis is oriented towards exploiting the statistics of the channel to optimize the average power-allocation for a better sum-rate. At the same time, the scheme also minimizes the inter-cell interference and improves control on the fairness among the mobile terminals. The research done in this thesis on the channel modeling, channel estimation and tracking, and power-allocation optimization will enable a better system design for massive MIMO. Cell deployment, communication strategy, and resource allocation schemes will benefit from this research work.

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