Parameterized Channel Feedback using Correlation-Based Channel Models for Multi-user MIMO Systems

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Recent work has demonstrated that in multi-user systems employing multiple-input multiple-output (MIMO) technology, nonlinear dirty-paper coding (DPC) techniques using exact channel state information (CSI) at the transmitter maximize the broadcast channel sum capacity. Similarly, if the precoding is restricted to linear processing, the capacity under this constraint is maximized using a regularized channel inversion beamformer. The difficulty, however, is that in wireless propagation channels that vary in time due either to node motion or motion of scatterers within the environment, the performance of these techniques rapidly deteriorates since it becomes impractical to maintain accurate CSI at the transmitter.

As a result of this problem, precoding techniques based on channel distribution information (CDI) have been developed. These techniques rely on accurate channel covariance information at the transmitter, a quantity which has been shown to vary much more slowly than the CSI. However, the full MIMO channel covariance matrix is much larger than the channel matrix, necessitating the feedback of a large amount of data. In environments where the covariance changes with time, the increased volume of feedback data can outweigh the benefits of the reduced frequency of feedback enabled by the CDI-based signaling strategy.

This paper shows that the covariance structure can be parameterized using established channel models which are based on the propagation physics of the environment. Specifically, the Kronecker and Weichselberger correlation models both offer a mechanism for feeding back model parameters which can then be used to generate an accurate channel covariance matrix for use in constructing the signaling strategy. Computational results using this technique reveal that incorporation of electromagnetic models into the communication scenario offers reduced system complexity with small loss in performance.