

NOTICE

Oral Defense of Doctoral Dissertation The Volgenau School of Information Technology and Engineering

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Bachelor of Technology, 2000

Master of Science, 2003

Friday, August 22, 2008

10:30 am – 12:30 pm

Science & Technology II Building, Room 100

MIMO WIRELESS SYSTEMS WITH LIMITED CHANNEL STATE INFORMATION AT THE TRANSMITTER

Dissertation Director: Dr. Bernd-Peter Paris
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Abstract

MIMO Wireless Systems with Limited Channel State Information at the Transmitter.

Shyam Prakash Pandula, PhD Candidate.

Multiple input multiple output (MIMO) systems using multiple transmit and receive antennas are widely recognized as an effective means to significantly improve the spectral efficiency and wireless link reliability. The performance of a MIMO system can be further enhanced when channel knowledge can be made available at the transmitter. Maximum gain can be achieved when perfect channel knowledge is available. In practice, however, perfect channel knowledge at the transmitter is never available because of the time varying nature of the channel and due to unavoidable estimation errors. As a result, the available channel state information at the transmitter (CSIT) is usually outdated instantaneous and/or statistical in nature. Precoding is a transmitter processing technique that exploits CSIT. The main objective of this thesis is to design robust precoding schemes when limited channel state information is available at the transmitter.

Our first contribution is a performance analysis of various receiver architectures for precoded systems under various degrees of CSIT. We show that significant performance gain can be achieved by precoding even with only a moderate amount of correlation between the available imperfect channel estimate and the current channel. Next, we address the case when channel covariance information alone is available at the transmitter. Using results from random matrix theory, we propose novel iterative power allocation algorithms that maximize the spectral efficiency.

We proceed to analyze the more general case when both the channel mean and covariance information is available at the transmitter. For the MIMO system with decorrelator receiver, using the moments of the SNR of each subchannel, we obtain a Taylor series approximation for the total average capacity. The obtained approximation is used to design a linear precoder that maximizes the average capacity of the system.

Finally, we present a novel linear precoder design for general space-time block coded (STBC) MIMO systems when both the channel mean and covariance information is available at the transmitter. The linear precoder is designed via approximate joint diagonalization of the channel mean and transmit covariance matrices. The resulting precoder minimizes the pair-wise error probability between a pair of block code words, averaged over channel fading statistics.