

# Preface

In this book, we study the interference cancellation and detection problem in multiantenna multi-user scenario using precoders. The goal is to utilize multiple antennas to cancel the interference without sacrificing the diversity or the complexity of the system.

First, we consider the case with two users and one receiver when users know each other channels. Before, in the literature, it was shown how a receiver with two receive antennas can completely cancel the interference of two users and provide a diversity of two for users with two transmit antennas. We propose a system to achieve the maximum possible diversity of four with low complexity. Our main idea is to design precoders, using the channel information, to make it possible for different users to transmit over orthogonal spaces. Then, using the orthogonality of the transmitted signals, the receiver can separate them and decode the signals independently. We also extend our scheme to any number of antennas and analytically prove that the system provides full diversity to both users.

However, the above scheme only works for two users. So we extend the scheme to more than two users. In other words, we propose a system to achieve interference cancellation and full diversity with low complexity for any number of users. Then, we extend the results to any number of users with any number of transmit and receive antennas. Our main idea is to design precoders, using the channel information, to make it possible for different users to transmit over orthogonal directions. Then, using the orthogonality of the transmitted signals, the receiver can separate them and decode the signals independently. We also analytically prove that our system provides full diversity to each user.

In practice, perfect channel information is not available, so we design precoders for two users with two transmit antennas and one receiver with two receive antennas using quantized feedback. We propose to construct codebook using Grassmannian line packing. By choosing precoders from the codebook properly, our proposed scheme can cancel the interference for each user. Also we analytically prove that our system can achieve full diversity for each user. Then we extend our scheme to any number of transmit and receive antennas. Simulation

results confirm our analytical proof and show that our scheme can serve as a bridge between a system with no feedback and a system with perfect feedback.

Finally, we investigate how to send codewords without interference with full diversity and low decoding complexity for X channels. We assume that we have two transmitters and two receivers. Each transmitter sends different codewords to each receiver at the same time. We propose our precoding and decoding schemes such that each receiver can get the desired signals from each transmitter without any interference. We show that our proposed scheme can provide full diversity for transmitted signals. Also our decoding complexity is low. To our best knowledge, this is the first scheme which can achieve interference-free transmission and full diversity for any transmitted codeword in X channel when all the users transmit at the same time. We also show that under certain conditions, our proposed scheme can be extended to a general case with any number of transmitters and receivers each with any number of antennas.

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