EE359 Project: Wideband MIMO System Design

Abstract: In the field of wireless communications, the multiple-input, multiple output (MIMO) channel is experiencing increased interest due to the drammatic increases in capacity that result from adding multiple transmit and receive antennas to wireless systems. Early work in the area centered on channels with flat fading characteristics. Here, it was found that channel capacity increases linearly with the number of antennas used [1]. However, the simple transmit and receiver architectures that result from the assumption of flat fading are not easily reproduced when it is relaxed. Thus, one topic of recent work has been appropriate receiver (and in some cases, transmitter) architectures for channels with intersymbol interference (ISI, e.g., frequency-selective fading).

The purpose of this project is to compare the performance of three MIMO system architectures in the presence of ISI. Two architectures are implemented in the receiver only. First, the optimal finite-length MIMO minimum-mean-square-error decision feedback equalizer (MMSE DFE) is computed (as reported in [2]). In this case, the equalization occurs using the matrix analogue of a standard single-input, single-output (SISO) DFE. Second, a multi-stage equalization structure is implemented (as in [3], where the authors expand on a multi-stage MIMO reciever architecture presented in [4]).

Recall that in [1], it is shown that the optimum structure for MIMO transmission in a flat-fading environment uses a channel decomposition that involves signal processing both at the receiver *and* transmitter. Thus, one would expect that the optimal system structure in an ISI environment would also involve transmitter-side processing, which neither of the two previous systems involve. In [5], an "discrete matrix-multitone" architecture is presented in which the channel is decomposed in a way analagous to the SISO DMT. This third architecture's performance is compared to the previous two receiver-only implementations. The performance metric used in all three cases is the simulated BER as a function of channel SNR. Several multi-input, multi-output channels are generated using random multipath components, with a four transmit antenna, four receieve antenna architecture (as in [5], example 1).

References

[1] EE359 course reader.

[2] N. Al-Dhahir and A. Sayed, "The Finite-Length Multi-Input Multi-Output MMSE-DFE", *IEEE Trans. Signal Proc.*, vol. 48, pp. 2921-2936, Oct. 2000.

[3] A. Lozano and C. Papadias, "Space-Time Receiver for Wideband BLAST in Rich-Scattering Wireless Channels", VTC2000, vol. 1, pp. 186-190, June 2000.

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[5] G. Raleigh and J. Cioffi, "Spatio-Temporal Coding for Wireless Communication", *IEEE Trans. Comm.*, vol 46, pp. 357-366, March 1998.