

ELECTRICAL & COMPUTER ENGINEERING SEMINAR

“Capacity and Performance Analysis for Communications with Finite Rate Feedback”

by

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Abstract

Channel state feedback from receivers to transmitters is not difficult to implement in modern communication systems because most of them are full duplex systems. The third Generation (3G) cellular phone systems such as CDMA 2000 and WCDMA are typical examples of such systems where a few bits of channel state information can be sent to the transmitter every few milliseconds. It is called finite rate feedback.

Contributions on the following two topics will be presented.

- (1) Finding the optimal method to exploit the finite rate feedback: Shannon has proved that a memoryless device, which selects a portion of a codeword to be transmitted according to discrete feedback, can optimally utilize the *given* memoryless feedback in a memoryless channel. However, in our case, one has the freedom to *design* channel state feedback. It is not clear whether the channel state feedback should be memoryless. If it is not memoryless, then the memoryless device at the transmitter is not optimal either. For memoryless channel with designable feedback, we proved a coding theorem which showed that a memoryless feedback generator is indeed optimal and gives the capacity formula. In addition, the proof shed light on how the feedback error may affect the performance.
- (2) Quantifying how much gain one can obtain in terms of information rate as a function of feedback rate. For application in Multiple-Input Multiple-Output (MIMO) systems in independent fading channel, we solve the open problem of performance analysis when the systems cannot be made equivalent to a Single-Input Single-Output systems. Using random matrix theory and extreme order statistics, we accurately characterize the performance gain as a function of the feedback rate (bits/channel use) for a power on/off strategy and show this strategy is near optimal. Central to the results is a closed form of ball volume formula in Grassmann manifolds. The analysis shows that the performance approaches that of perfect channel state information at transmitter exponentially fast when feedback rate increases.

Biography

Dr. Youjian (Eugene) Liu received the Ph.D. and M.S. degree in Electrical Engineering from The Ohio State University in 2001 and 1998 respectively. Since August 2002, he has been an Assistant Professor with Department of Electrical and Computer Engineering, University of Colorado at Boulder. From January 2001 to August 2002, he worked on 3G mobile communication systems as a Member of Technical Staff in Wireless Advanced Technology Laboratory, Lucent Technologies, Bell Labs Innovations, Whippany, New Jersey. His research interests include MIMO communications, coding theory, and information theory. He has regularly served as reviewer and Member of Technical Committee for all major IEEE journals and conferences (including Globecom, ICC, VTC, etc.) that are related to communications. He is the recipient of 2005 Junior Faculty Development Award at University of Colorado.

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