Information Theoretic Aspects of Constrained Systems

Shlomo Shamai
Department of Electrical Engineering
Technion City, Haifa 32000, Israel
sshlomo@ee.technion.ac.il

Abstract:

Central information theoretic aspects of constrained signaling and constrained signal processing, are overviewed, with emphasis on constrained signaling on the Gaussian dispersive channel.

First, discrete time models for the dispersive Gaussian channel are presented along with bounding techniques of the associated information rates, which allow for constrained signaling alphabets. The Minimum Mean Square Unbiased Decision Feedback Equalization (MMSE-DFE-U) conjectured bound by Shamai and Laroia is highlighted, and demonstrated on typical channels.

Coding approaches motivated by the canonic MMSE-DFE-U representations are discussed with emphasis on a novel precoding technique by Erez-Shamai-Zamir which achieves channel capacity, while putting the central processing burden on the transmitting side.

The discrete channel model is examined in the realm of peak power and/or bandwidth constraints covering a variety of applications in wireline and wireless communications and magnetic recording. This motivates the examination of optimal capacity achieving channel inputs, subjected to peak and average power constraints. The results by Smith and Shamai-Bar David for the scalar and quadrature discrete time AWGN channels are reviewed, and the underline techniques are shortly discussed.

A variety of interesting examples in which the information theoretic optimal signal distribution is discrete in nature are mentioned.

Time permitting, information theoretic implications of constrained signal processing are discussed with focus put on: Mismatched decoding, Quantized oversampling and Robustness issues.