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Generalized Modulation and Iterative Demodulation

Modulation is the process of mapping discrete signals onto basis waveforms suitable for transmission. These basis waveforms are typically engineered to be orthogonal. However, in many modern high-density communications channels, orthogonality of these basis waveforms cannot be guaranteed and is often lost. In this talk we consider modulation where the signal waveforms are correlated.

While it is well-known that for low spectral efficiencies linear separation via minimum mean-square error (MMSE) filtering provides close to optimal performance, linear approaches fail as higher spectral utilization is desired. The alternatives of approximations to maximum-likelihood decoders, such as sphere decoding quickly become practically infeasible due to complexity constraints. We propose an alternate method where the redundancy required to achieve reliability is achieved by increasing the number of signal functions used. It is shown that for the case of uniformly random signal functions, the capacity of the increased set of signal waveforms is nondecreasing and achieves the capacity of the Gaussian multiple access channel as it upper limit, when the number of waveforms becomes large. Furthermore, a simple iterative demodulator allows achievable spectral efficiencies beyond those achieved by linear processing, and it is proven that the capacity of the channel can be achieved to within less than 1 bit as the number of signal functions becomes large.