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*Generalized Modulation*

Classic modulation in communication theory is based on representation of an information-bearing signal as a linear combination of orthonormal basis waveforms. At the receiver the signal is usually passed through a bank of filters matched to the orthogonal basis waveforms and simple post processing acquires the transmitted information. In reality, however, specifically in modern communication systems, the transmitted signal is rather viewed as a combination of correlated waveforms. For example in Multiple Input Multiple Output systems the base waveforms can de-orthogonalise during the transmission and in random Code Division Multiple Access they are chosen randomly and independently. Therefore, fundamental understanding of general modulation and demodulation process constitutes an important problem in modern digital communications.

We consider signals represented as a linear combination of random waveforms with bounded average cross-correlation. The signals are transmitted over additive white Gaussian noise channel. It is well known that signal reception with optimum maximum-likelihood decoders quickly becomes impractical due to complexity constraints. On the other hand, linear signal separation via, for example, minimum mean-square error (MMSE) filtering provides close to optimal performance only for small information loads. We propose a modulation format introducing redundancy and interleaving to the data at the transmitter so that at the receiver the information can be recovered using an iterative distributed message-passing detection algorithm designed to solve inference problems on graphical models. We prove that the capacity of the channel can be approached to within less than 1 bit per dimension as the number of base signal waveforms becomes large.