

Adaptive Linear MMSE Detectors for Reception of CDMA Signals.

Master Thesis Abstract

The scope of the Master Thesis refers to modern wireless multiuser communication systems and adaptive processing of CDMA signals.

An important property of the air interface of a wireless communication system is the multiple access method, wherein prior-art methods are commonly based on time and / or frequency multiplex. If a Code Division Multiple Access (CDMA) is employed, all users use the same frequency at the same time.

In a CDMA system, each user is assigned a distinct signature waveform. Before transmission, the digital signal from each user is multiplied by the corresponding signature waveform (Direct Sequence CDMA). The signature waveform is a signal, which has a much larger bandwidth than the information-bearing signal from the user and is selected from a set of mutually orthogonal code sequences. The CDMA system is thus a spread spectrum technique.

At the base station, the sum of all the broadband signals is received. The simplest way to demodulate a signal of a specific user is to correlate the received signal with the signature waveform of that user. However, since the conventional receiver is not optimal in practical applications, advanced types of more optimal multiuser detectors have been derived in last years, e.g. in form of adaptive discrete time filters.

The Master Thesis concerns linear adaptive multiuser detectors for reception of DS-SS-CDMA signals, wherein said detectors are designed for minimalizing the mean square error being determined by comparing the originally transmitted data with the detector output data estimate (MMSE detectors). In particular, the Master Thesis concerns a trained version and a blind version of known linear adaptive MMSE detectors, which use the stochastic gradient algorithm for implementing the adaptive rule.

A universally applicable software simulator of a synchronous CDMA system was created in the MATLAB algorithm development environment, simulating both kinds of studied detectors as base-station receivers. With a close relation to the theoretical background, relevant practical and functional characteristics of both detectors such as algorithm convergence or bit error probability were studied in the built simulator. An AWGN communication channel model was used.

As the result of the study, several serious defects of said adaptive MMSE detection algorithms were revealed such as inapplicable design of algorithm parameters or inadvisable function approximation, wherein suitable algorithm amendments are proposed in the conclusion of the Master Thesis.