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A novel low complexity multiuser detector based on modified genetic algorithm in direct sequence-code division multiple access communication systems

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Abstract. In this paper, we present an efficient evolutionary algorithm for Multiuser Detection (MUD) problem in Direct Sequence-Code Division Multiple Access (DS-CDMA) communication systems. The optimum detector for MUD is the Maximum Likelihood (ML) detector, but its complexity is very high and involves an exhaustive search to reach the best fitness of the transmitted [illegible] suboptimal multiuser detectors with less complexity and reasonable performance. The proposed algorithm is a modified Genetic Algorithm (GA), which reduces the dimension of the search space, and provides a suitable framework for future extension to other optimization problems, especially for high dimensional ones. This algorithm is compared with ML and two famous model-free optimization methods: Particle Swarm Optimization (PSO) and Ant Colony Optimization (ACO) algorithms, which have been used for MUD in DS-CDMA. The simulation results show that the performance of this algorithm is close to the optimum detector, it has very low complexity, and it works better in comparison to other algorithms.

1. Introduction

In a DS-CDMA system, the signal is received and detected by a Matched Filter Bank (MFB), which constitutes the conventional detector. This type of receiver is unable to optimally recover the signal when the channel is contaminated by Additive White Gaussian Noise (AWGN), and suffers from flat or frequency selective fading, because the DS-CDMA signal is affected by Multiple Access Interference (MAI) and also by the Near-Far Ratio (NFR) [1]. In fact, the signature signals of different users are not completely orthogonal to each other, and cross correlation among these signals results in multiple access interference. Therefore, the conventional matched filter detector, as in single user communication, is no longer effective and causes many problems [2]. In 1986, Verdu et al. [3] proposed the optimum multiuser detector (OMUD), which consists of a bank of matched filters followed by a Maximum Likelihood Sequence Estimator (MLSE). The MLSE detector generates a maximum likelihood sequence, $\hat{b}$, which is associated with the transmitted sequence, as presented in Figure 1 [4]. Vector

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