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Coordinating transmit power and carrier phase for wireless networks with multi-packet reception capability

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Abstract

Driven by advances in signal processing and multiuser detection (MUD) technologies, it has become possible for a wireless node to simultaneously receive multiple signals from other transmitters. In order to take full advantage of MUD in multi-packet reception (MPR) capable wireless networks, it is highly desirable to make the compound signals from multiple transmitters more separable on its constellation at the receiver by coordinating both the transmit power level and carrier phase offsets of the transmitters. In this article, we propose a feedback-based transmit power and carrier phase adjustment scheme that estimates the symbol energy and the carrier phase offset for each transmitter's received signal, computes the optimal received power level and carrier phase shift to maximize the minimum Euclidean distance between the constellation points, and finally feeds the optimal transmit power level and phase shift information back to the transmitters. We then evaluate the performance of the proposed transmit power and carrier phase adjustment scheme and subsequently show that the proposed scheme significantly reduces the error probability in a multiuser communication system having MPR capability.

1 Introduction

In conventional wireless networks, each receiver is only capable of decoding signals from one transmitter at a time; referred to as single-user detection (SUD). In SUD, when a mixed signal from multiple transmitters is sensed, the receiver typically discards the signal and treats it as a collision. However, signal processing technology has rapidly evolved, and compound signals from multiple transmitters have become decodable at the receiver side [1,2]. To effectively decode multiple signals in a multiple access environment, multiuser detection (MUD) can be used. In [2], the optimum multiuser detector has a computational complexity that increases exponentially with the number of active users. Therefore, several suboptimum detectors have been proposed in order to achieve a performance comparable with that of the optimum detector while maintaining a low complexity. The decorrelating detector [3], the decision feedback detector [4], the minimum mean squared error (MMSE) [5], and multistage detectors [6] are examples of suboptimum multiuser detectors. Some of these multiuser detectors are also suitable for blind adaptive implementations, in which information about the interfering users (such as their powers and signature sequences) is not needed for the construction of the receiver filter of a desired user. A blind adaptive implementation of an MMSE multiuser detector is given in [7], and blind adaptive decorrelating detector implementations are shown in [8,9].

Since MUD technology permits simultaneous packet reception from multiple sources, compound signals, which were previously treated as a collision event in conventional wireless networks, are now preferred for their ability to enhance the achievable throughput performance [10-16]. However, how to take advantage of the MUD technique and how to adjust its tunable parameters in designing the medium access control (MAC) for multi-packet reception (MPR) capable wireless networks and maximize the achievable throughput have yet to be sufficiently studied.

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