Multiuser Detection in Dualrate DS-CDMA Systems Using ICA

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ABSTRACT

This article proposes an ICA-based blind multiuser detection technique to detect the signal of the desired user in a dual rate DS-CDMA system. In the present competitive scenario, communication is the most important tool in business and it has become a necessity to remain connected. Depending on the nature of data and quality of service requirements, users transmit signals at different rates. DS-CDMA systems provide straightforward implementation of multi rate signals and have been proposed as a promising system to support multi rate signals. It is desired to have spectrum efficient detection techniques for multi rate DS-CDMA systems. Keeping this requirement in mind, an ICA-based detection technique has been proposed for dual rate DS-CDMA systems. The BER performance of the proposed detection technique has been compared with the conventional matched filter and rake detector. The simulation results illustrate the effectiveness of the proposed approach.

Keywords: dual-rate DS-CDMA; ICA; multiple processing gain; multiuser detection

INTRODUCTION

Communication is undoubtedly an essential and vital part of the human life. Wireless access technology provides rapid and cost effective deployment of basic communication services for consumers. The objective of any business organization is to sell a quality product at a fair price. Incorporation of the features to support different rate signals in a mobile phone will lead to a better consumer product without any significant change in the cost. Therefore, the current research interest is to devise ways and means to detect the signal of the users in multi rate systems. Also to reduce the cost, it is desired to make efficient use
of limited radio resources in the operation of wireless communication systems. The choice of a multiple access technique has a large influence on the capacity of the communication system. Because bandwidth is a major problem in modern times, Code division multiple access (CDMA) has a very clear advantage over Global System for Mobile communications (GSM). The number of channels (users) that can be allocated in a given bandwidth is comparatively higher for CDMA as compared to GSM. The cost of setting up a CDMA network is also comparatively less than the GSM network. Due to these advantages, direct sequence code division multiple access (DS-CDMA) has been proposed as a promising multiple access technique. In the current cautious business climate, every user wants to have the facility to transmit and receive multimedia data. The third generation (3G) systems are intended to provide various multimedia services, which are inherently at different rates.

The inter symbol interference (ISI), multiple access interference (MAI) and near-far problem are the major issues of concern in future high speed integrated services of wireless DS-CDMA systems. The framework of multi user detection (MUD) treats MAI and ISI in a unified way, so that the interference and near far problem can be alleviated (Verdu, 1998). There are different multi rate access methodologies to implement a multi rate DS-CDMA system (Wyrwas, Miller, & Zhang, 1992). Among the various schemes, multicode and multiple processing gain (MPG) access are two of the most popular methods. It is preferable to adopt the MPG access scheme to achieve better spectrum efficiency. In the MPG scheme, the user’s data rate is adapted by changing the length of the spreading code sequence.

Most of the current research conducted in MUD for CDMA communications follows a common assumption that all the active users have the same data rate. The move toward third generation wireless communication systems has initiated investigation of MUD for multirate systems (Chen & Li, 2000). The decorrelating detector (Saquib, Yates, & Mandayam, 1996a), the MMSE detector (Buzzi, Lops, & Tulino, 2001), successive interference cancellation (Johansson & Svensson, 1995), parallel interference cancellation (Van Meeteren, Ojanpera, Nikookar, & Prasad, 1999), multi stage receiver (Johansson & Svensson, 1996) and decision feedback detector (Saquib, Yates, & Mandayam, 1996b) have been proposed for multi rate CDMA systems. Blind techniques for multi rate CDMA systems have also been proposed (Ma & Tugnait, 2002; Yan & Roy, 2000). The references given above are just representative of the literature on this topic.

In a practical DS-CDMA system, to adapt to the changing users either training-based or blind receivers can be used. In training-based receivers, training sequences are transmitted periodically before the data transmission. This results in loss of spectrum efficiency as the spectrum is utilized for transmitting training sequences instead of data. Blind adaptive techniques do not require training sequences and are spectrum efficient in comparison to their nonblind counterparts. Further, blind detection techniques are preferable in the downlink because of various reasons. First, each user knows only his code, while the codes of the interfering users are unknown. Second, the users do not have such a signal processing capacity as the base station. Thirdly, the issues of cost, size and weight are much larger concerns for the mobiles than for the base stations.
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