Chapter 12 Performance Analysis of Optimum Interleaver based on Prime Numbers for Multiuser Iterative IDMA Systems

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ABSTRACT

In recently proposed multiple access techniques like IDMA and OFDM-IDMA, the user separation is done by user specific interleavers in contrast to the conventional CDMA scheme, where user separation is assured with user-specific signature sequences. The user specific interleavers must demonstrate minimum probability of collision amongst each other in addition to other merits, including minimal consumption of bandwidth, least hardware for their generation, and least memory requirement. In this paper, the authors propose an interleaver based on prime numbers for the generation of user specific interleavers to remove the problem of high consumption of bandwidth. The simulation results demonstrate the optimal performance of prime interleaver (PI), which is based on prime numbers, apart from other merits in comparison to random and other interleavers.

INTRODUCTION

By researchers, significant amount of research has been done in the field of wireless communication. The recently developed technique including iterative multi user detection (MUD) techniques for suppressing multiple access interference (MAI) (Liu, 2003; Ping, 2006) has also drawn their attention. Interleave division multiple access (IDMA) and OFDM-IDMA are the two multiple access (MA) schemes that make use of the iterative MUD efficiently, (Verdú, 1999). In IDMA, interleavers are being employed as the only means of user

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separation while in CDMA the signature sequences were designed to be means of user separation as the spreader provides no coding gain (Verdú, 1999). With even random interleavers, the IDMA system performs similarly and even better than a comparable CDMA system (Ping, 2006). IDMA outperforms CDMA in terms of better immunity to multiple access interference (MAI) and higher user count. IDMA also inherits the advantages of CDMA such as asynchronous transmission, diversity against fading and cross cell interference mitigation at a reduced cost of complexity (Verdú, 1999) and high data rate. This chip by chip turbo type detection technique in IDMA also reduces the complexity of receiver multi use detector (MUD) as compared to that used in CDMA system (Ping, 2006; Verdú, 1999).

The efficiency of IDMA system is dependent on the generation of various pseudo random interleaving patterns for each user. The system performance seriously degrades when the interleaving patterns are not orthogonal to each other i.e., the collision among the interleaving patterns is not minimum. These interleavers disperse the coded sequences so that the adjacent chips are approximately uncorrelated, which facilitates the simple chip-by-chip detection. In case of interleavers in IDMA systems, the parameters such as ease of generation, hardware required, bandwidth consumption during transmission, and memory requirement at transmitter and receiver end, may be vital parameters for generation of orthogonal interleavers. The greater the size of interleaver the more it consumes the memory and extra bandwidth for transmission, this becomes a greater problem when the number of users increase. In Ping (2006), random interleaver has been utilized in IDMA systems, while in Wu (2006), an efficient technique for interleaver generation in IDMA has been proposed in.

This paper is organized as follows. The following section presents the importance of interleavers in digital communication. Studies of relevant literature are presented. The mechanism of interleaving process is highlighted. The importance of interleavers in IDMA systems is also discussed. The next section focuses on available various orthogonal interleavers for IDMA scheme. The IDMA systems model is then duly explained. The motivation for the work and mechanism of propose prime interleaver and the numerical results are presented.

INTERLEAVERS IN DIGITAL COMMUNICATION

In communication systems, most of the wellknown codes have been developed to combat against the noise that is assumed to be statistically independent. Typical channel model causing this type of noise would be Additive White Gaussian Noise channel (AWGN). However, there are some physical channels that show bursty error characteristics, such as multipath fading channel, in which fading often causes the signal to fall below the noise level and, thus, results in the burst type of error. Interleaving is frequently used in digital communication and storage systems to improve the performance of forward error correcting codes. Many communication channels are not memoryless: errors typically occur in bursts rather than independently. If the number of errors within a code word exceeds the error-correcting code's capability, it fails to recover the original code word. Interleaving ameliorates this problem by shuffling source symbols across several code words, thereby creating a more uniform distribution of errors.

Interleaving is a technique commonly used to overcome correlated channel noise such as burst error or fading (Rappaport, 2002; Tse, 2005; Olavarrieta, 2004). In interleaving mechanism, the input data rearranges itself such that consecutive data are split among different blocks. At the receiver end, the interleaved data is arranged back into the original sequence by the de-interleaver. As a result of interleaving, correlated noise introduced 13 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage: www.igi-global.com/chapter/performance-analysis-optimum-interleaverbased/62767

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