Performance Enhancement of IDMA System using Large Block Interleaving with BPSK Modulation

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Abstract - The wireless communication is the present system to share information over internet as well as inside house and offices. The reliability of such network is nothing but the overall lower and lower error rate and if the system is based on the interleaver division multiplexing(IDMA) than in such cases the compatibility of the system to handle multiple users at a time with lower error rate is crucial task. In this paper an IDMA based taken into consideration and worked towards making user handling capacity more with reduction in bit error rate(BER). The result analysis shown that the system able to handle more users with lower BER. The optimum bit error rate achieved is lower than 10^{-5}, which is significantly lower than the existing research.

Keywords - IDMA, Block Interleaving, BPSK, Wireless Communication.

I. INTRODUCTION

New products and services in the wireless market require higher data rates, improved link reliability, and the ability to cope with user interference. The use of multiple-input multiple-output (MIMO) communications has led to increased data rates and improved link reliability, and new multiuser transmission schemes such as interleave-division multiple access (IDMA) have been proposed. With IDMA, user separation is obtained via user-specific interleavers combined with low-rate channel coding. These new technologies and transmission schemes, however, require sophisticated and powerful receiver structures, which employ iterative algorithms.

Wireless communication has become ubiquitous in the last two decades. Initially, only high-end notebooks were equipped with connectivity to Wireless Local Area Networks (WLAN), which allowed for wireless broadband access to the internet. Due to increasing demand, WLAN connectivity is now common to all notebooks and many new consumer devices have been introduced to the market, which offer new services like multimedia streaming and video-on-demand. Many access points for WLAN have been installed in homes and offices, allowing for wireless internet access. This development triggered customer demand for “wireless broadband access everywhere”. Existing services, like surfing the internet or watching a video stream, are provided in a mobile environment. This creates new customers (e.g. people surfing the internet while commuting); extrapolating the success of wireless broadband by means of WLAN, this will be a huge market. In addition to providing existing services in a mobile fashion, also many new services have become available, which explicitly require mobile broadband access. One example for such a new service is “augmented reality”, which enables users to obtain interactive information about sights near their current location by a clever combination of GPS enabled mobile devices, broadband internet access and a (user-generated) database accessible over the internet. Many of these new services are currently evolving, and will offer attractive opportunities and revenue models for service developers and network operators. Current WLAN standards work reliably only up to 100 meters, making deployment in large areas, especially outdoors, difficult and costly. Given the infrastructure cellular network operators already have, it is only natural to extend current cellular communication technologies such that broadband internet access can be provided. Current second-generation cellular communication technologies like the Global System for Mobile Communications (GSM) are mostly tailored for voice-centric network traffic and perform poorly for data-centric applications. The third-generation cellular technology, Universal Mobile Telecommunications System (UMTS) and extensions, such as High Speed Downlink Packet Access (HSDPA) are better suited for data-centric network traffic. However, these new standards are not expected to be able to provide the increasing data rates and increased levels of quality of service (QoS) required in the future. Therefore new standards for the upcoming fourth-generation (4G) cellular communication systems have been proposed, which provide higher data rates and support QoS constraints. Most prominently, Worldwide Interoperability for Microwave Access (WiMAX) and Long-Term Evolution

(LTE) of the 3GPP are currently considered or being already deployed.

II. INTERLEAVE-DIVISION MULTIPLE ACCESS TRANSMISSION SCHEMES

Interleaving Division Multiple Access (IDMA) is a spread-spectrum technique which allows several users to simultaneously share a given bandwidth. In IDMA the spectrum of the original data sequence is spread by means of forward error correction (FEC) coding, spreading sequences or combinations of FEC and spreading.

Structure of the Transmitter:

The IDMA transmitter resembles the one for standard CDMA systems. The difference consist on the reverse order of interleaving and spreading. In fact, the information bits are first encoded and spread and subsequently interleaved, while in CDMA the spreading follows the encoding and interleaving of the information bits. In figure 2.1, the structure of the IDMA transmitter is shown.

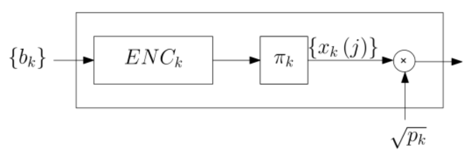

Figure 2.1: A typical structure of an IDMA Transmitter.

Structure of the Receiver:

In figure 2.2 the structure of the IDMA receiver is shown.

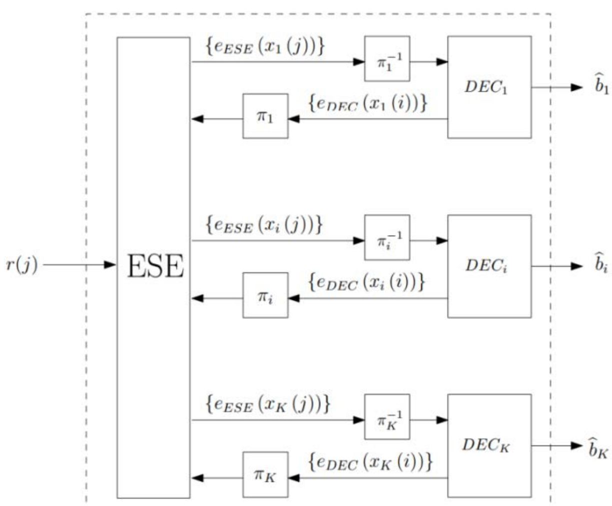

Figure 2.2: A typical structure of an IDMA Receiver.

I N multiuser communications, large performance gains can be achieved by using a turbo-style interaction between multiuser detector and channel decoder [5]. Here, we consider an uplink scenario where U users transmit data to a common base station via multiple-input multiple-output (MIMO) channels. User separation is achieved by means of a recently introduced multiple-access technique known as interleave-division multiple access (IDMA) [18].

Using a factor graph framework [4, 5], we develop an iterative multiuser MIMO-IDMA receiver that performs joint multiuser data detection, channel decoding, and pilot-aided channel estimation. An orthogonal frequency-division multiplex (OFDM) modulation format is adopted to accommodate frequency selective (time-dispersive) channels. The proposed receiver is suited to higher-order symbol alphabets for increased spectral efficiency, and it uses a selective message update scheme for reduced complexity.

With IDMA, user separation is obtained viauser-specific interleavers combined with low-rate channel coding. These new technologies and transmissionschemes, however, require sophisticated and powerful receiver structures, which employ iterative algorithms.

Problems with TDMA, FDMA and CDMA:

TDMA and FDMA require centralized control and strictsynchronization. They are not flexible in many situations. Forexample, it is quite difficult to synchronize an ad hoc network.

TDMA and FDMA are strictly sub-optimal in fading environments.In particular, TDMA and FDMA (and OFDMA) can be seriouslyinferior in MIMO channels. This is related to multi-user gain.

CDMA is flexible regarding synchronization. However, CDMA is alow-rate scheme by nature. It is difficult to provide high single-userthroughput with CDMA.

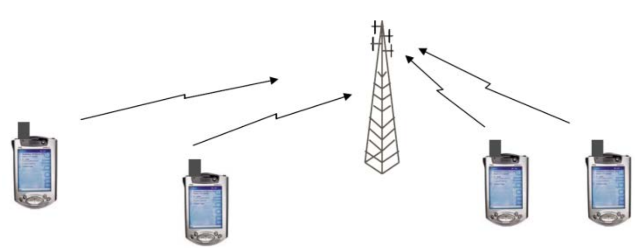

Fig. 2.3 Multiuser gain

Multi-User Gain (MUG):

From information theory, allowing multiple users to transmit simultaneously can lead to significantly power reduction. This advantage is referred to as multi-user gain.

The Chip-By-Chip (CBC) Detection:

Thanks to the interleaving operation at the chip level, the code structure is dispersed and allows to consider consecutive chips independent from each other. In addition, the multiple access channel is the summation of all the active users' signals.

III. Proposed Methodology

The IDMA system is the better substitute of CDMA and TDMA techniques used earlier in the wireless communication system. The system is analyzed by calculating the error rate performance of the system by monitoring end to end transferring of data or information.Now working on the same context and to make system more efficient in terms of error rate. The proposed system is given in the below figure. The proposed IDMA system is facilitated with the block interleaving and the different block sizes are also analyzed for the performance optimization.

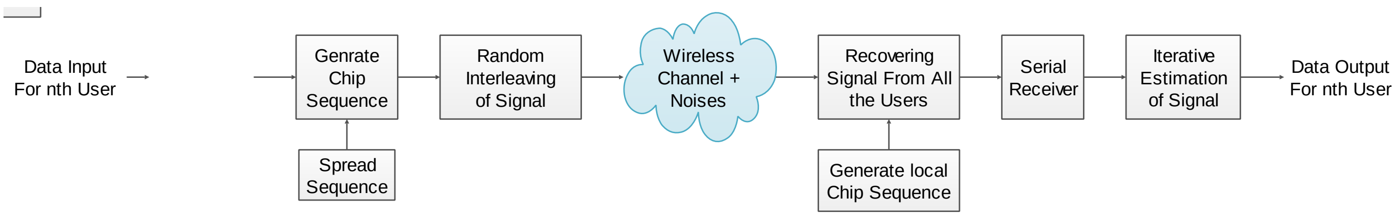

Fig. 3.1 Block diagram of the proposed methodology

The major blocks are shown in the figure 3.1. The first block is BPSK modulation which is very simple in operation and having better performance than other methodologies with IDMA system. The next block is to generate chip sequence by multiplying spreading sequence to get the signal to be transmitted over network. Now the signal is randomly interleaved at the transmitter end to the channel, and during transmission various noises being added to the signal and reaches to the receiver. The received signal is than recovered using locally generated Chip sequence. After that signal is serially recovered and iterative estimation is performed. At the end data is received at the output.

The above explained IDMA system with block interleaving is implementedwith the simulation tool and the algorithmic flow chart is shown in the figure 3.2. The steps of executions are as follows:

a. Start simulation
b. Create simulation environment of IDMA using variables
c. Initialize wireless channel for user
d. Generating spreading sequence

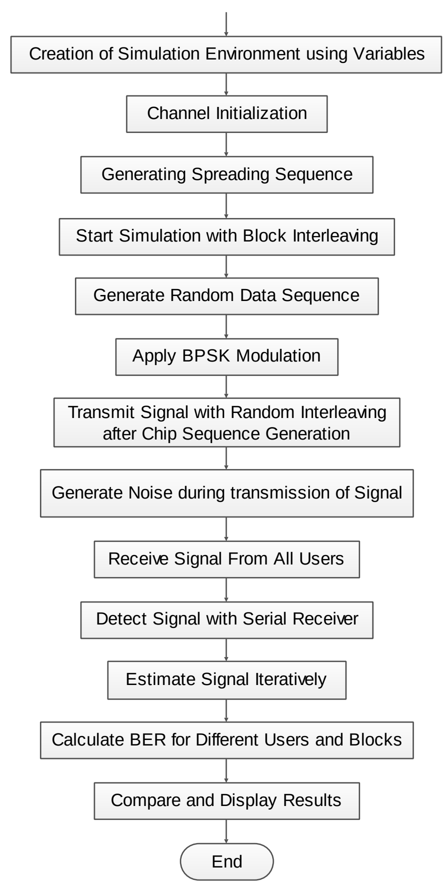

Fig. 3.2 Flow chart of the proposed methodology

e. *Transmission will be done with block interleaving*
f. *Generate Random Data Sequence*
g. *Apply BPSK Modulation*
h. *Transmit Signal with random block interleaving after chip sequence generation*
i. *Generate noise during transmission of signal*
j. *Receive signal from all users*
k. *Detect signal with serial receiving*
l. *Estimate signal iteratively to college more and more information*
m. *Calculate bit error rate(BER) for different users and different blocks*
n. *Compare and display results*
o. *End of simulation*

IV. Simulation Results

The simulation of the system proposed in this paper will give analysis of the bit error rate for proposed technique. The system and proposed implementation and its flow chart shown in the previous section. In this section the simulation is performed on the implemented system and the BER vs SNR curves are drawn which are as follows.

In Fig. 4.1 the proposed IDMA system is evaluated with the 50 blocks, the blocks are randomly interleaved and the BER is calculated and compared for 2, 4 and 6 users. The optimum BER achieved for 2 users it is $8x10^{-5}$, for 4 usersit is $4x10^{-5}$ and for 6 usersit is $5x10^{-5}$. All are quite near but best performance is with 4 users.

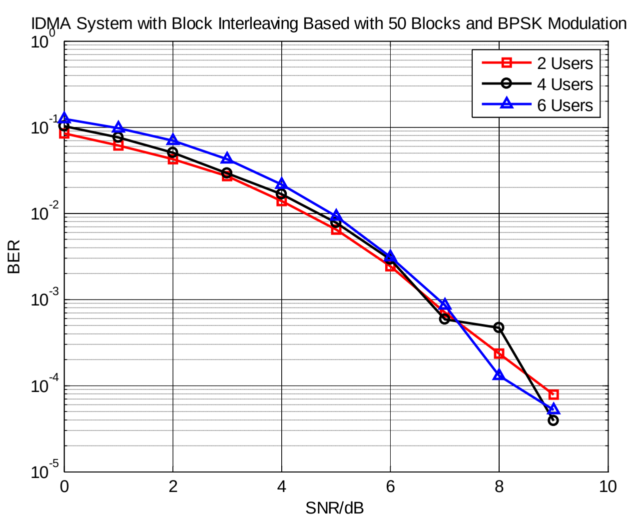

Fig. 4.1 BER vs SNR curve for 50 Blocks Interleaving

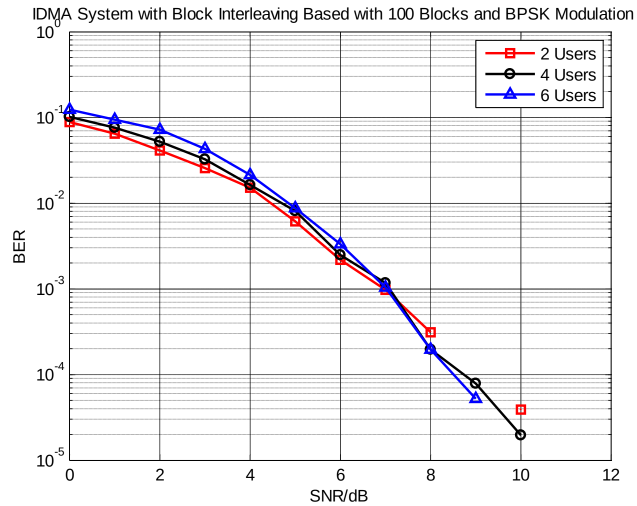

Fig. 4.2 BER vs SNR curve for 100 Blocks Interleaving

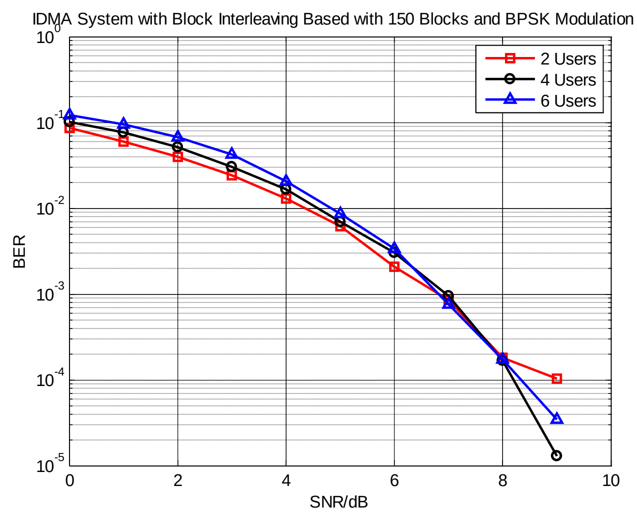

Fig. 4.3 BER vs SNR curve for 150 Blocks Interleaving

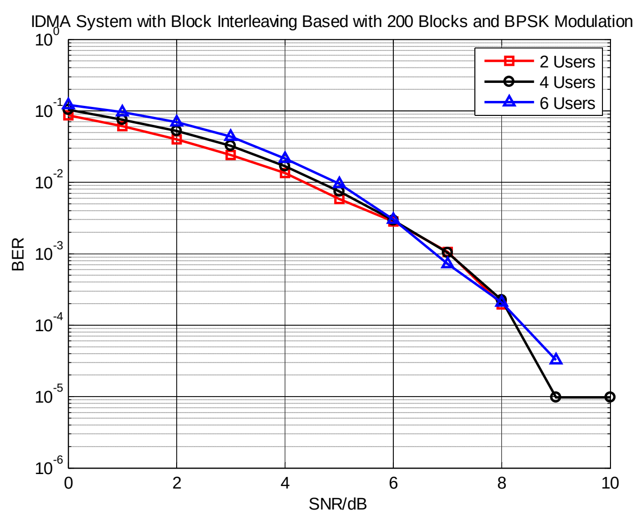

Fig. 4.2 BER vs SNR curve for 200 Blocks Interleaving

In Fig. 4.2 the proposed IDMA system is evaluated with the 100 blocks, the blocks are randomly interleaved and the BER is calculated and compared for 2, 4 and 6 users. The optimum BER achieved for 2 users it is $4x10^{-5}$, for 4 users it is $2x10^{-5}$ and for 6 users it is $5x10^{-5}$. All are quite near but best performance again with 4 users.

In Fig. 4.3 the proposed IDMA system is evaluated with the 50 blocks, the blocks are randomly interleaved and the BER is calculated and compared for 2, 4 and 6 users. The optimum BER achieved for 2 users it is $1x10^{-4}$, for 4 users it is 1.5 $x10^{-5}$ and for 6 users it is $4x10^{-5}$. All are quite near but best performance is with 4 users.

In Fig. 4.4 the proposed IDMA system is evaluated with the 50 blocks, the blocks are randomly interleaved and the BER is calculated and compared for 2, 4 and 6 users. The optimum BER achieved for 2 users it is $2x10^{-4}$, for 4 users it is 1 $x10^{-5}$ and for 6 users it is $3x10^{-5}$. All are quite near but best performance is with 4 users.

The comparison of bit error rate for different block sizes with existing technique shown in Table I.

Table - I: Performance Comparison of BER with Existing Work

SNR	Bit Error Rate				
	Existing Methodology	Proposed Methodology with 200 Blocks	Proposed Methodology with 150 Blocks	Proposed Methodology with 100 Blocks	Proposed Methodology with 50 Blocks
0	0.5000	0.1037	0.1016	0.1020	0.1192
1	0.4900	0.0747	0.0767	0.0756	0.0975
2	0.4800	0.0520	0.0514	0.0519	0.0709
3	0.4700	0.0323	0.0304	0.0326	0.0417
4	0.4600	0.0169	0.0167	0.0164	0.0238
5	0.4400	0.0075	0.0070	0.0081	0.0094
6	0.4000	0.0029	0.0031	0.0025	0.0033
7	0.3300	0.0010	0.0010	0.0012	0.0011
8	0.2600	0.0002	0.0002	0.0002	0.0002
9	0.1400	0.0000	0.0000	0.0001	0.0001
10	0.0400	-	-	-	-
11	0.0190	-	-	-	-
12	0.0024	-	-	-	-

V. CONCLUSION AND FUTURE SCOPE

The simulation of the block interleaving based system is analyzed in this paper and it was analyzed thatthe large block sizes gives better performance than the lower block sizes. The results of the proposed methodology are also compared with the existing results and found that the proposed methodology of this paper is better, and having less complexity than the previous methods. In the future works the filtering techniques can be integrated with the proposed methodology to improve the performance and to make system more reliable and error free.

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