ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering
Vol. 2, Issue 7, July 2013

COMPARSION OF VARIOUS DETECTION TECHNIQUES OF MULTI INPUT MULTI OUTPUT INTERLEAVE DIVISION MULTIPLE ACCESS SYSTEMS

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ABSTRACT: Different interleavers are employed in Interleave Division Multiple Access (IDMA) instead of using different signatures as in a conventional code-division multiple-access (CDMA) scheme. Multiple Input Multiple Output (MIMO) system exploits multiple antennas at transmitter and receiver to mitigate the fading effect. To offer the promising communication beyond 3G and 4G wireless communication, IDMA systems combined with multiple antennas. Traditional MIMO system provides benefit of spatial diversity. In addition, the usage of multiple transmitter and receiver antennas can significantly improve the wireless communication performance. In this paper, comprehensive review of the MIMO-IDMA system is performed based on various multi user detection techniques is presented.

Keywords: Multiple Input Multiple Output (MIMO), Interleave Division Multiple Access (IDMA)

I. INTRODUCTION

This paper presents an approach to asynchronous multiple access scheme called interleave division multiple- access (IDMA) system with MIMO system support [1] [12]. In an IDMA scheme, different interleavers are used to distinguish users as against different codes in a conventional code division multiple access (CDMA) system. In a conventional CDMA scheme, interleavers are placed before the spreaders and they are effective only when used in conjunction with channel coding [2,3]. Wide literature has discussed the role of interleavers in a multiple access systems [1]. IDMA inherits many benefits of CDMA; in particular, path diversity and mitigation of intra cell interference. Also all the users employ a common spreading sequence. Now days, the demand of communication system is towards high capacity and faster data rate with minimum loss. In Wireless communication, MIMO is one of the techniques that can increase spectral efficiency and link reliability [4]. MIMO profile in any wireless communication system can be realized by two schemes namely (1) using the classical BELL labs architecture (VBLAST–Vertical Bell Laboratories Space Time architecture) and (2) Space Time Block Codes. Hence, combining these techniques with the IDMA system can result in MIMO MC/IDMA that can offer bandwidth efficiency, space diversity and lower speed parallel type of signal processing and interference rejection capability (ISI reduction) in high data rate transmission. Of late, significant progress has been made in multi-user detection for CDMA systems [13]. Multi user detection in IDMA systems has been well researched, to enhance the MIMO-IDMA performance. In this paper, we compare the performance of the MIMO MC/IDMA scheme with various multiuser detection schemes.

The paper is organized as follows: In Section II, The role of VBLAST and STBC codes for MIMO IDMA systems have been discussed, in section III, various detection techniques are discussed. In section IV various multi-user detection schemes are discussed on MIMO-IDMA system and their results are also shown. In section V detection schemes are compared based on different parameters and the paper is concluded in Section VI.

II. VBLAST

Among conventional detection techniques in MIMO communication such as zero forcing (ZF) minimum mean square error (MMSE) and OSIC shows better performance at the cost of higher complexity [15]. By the application of V-BLAST algorithm on all of the above detection techniques shows better performance than without V-BLAST and even the complexity of the system reduces. Therefore V-BLAST based detection techniques can be preferred over

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conventional methods in MIMO-IDMA system with high data transmission capacity where high efficiency is required with lower complexity.

Here Symbols are transmitted through M antennas. Each receiver antenna receives a superposition of faded symbols. The decoder would select the set of symbols that are closest in Euclidean distance to the received N signals. The V-BLAST detection algorithm is a recursive procedure that extracts the components of the transmitted vector x according to a certain order (k1, k2,…,kM) of the elements of x, where, (k1, k2,…,kM) is a permutation of (1,…, M). In VBLAST, this permutation depends on H (which is known at the receiver by assumption) but not on the received vector.

STBC

Space-time block codes are used for MIMO systems to enable the transmission of multiple copies of a data stream across a number of antennas and to exploit the various received versions of the data to improve the reliability of data-transfer. Space-time coding combines all the copies of the received signal in an optimal way to extract as much information from each of them as possible. When using space-time block coding, the data stream is encoded in blocks prior to transmission. These data blocks are then distributed among the multiple antennas (which are spaced apart to decorrelate the transmission paths) and the data is also spaced across time. A space time block code is usually represented by a matrix. Each row represents a time slot and each column represents one antenna's transmissions over time.

III.DETECTION TECHNIQUES

A. Zero forcing

Zero Forcing is a linear detection technique. The pseudo inverse of the signal is applied to the received signal in order to make a decision about one user

B.Minimum Mean Square Error

MMSE is also a linear detection technique but more reliable than ZF in case of noisy channel [10]. MMSE does not apply pseudo inverse of signal to make decision about one user, instead it attenuates them to noise level thereby reducing the diversity order.

C.Linear Least Square Estimation(LLSE)

In LLSE detection technique weighting matrix is used to obtain received vector. It does not eliminate co-channel interference nor enhances noise power.

D.Ordered Successive Interference Cancellation (OSIC)

Here the main Idea is to detect the symbols in the order of decreasing SNR. It provides a reasonable trade–off between complexity and performance (between MMSE and ML Rx). It also achieves a diversity order which lies between N − M+ 1 and N for each data stream.

IV. MULTI USER DETECTION

Prabagarane Nagaradjane1 et al., has proposed MIMO Multi Carrier Interleave Division Multiple Access System with Multiuser Detection based on VBLAST ZF and LLSE/MAP architecture. In this paper, the receiver is employed with ZF, LLSE, VBLAST/ZF/MAP and VBLAST/LLSE/MAP detectors. The performance of the system is analyzed for different channel conditions using extensive simulation runs based on Monte Carlo simulation trials. As shown in figure 1 authors have shown that VBLAST/LLSE/MAP multiuser detector is better compare to ZF, LLSE, and VBLAST/ZF/MAP.[5,6]

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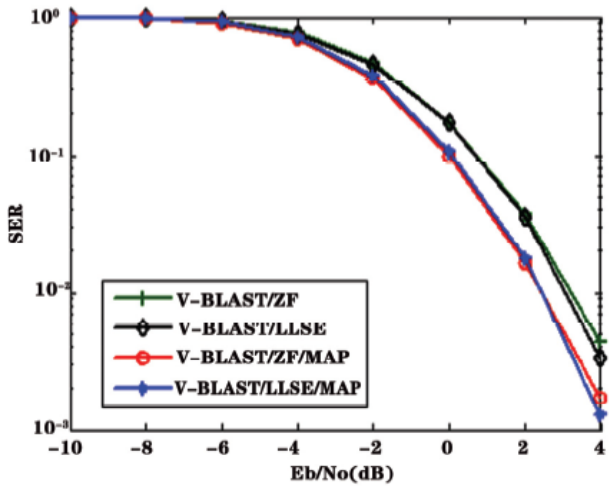

Fig. 1 SER of VBLAST/ZF, VBLAST/LLSE, VBLAST/ZF/MAP and VBLAST/LLSE/MAP receiver[5,6]

Kuttathatti Srinivasan Vishvaksenan et al., has proposed Performance Analysis of MIMO IDMA System Employing Turbo Coding with Multi-User Detection over Frequency-Selective Wireless Communication Channel using MMSE and ZF detectors. In this paper, the receiver is employed with OSIC using ZF and MMSE for frequency fading channel to combat MAI and MUI problem. The performance of the system is analyzed for different channel conditions using extensive simulation runs based on Monte Carlo simulation trials. As shown in figure (2) authors have shown that MIMO-IDMA with MMSE results is in terms of better BER compared to MIMO IDMA with ZF.[7,8]

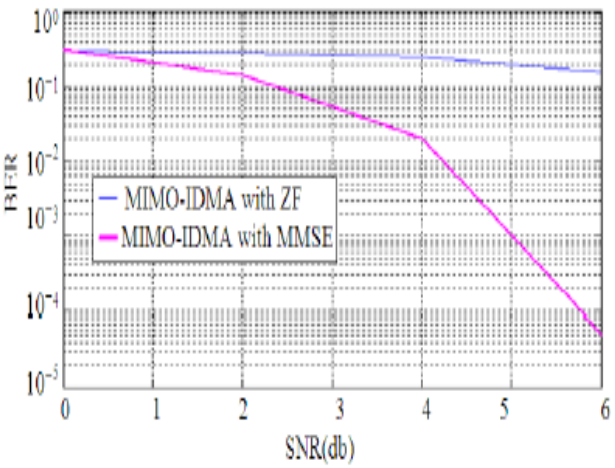

Fig. 2 Comparison of Bit Error Rate (BER) performance of coded MIMO-IDMA with ZF and MMSE MUD[7,8]

Lance Linton et al., has proposed Multiuser MIMO Communications using Interleave-Division Multiple-Access and Golden Codes. In this paper the receiver uses the soft multiuser detection and user has compared the performance of GC Scheme against MIMO-IDMA schemes employing the Alamouti code and V BLAST. As shown in figure(3) authors have shown that GC-IDMA outperforms Alamouti and V-BLAST IDMA at moderate and high SNR levels For BER of 10−5 or less, the Eb/N0 requirement for the Golden code is 1.5dB less than the Alamouti code and 1dB[9].

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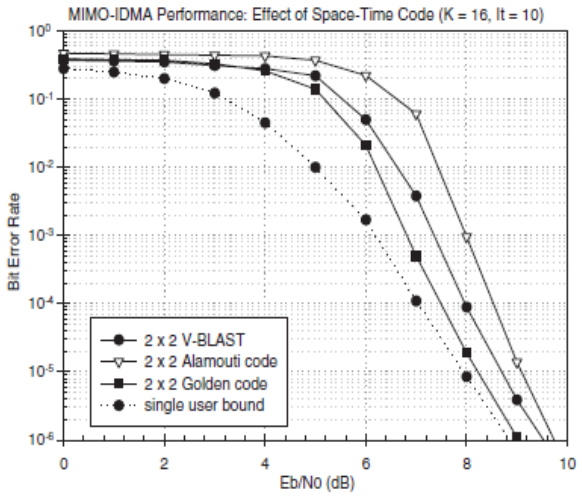

Fig.3 Alamouti-, V-BLAST- and GC-IDMA Performance [9]

K.S.Vishvaksenan et al. has proposed Joint VBLAST/STBC assisted MIMO MC-IDMA System in Frequency Selective Channels. In this paper authors have compare the performance of the considered system with double space-time transmit diversity (DSTTD) aided MC-IDMA system with using ZF-OSIC detection technique at the receiver side is to mitigate MAl and MSI in the context of the considered joint VBALST/STBC MC-IDMA system. As shown in figure(4) authors have shown that coded MC IDMA system with joint VBLAST/STBC processing is capable of achieving better bit error rate (BER) as compared to DSTTD system when employed with ZF-OSIC[14]

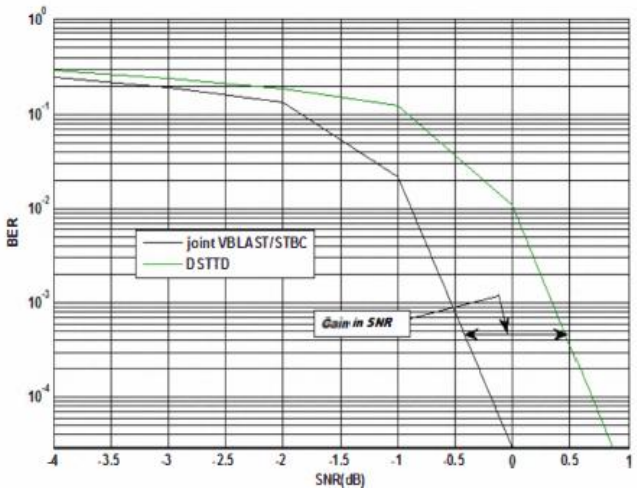

Fig. 4 Comparison of Average Bit error rate (BER) performance of coded joint VBLAST/STBC MIMO MC-IDMA with DSTTD assisted MIMO MCIDMA[14]

In [10] Clemens Novak et al., has proposed MIMO-IDMA: Uplink Multiuser MIMO Communications Using IDMA and Low-Complexity Iterative Receivers. In this they have developed an iterative receiver for MIMO-IDMA that incorporates an efficient soft multiuser detector whose complexity is linear in the number of users. Both flat-fading and frequency-selective MIMO channels are considered.

In [11] Clemens Novak et al., has proposed Low Complexity Factor Graph Receivers for Spectrally efficient MIMO-IDMA. In this the receiver is turbo multiuser receiver based on a factor graph framework and the sum-product algorithm. Gaussian approximations for certain messages propagated through the factor graph lead to a complexity that scales only linearly with the number of users. To further reduce complexity, authors introduce a selective message update scheme.

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V. COMPARISON

Detection Technique	Parameters			
	Number of Transmitter Antenna	Number of Receiver Antenna	Modulation Technique	Advantage
VBLAST ZF/MAP	8	12	16 QAM	Performance improvement in form of SER compared to ordinary VBLAST/ ZF detector. Eb/N0 ranges between -10 dB and 4 dB.
VBLAST/LLSE/MAP	8	12	16 QAM	VBLAST/LLSE/MAP multiuser detector is Better compare to ZF, LLSE, and VBLAST/ZF/MAP in terms of SER performance.
VBLAST/ZF/OSIC	2	2	BPSK	Very low receiver complexity, under different channel condition results in better BER and interference suppression than MIMO/CDMA.
VBLAST MMSE/OSIC	2	2	BPSK	Can mitigate multi-user interference and inter antenna interference with less detection complexity and results is in terms of better BER compared to MIMO IDMA with ZF
STBC,VBLAST AND GODLEN CODE	2	2	QPSK	For bit error rate of 10−5 or less, the Eb/N0 requirement for the GC-IDMA is 1dB less than the Alamouti-IDMA and V-BLAST-IDMA.
JOINT VBLAST/STBC WITH ZF-OSIC	4	2,3	BPSK	System with joint VBLAST/STBC processing can result in higher capacity when employed with ZF-OSIC by mitigating, the effects of MAl and MSI.

VI. CONCLUSION

The MIMO technique, utilized at the transmitter and receiver of a communication system, helps to achieve a very high spectral efficiency and high channel capacity. Thus, the implementation of system by using space diversity concept in the wireless system will assure a high data rate and link reliability. The paper reviewed MIMO-IDMA system performance on various available multi-user detection techniques.

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