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PERFORMANCE IMPROVEMENT OF QAM BASED WIRELESS COMMUNICATION SYSTEM USING OSTBC

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ABSTRACT

Wireless communication system is rapidly enhancing using various techniques by many researcher & to meet the requirement of accurate and fast data communication in fading environment. The MIMO technique plays an important role in this direction. It allows upto provide higher order modulation for maintaining the errors in limits. This paper describes one of the MIMO techniques namely orthogonal space time block code. This technique improves the BER of the QAM-16,QAM-32 and QAM-64 based communication in Rayleigh fading environment. The result shows an improvement in the BER.

KEYWORDS: MIMO –OFDM, STBC, OSTBC, QAM, etc.

INTRODUCTION

Wireless communication is one of the most vivacious areas in the communication field now a day. Although the development in this area was started way back in 1960s, but a lot of research is done in this area in last decade. The reason for this is due to a variety of factors . The demand for seem-less connectivity has risen manifolds, mainly due to cellular telephony but expected to be soon eclipsed by wireless data applications.The sophisticated signal processing algorithms can be implemented with the advent of VLSI technology. Due to the success of 2G wireless standards especially CDMA it has been shown that communication ideas can be implemented in practice. The research push in the past decade has led to a much better-off set of perspectives and tools on how to communicate over wireless channels, and the scenario is still very much in the emerging stage.There are two fundamental aspects of wireless communication that make the problem demanding and motivating as compared to wire line communication system. First is the phenomenon of fading: the time variation of the channel strengths due to the small-scale effect of multipath desertion, as well as larger-scale effects such as path loss via distance attenuation and shadowing by obstacles. next, unlike in the wired world where each transmitter–receiver pair can often be thought of as an isolated point-to-point connection, wireless users communicate over the air and there is significant interference between them. sgnals from a single transmitter to multiple receivers, or between different transmitter–receiver pairs (e.g., interference between users in different cells).

OFDM has become a popular technique for transmission of signals over wireless channels [1]. OFDM has been adopted in several wireless standards such as digital audio broadcasting (DAB), digital video broadcasting (DVB-T), the IEEE 802.11a [2] LAN standard and the IEEE 802.16a MAN standard. OFDM is also being pursued for dedicated short-range communications (DSRC) for road side to vehicle communications and as a potential candidate for fourth- generation (4G) mobile wireless systems.OFDM has many advantages compared with other transmission techniques. One of such advantages is high spectral efficiency (measured in bits/sec/Hz). The orthogonal in OFDM implies a precise mathematical relationship between the frequencies of the sub channels that use in the OFDM system. Each one of the frequencies is an integer multiple of a fundamental frequency. This ensures that a sub channel does not interfere with other sub channels even though the sub channels overlap. This results in high spectral efficiency.

The first aims to improve the power efficiency by maximizing spatial. Such techniques include delay diversity [3], STBC and STTC, The second class uses a layered approach to increase capacity. One popular example of such a system is V-BLAST suggested by Foschini et al. [6] where full spatial diversity is

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usually not achieve. Finally, the third type exploits the knowledge of channel at the transmitter system. It decomposes the channel coefficient matrix using SVD and uses these decomposed unitary matrices as pre- and post-filters at the transmitter and the receiver to achieve near capacity [7].

LITERATURE SURVEY

Paper [10] introduced a new generation of IEEE 802.11n wireless network standard. The objective is to obtain numerical values for various measures of networking performance of IEEE 802.11n. The initial approach was to investigate the abilities of IEEE 802.11n standard to model a transmitter and receiver that communicated over a user defined channel. Simulation of single OFDM symbol SISO system followed by MIMO is presented. Also, the performance of the system using MATLAB built in BER tool in both SISO and MIMO Techniques is tested. Different Variation in BER on varying Parameters like Delay and K factor are carried out in the work.

The paper [11] gives an idea about the theoretical framework for the analysis of code diversity. It can be applied to an arbitrary space–time code, but the value of code diversity will depend on the particular choice of code. It is also shown that it not only improves the diversity and coding.Advantages for general space time codes but also enables optimal decoding performance with Low complexity decoding and only a small number of feedback bits. The method of code diversity also reduces the capacity loss associated with some forms of space–time coding. The code diversity scheme presented here is more robust than other low-rate feedback schemes such as transmit antenna selection and its variations. A new family of full-rate circulate codes are introduced and the advantage of suboptimal linear decoding in combination with code diversity is also demonstrated. A bit and power allocation strategy for AMC based spatial multiplexing MIMO-OFDM systems is explained in [12]. This strategy aims to maximize the average system through put by allocating the available resources optimally among the utilized bands depending on the corresponding channel conditions and the total transmission power constraints. The average system through put is represented as a trade-off criterion between the spectral efficiency and BER. The considered AMC technique utilizes distinct modulation and coding scheme (MCS) options rather than adopting fixed or encoded approaches. The transmitter divides the OFDM frame at each transmit antenna into bands depending on the number of active users in an assigned base station (BS). The simulation results show superior performance of the MIMO-AMC-OFDM system, which adopts the proposed strategy, over other conventional schemes.

A channel estimation method for STBC - OFDM is investigated in [13] for Mobile Wi-Max systems. A new channel estimation approach is proposed using the dedicated pilot subcarriers defined at constant intervals by the Wi-Max standard. The estimation method has low computation as only linear operations are needed due to orthogonal pilot coding. The performances of the proposed method have been demonstrated by extensive computer simulations. For the OFDM system with two transmit antennas and one to four receive antennas and using QPSK modulation, the simulated results under different Stanford University Interim (SUI) channels show that the proposed method has only a 4dB loss compared to the ideal case where the channel is known at the receiver.

One of the research focuses on the performance of a LTE system with two transmit-antennas and two receive antennas in a frequency selective fading environment. 4G wireless systems predominately employ MIMO with an OFDM system. Like other 4G systems LTE also employs MIMO-OFDM physical layer. MIMO helps in increasing the through put whereas OFDM converts a frequency selective fading channel to multiple flat fading sub-channels facilitating easy equalization. It is proposed that LTE system should mandatorily support 2x2 MIMO setup. The performance of the MIMO system is better than that of a single antenna based system either in terms of performance (diversity) or through put as in the case of transmit diversity or spatial multiplexing respectively.

A novel analytical method for BER and FER estimation of bit-loaded coded MIMO-OFDM systems operating over frequency-selective quasi-static channels with non-ideal interleaving is developed later. The presented numerical results illustrate that the proposed analysis technique provides an accurate estimation of the BER of loaded BICM-MIMO-OFDM systems. This allows the system performance analysis without resorting to lengthy simulations. In the case of bit loading, the relative performance of bit-loading algorithms for coded OFDM is system dependent, and thus, some care should be given to the selection of loading algorithms for coded OFDM systems. The proposed SL (Selected Loading) algorithm guarantees the best performance, at a cost of somewhat higher

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complexity, when performing loading. Adaptive interleaving has been confirmed to be an interesting alternative and addition to bit loading in coded OFDM.

ORTHOGONAL SPACE TIME BLOCK CODE

The transmit diversity scheme designed by Alamouti can be used only in a system with two transmit antennas. It turns out that this technique belongs to a general class of codes named Space–Time Block Codes or, more precisely, Orthogonal STBCs, since they are based on the theory of orthogonal designs. The authors of [4] introduced the theory of generalized orthogonal designs in order to create codes for an arbitrary number of transmit antennas.

The general idea behind STBCs construction is based on finding coding matrices X that can satisfy the following condition,

$$X.XH = p.\left(\sum_{i=1}^{n} |x_i| 2\right).InT \quad - (1)$$

In this equation, XH is the Hermitian of X, p is a constant, InT is the identity matrix of size nT × nT, nT represents the number of transmit antennas, and n is the number of symbols xi transmitted per transmission block in X. The generalized theory of orthogonal design is exploited to provide codes that satisfy Equation 1.

The orthogonal property of STBCs is reflected in the fact that all rows of X are orthogonal to each other. In other words, the sequences transmitted from two different antenna elements are orthogonal to each other for each transmission block. For real signal, it is possible to reach full rate. However, it has been proven in [4] that this statement is false for two-dimensional constellations, i.e., complex signals. The encoding and decoding approaches follow the pattern described in Alamouti's scheme.For complex signals, the theory of orthogonal designs can be used to generate coding matrices that achieve a transmission rate of 1/2 for the cases of 3 and 4 transmission antennas.

$$X_{1/2} = \begin{bmatrix} x_1 & -x_2 & -x_3 & -x_4 & x_1^* & -x_2^* & x_3^* & -x_4^* \\ x_2 & x_1 & x_4 & -x_3 & x_2^* & x_1^* & x_4^* & -x_3^* \\ x_3 & -x_4 & x_1 & x_2 & x_3^* & -x_4^* & x_1^* & x_2^* \end{bmatrix}$$

$$X_{1/2} = \begin{bmatrix} x_1 & -x_2 & -x_3 & -x_4 & x_1^* & -x_2^* & -x_3^* & -x_4^* \\ x_2 & x_1 & x_4 & -x_3 & x_2^* & x_1^* & x_4^* & -x_3^* \\ x_3 & -x_4 & x_1 & x_2 & x_3^* & -x_4^* & x_1^* & x_2^* \\ x_4 & x_3 & -x_2 & x_1 & x_4^* & x_3^* & -x_2^* & x_1^* \end{bmatrix}$$

Using the theory of orthogonal design to construct STBCs is not necessarily the optimal approach. There exist some sporadic STBCs mentioned in the literature, that can provide a transmission rate of 3/4 for schemes of either 3 or 4 transmit antennas.

$$X_{3/4} = \begin{bmatrix} x_1 & -x_2^* & x_3^* & 0 \\ x_2 & x_1^* & 0 & -x_3^* \\ x_3 & 0 & -x_1^* & x_2^* \end{bmatrix}$$

$$X_{3/4} = \begin{bmatrix} x_1 & 0 & x_2 & -x_3 \\ 0 & x_1 & x_3^* & x_2^* \\ -x_2^* & -x_3 & x_1^* & 0 \\ x_3^* & -x_2 & 0 & x_1^* \end{bmatrix}$$

It is important to notice that the channel coefficients must remain constant during the transmission of a block of coded symbols X. The decoding of the STBCs described above can be easily deduced from the encoding matrix. Let us assume that we wish to estimate symbols xp and that we have defined by the received signal from antenna j at time instance k. It is important to remember that STBCs based on orthogonal design do not achieve a rate of 1 for complex signal constellations.

METHODOLOGY

The QAM based wireless communication simulation scheme including OSTBC has been given in the figure 1.

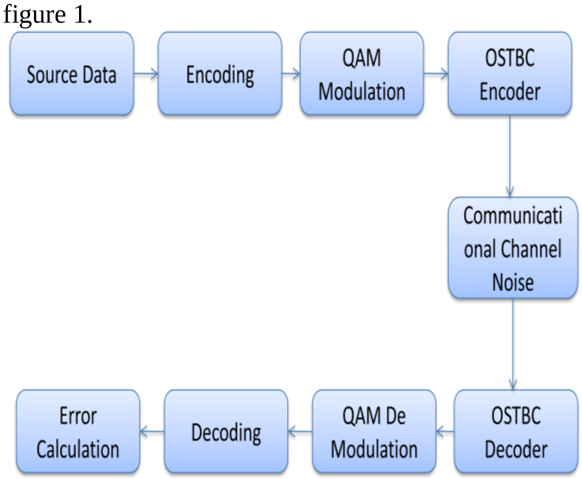

Fig: 1 Block diagram of the communication system

The random data for the communication has been used for the simulation. The Quadrature Amplitude modulation scheme has been used as digital modulation. The random data is genrated and modulated for the communication. Before the transmission the modulated data is encoded using the OSTBC encoder. Then it is passed through the Rayleigh fading channel and white Gaussian noise has been added to simulate the AWGN channel. The zero forcing equalizer has been used at the receiver for the equalization and then it is decoded using OSTBC decoder. The data is demodulated and error is calculated for performance analysis.

RESULTS AND DISCUSSION

System description

The simulation parameter is given in the table below .

Table: 1Simulation Parameter

S. No.	Parameter	Value
1	Input data size	3000 bits
2	Modulation type	QAM-16, QAM-32and QAM -64
3.	MIMO technique	OSTBC
4.	Encoder Rate	¾
5.	No. of antenna	4

The Simulation result in term of BER is shown below for QAM-1 , QAM-32 and QAM-64.

A. BER performance for QAM-16,QAM-32 and QAM-32 which transmit the bit 4 to 5 time faster than BPSK system has been simulated and result is shown in Fig 2.

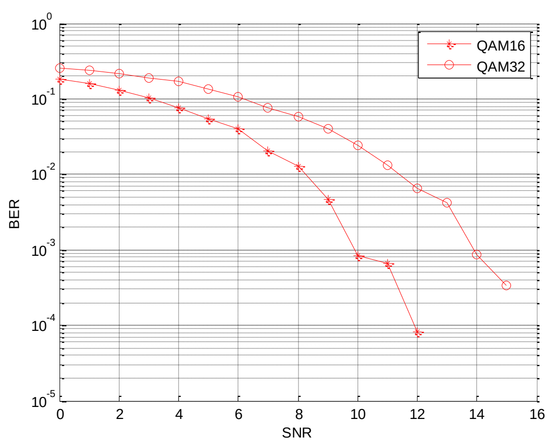

Fig: 2 BER curve for 3 antenna OSTBC encoding with zero forcing equalization

B. BER performance for OSTBC for 4 antenna:

The BER performance for QAM-16, QAM-32 and QAM-64 further improve adding 1 more antenna. The improvement can be seen clearly from Fig 2 as compare to Fig 3.

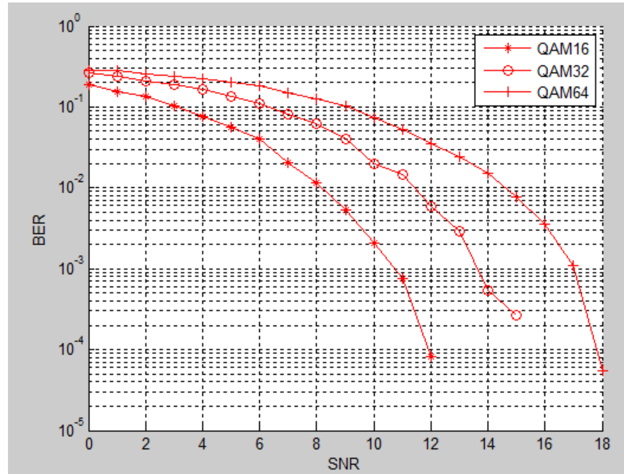

Fig: 3 BER curve for 4 antenna OSTBC encoding with zero forcing equalization

CONCLUSION

The BER performance for QAM-16,QAM-32 and QAM-64 further has been simulated and improvement with the OSTBC is clearly seen by adding one more antenna. With QAM-32 and QAM-64,1 db .SNR gain has been obtained with one more antenna

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