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Performance Evaluation of Various Channel Coding Techniques for Mimo-Ofdm

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Abstract

In wireless communication, the BER performance is affected by channel noise, synchronization error, distortion and wireless fading channel. The Multiple-input and multiple-output (MIMO) is the use of multiple antennas in wireless communication to improve BER performance. In this paper, work has been performed channel coding techniques for MIMO-OFDM(Multiple Input Multiple Output-OrthogonalFrequency Division Multiplexing). The using different modulation (M-QAM) and AWGN channels. The results has been shown in the paper for the simulation in various condition.

Keywords: MIMO (Multiple-Input Multiple-Output), OFDM, M-QAM (Multilevel quadrature amplitude modulation) , AWGN, 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, a lot of research is done in this area in last decade. The reason for this is due to a variety of factors discussed.

OFDM has become a popular technique for transmission of signals over wireless channels. A OFDM has been adopted in several wireless standards such as digital audio broadcasting (DAB), digital video broadcasting (DVB-T), the IEEE 802.11a LAN standard and the IEEE 802.16a [2] 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 fourthgeneration (4G) mobile wireless systems. In OFDM converts a frequency-selective channel into a parallel collection of frequency flat sub-channels. In the subcarriers have the minimum frequency separation required to maintain orthogonally of their corresponding time domain waveforms, and yet the signal spectra corresponding to the different subcarriers overlap in frequency. In available bandwidth is used very efficiently. The channel is available at the transmitter, an then the OFDM transmitter can adapt its signaling strategy to match the channel. An Due to the fact that OFDM uses a large collection of narrowly spaced sub-channels, this adaptive strategies can approach the ideal water pouring capacity of a frequency-selective channels. In practice this is achieved by using adaptive bit loading, where different sized signal constellations are transmitted on the subcarriers.

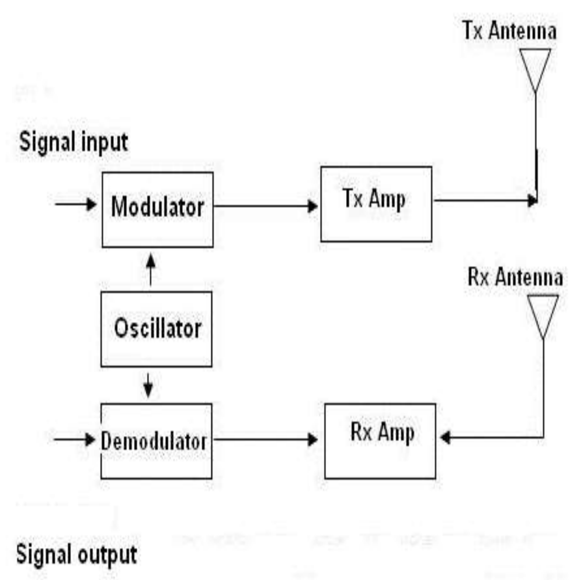

Fig: 1 wireless communication

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Basic OFDM System

Multicarrier transmission, also known as OFDM is a technique with a long history back to 1960that has recently seen rising popularity in wireless and wire line applications. In the recent interest in this technique is mainly due to the recent advances in digital signal processing. International standards making use of OFDM for high-speed wireless communications are already established or being established by IEEE 802.11, IEEE, 802.16, IEEE 802.20 and ETSIBRAN committees. For wireless applications, an OFDM-based system can be of interest because it provides greater immunity to multipath fading and impulse noise error, and eliminates the need for equalizer, while efficient hardware implementation can be realized using FFT techniques.

OFDM is a multi-carrier modulation technique where data symbols modulate a parallel collection of regularly space. The sub-carriers have the minimum frequency separation required to maintain orthogonally of their corresponding time domain waveforms, for yet the signal spectra corresponding to the different sub-carriers overlap in frequency. In spectral overlap results in a waveform that uses the available bandwidth with very high bandwidth efficiency.

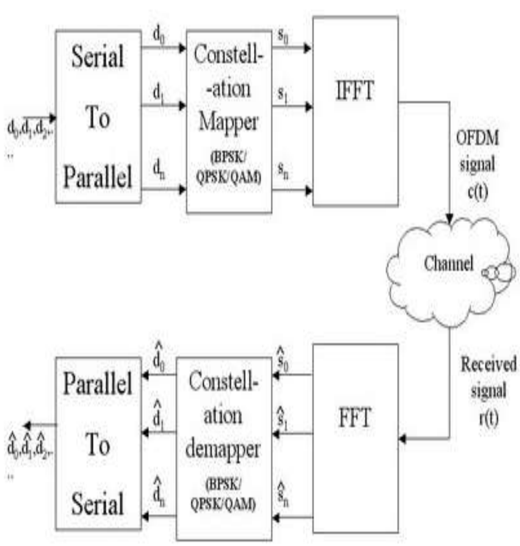

Fig: 2 Block diagram of OFDMsystem

OFDM is simple to use on channels that exhibit time delay spread or, frequency selectivity, equivalently. The Frequency selective channels are characterized by either their delay spread or their channel coherence bandwidth which measures the channel de-correlation in frequency. The coherence bandwidth is inversely proportional to the root-mean-square (rms) delay spread.

Multiple-Input-Multiple-Output (MIMO)

Multi-antenna systems can be classified into three main categories. Multiple antennas at thetransmitter side are usually applicable for beam forming purposes. Its transmitter or receiver side multiple antennas for realizing different (frequency, space) diversity schemes. The third class includes systems with multiple transmitter and receiver antennas realizing spatial multiplexing (often referred as MIMO by itself).

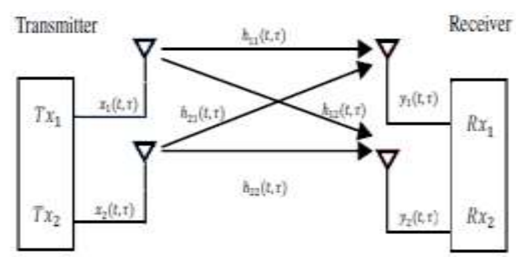

Fig: 3Block diagram of MIMO system

In radio communications MIMO means multiple antennas both on transmitter and receiver side of a specific radio link. The case of spatial multiplexing different data symbols are transmitted on the radio link by different antennas on the same frequency within the same time interval. In Multipath propagation is assumed in order to ensure the correct operation of spatial multiplexing modle, since MIMO is performing better in terms of channel capacity in a rich scatter multipath environment than in case of environment.

MIMO with Alamouti Space Time Coding

Historically, the transmit diversity technique proposed by Alamouti was the first STBC. The encoding and decoding operation is carried out in sets of two modulated symbols. Hence, the information data bits are first modulated and mapped into their corresponding constellation points. Therefore, let us denote by x1 and x2 the two modulated symbols that

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enter the space–time encoder. Are usually, in systems with only one transmit antenna, these two symbols are transmitted at two consecutive time instances t1 and t2. Its times t1 and t2 are separated by a constant time duration T. In the Alamouti scheme, during the first time instance, the symbol x1 and x2 are transmitted by the first and the second antenna element, respectively. During the second time instance t2, the negative of the conjugate of the second symbol, i.e., –x2*, is sent to the first antenna while the conjugate of the first constellation point, i.e., x1*, is transmitted from the second antenna. The encoding operation is described. The transmission rate is equal to the transmission rate of a SISO. The space–time encoding mapping of Alamouti's two-two-branch transmits diversity technique can be represented by the coding matrix:

$$X_1 = \begin{bmatrix} x_1 & -x_2^* \\ x_2 & x_1^* \end{bmatrix} \qquad (1)$$

In the coding matrix X1, the subscript index gives the transmit rate compared to a SISO system. For Alamouti's scheme, the transmission rate is 1. The rows of the coding matrix represent the transmit antennas while its columns correspond to different time instances.

It is clear that the encoding is done in both the space and time domains are Let us denote the transmit sequence from antennas one and two byx^1 andx^2 , respectively.

$$x^{t1} = [\,x_1, -x*_2] \qquad (2)$$

$$x^{t2} = [\,x_2, x*_1] \qquad (3)$$

The key feature of the Alamouti scheme is that the transmit sequences from the two transmitantennas are orthogonal, since the inner product of the sequencesx^1 andx^2 is zero, i.e.

$$x^{t1} . x^{t2} = x_1 x*_2 - x*_2\, x_1 \quad (4)$$

The code matrix has the following different property

$$X . X^H = [\begin{matrix} |x_1|^2 + |x_2|^2 & 0 \\ 0 & |x_1|^2 + |x_2|^2 \end{matrix}]$$

$$= (|x_1|^2 + |x_2|^2)\, I_2 \qquad (5)$$

Where$I_2$is a2 X 2 identity matrix

At the receive antenna, the received signals over two consecutive symbol periods, denoted byr_1

$$r_1 = h_1 x_1 + h_2 x_2 + n_1 \qquad (6)$$

$$r_2 = -h_1 x*_1 + h_2 x*_2 + n_2 \qquad (7)$$

Wheren_1 and$n_2$are independent complex variables with zero mean and power spectral density$N0/2$ per dimension, representing additive white Gaussian noise samples at time t and $t + T$, respectively.

Additive white Gaussian noise (AWGN)

Additive White Gaussian Noise (AWGN) is common to every communication channels, which is the statistically random radio noise characterized by a wide frequency range with regards to a signal in the communications channel.

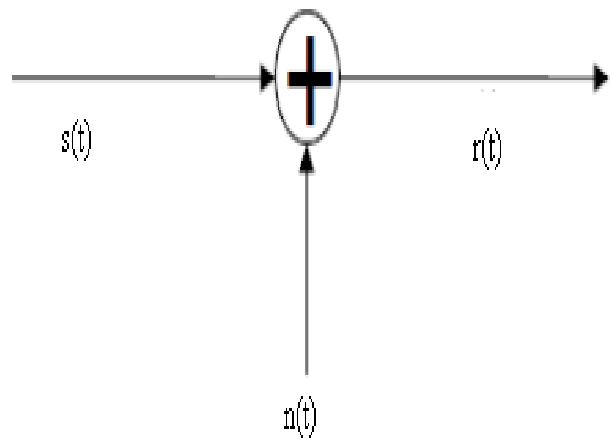

Fig:4 AWGN

I use MATLAB tools to generate both data and noise sequence and add them together, as recover signal from noisy received data and calculate noise power, calculate SNR and BER and then plot them with different SNR values.

A basic and generally accepted model for thermal noise in communication channels, if the set of assumptions that

- The noise is additive, i.e., the received signal equals the transmit signal plus some noise, and where the noise is statistically independent of the signal.
- The noise is white, i.e., the power spectral density is flat signals, so the autocorrelation

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of the noise in time domain is zero for any non-zero time offset.

- The noise samples have a Gaussian nosie distribution.

Mathematically, thermal noise is described by a zero-mean Gaussian random process where the random signal is a sum of Gaussian noise random variable and a dc signal that is

$z=a+n$

Where the pdf for Gaussian noise can be represented as follows where σ2 is the variance of n.

$$p(z) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left[-\frac{1}{2}\left\{\frac{z-a}{\sigma}\right\}^2\right] \quad (8)$$

Results

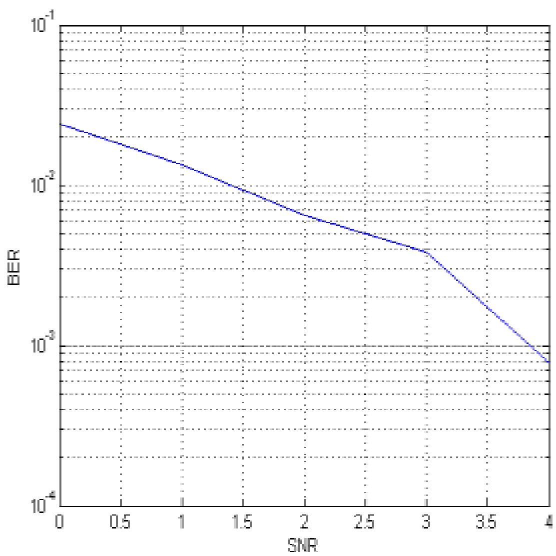
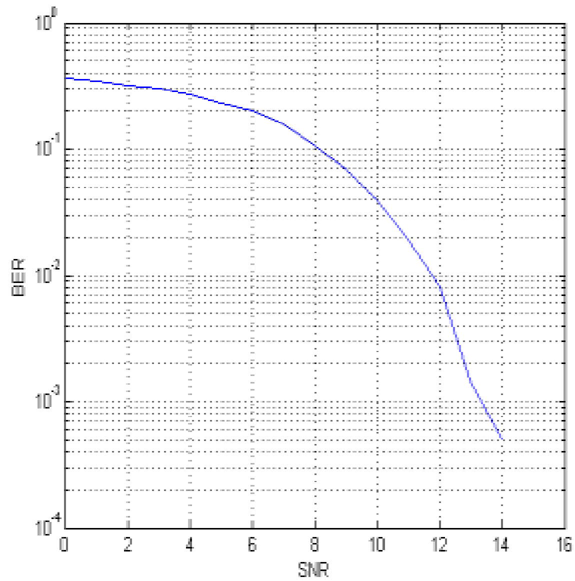


Fig: 5Performance of PSK for compares SNR Vs BER



Fie: 6 Performance QAM for compare SNR Vs BER

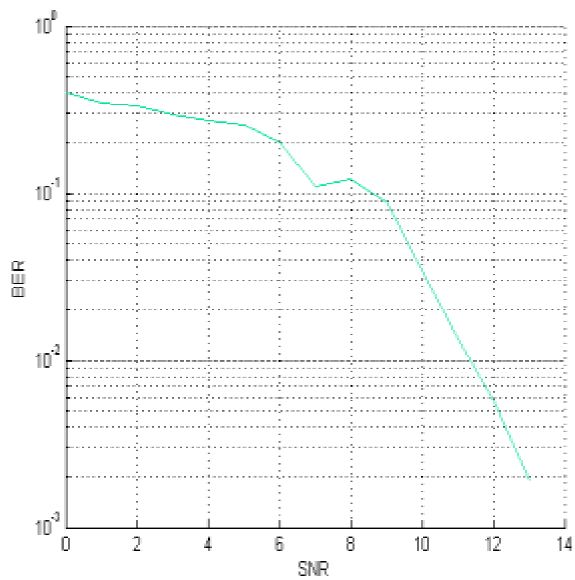


Fig:7 Performance SNR Vs BER using OFDM-MIMO

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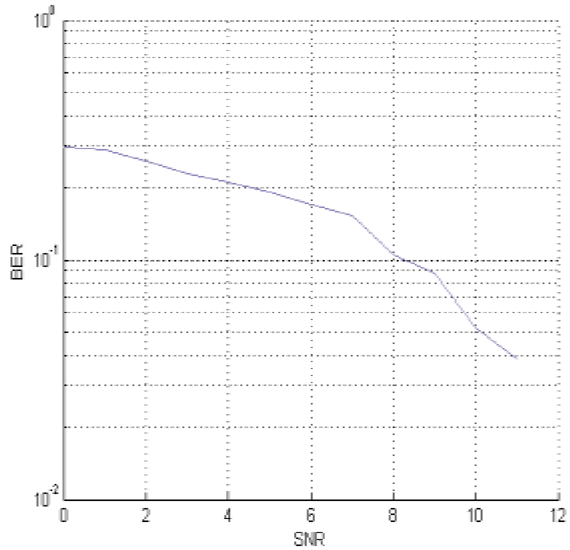

Fig:8 Performance SNR Vs BER using RS code

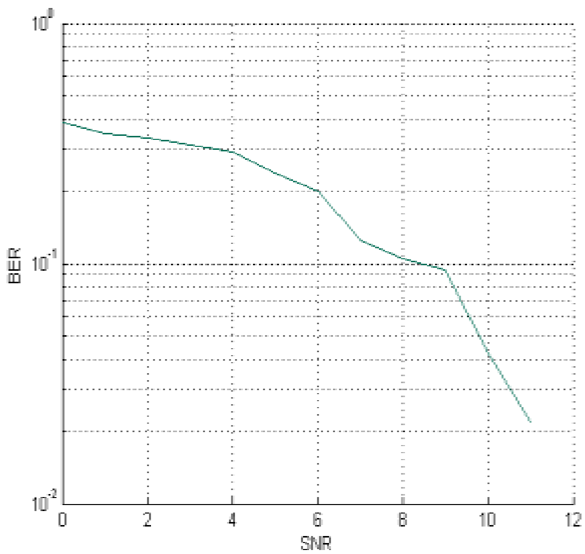

Fig:9 Performance SNR Vs BER using rs and convolution concatenation code

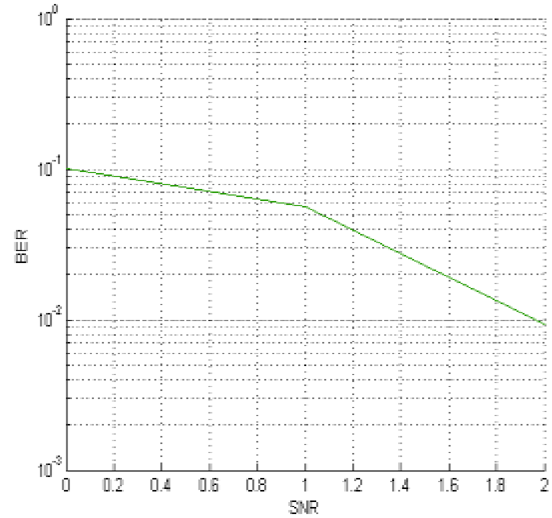

Fig:10 Performance of SNR Vs BER using turbo code

Conclusion

The MIMO-OFDM system simulation setup with Alamouti scheme has been developed. So channel capacity optimization is necessary to improve the performance of MIMO-OFDM System. It is found that with increase of modulation order the capacity enhancement is compare to BER and SNR.

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