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Comparative Analysis Between BPSK and QPSK Modulation Technique Based on BER Analysis using V-BLAST Based MMSE Technique

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Abstract: The rich-scattering wireless channel is capable of huge theoretical capacities. The multiple input multiple output (MIMO) antenna system provides very promising gain in capacity without increasing the use of frequency spectrum, throughput, and power consumption in wireless communication. This also shows less sensitivity to fading, hence it leads to a breakthrough in the data rate of wireless communication systems. There are many schemes that can be used to MIMO systems such as space-time block code, space-time trellis code, and the Vertical Bell Labs Space-Time Architecture (V-BLAST). The V-BLAST is an ordered successive cancellation method applied to receiver and at every stage the stream with the highest SNR is decoded. In this proposes paper the analysis and performance of general MIMO system V-BLAST architecture with MMSE technique is used for linear detectors in fading channels with different antenna selections and digital modulation methods. In this proposed paper a comparative analysis between bpsk and qpsk modulation technique is given.

Keywords: MIMO, SIC, V-BLAST, MMSE.

Introduction: Wireless communications is an important part of the telecommunications industry. It is easily the fastest growing part of the telecommunications industry. The available resources are limited and therefore maximizing how we use it is a very attractive research area. The advent of multiple input, multiple output (MIMO) antennas has had a major influence on how the current capacity limits of single antenna systems could be increased without the need of overwhelming computational difficulty[2]. MIMO system is having enhanced capacity and can be used in combination with multi-user techniques to improve system throughput.

There is a growing amount of end-users in the wireless spectrum which has led to a need for improved bandwidth usage and the BER values. Means new technologies which would be able to increase the capacity of wireless systems are proving to be a crucial point of research in these modern times[3]. Hence, the focus of the research was to examine, identify and establish a detector capable of delivering rates required by the demand of the end users in modern day telecommunication systems.

Multiuser detection (MUD) is a technique that has been widely accepted in current telecommunications technologies as the demand from the end user increases. It enables the multiple users to share the same wireless communications channel and therefore increasing overall system capacity. Essentially, MUD can be imagined as one of the most important breakthroughs achieved in wireless telecommunication technology. The demand caused by the end user led to a lot of users operating within the same frequency allocation as seen in the 3G mobile broadcast cells although they do so at different time intervals[5]. The advent of increased users caused the introduction of multiple access interference (MAI) in mobile wireless communication systems. MAI is caused by interference among the existing multiple users allotted to the same frequency range. MAI takes place when these users access the allotted frequency band at the same time. In spirit, although several users can transmit at the same frequency, MAI would be present provided two or more users are transmitting at the same time. Multiuser detection (MUD) techniques aim to remove the effect of MAI from the wireless system [1].

BER Analysis in BPSK Modulated Transmission: The various modulation techniques like BPSK modulation and QPSK modulation can be utilize for BER analysis at receiving end in communication channel. In Phase Shift Keying technique, the phase of the carrier is changed according to input the data signal. The phase of the modulated signal itself conveys some information in this case the demodulator must have a reference signal to compare the received signal phase. This is termed as coherent detection BPSK is the simplest form of phase shift keying (PSK). It uses two phases which are 0° and 180°[4].

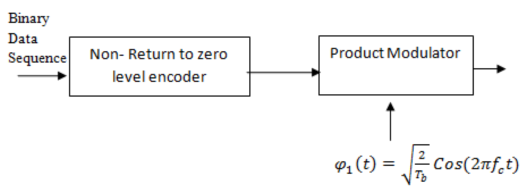

Fig.1

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To generate a binary PSK signal, we have to represent the binary sequence in polar form with symbols 1 and 0 represented by constant amplitude levels of $+\sqrt{E_b}$ and $-\sqrt{E_b}$ respectively. The resulting binary wave (in polar form) and a sinusoidal carrier φ_1 (t), whose frequency $f_c = (n_c / T_b)$ for some fixed integer n_c are applied to a product modulator. The carrier and the timing pulses used to generate the binary wave are usually extracted from a common master clock; the desired PSK wave is obtained at the modulator output.

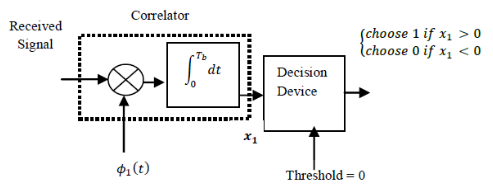

Fig.2

To detect the original binary sequence of 1s and 0s, we apply the noisy PSK signal x(t) (at the channel output) to a correlator, which is supplied with a locally generated coherent reference signal φ_1 (t), The correlator output x_1 is compared with a threshold of zero volts. If $x_1>0$ the receiver decides towards symbol 1. On the other hand, if $x_1<0$, it decides in the side of symbol 0. If x_1 is exactly zero, the receiver makes a random guess in favor of 0 or 1.

A. Implementation

In coherent binary PSK system, the pair of signals $s_1(t)$ and $s_2(t)$ used to represent binary symbols 1 and 0, respectively. They are defined by

$$S_1(t) = \sqrt{\frac{2E_b}{T_b}} Cos(2\pi f_c t + \pi)$$

$$= -\sqrt{\frac{2E_b}{T_b}} Cos(2\pi f_c t) \quad for\ binary\ 1$$

Where $0 \le t \le T_b$, and E_b is transmitted signal energy per bit where f_c is the frequency of the carrier wave. A pair of sinusoidal waves that differ only in a relative phase shift of 180 degree, these are referred to as antipodal signals. Hence, the signal space can be represented by the single basis function.

$$\varphi_1(t) = \sqrt{\frac{2}{T_b}} Cos(2\pi f_c t)\ where\ 0 \le t < T_b$$

Where 1 is represented by $\sqrt{E_b}\ \varphi_1(t)$ and 0 is represented by $-\sqrt{E_b}\ \varphi_1(t)$

B. Bit error rate

The value of bit error rate for coherent binary Phase shift keying is given by

$$P_e = erfc(\sqrt{\frac{E_b}{N_o}})$$

As we boost the transmitted signal per energy bit, E_b, for a specified noise spectral density N_0, the message points corresponding to symbols 1 and 0 move further apart, and the average probability of error P_e is correspondingly reduced in accordance with the above equation.

BER Analysis in QPSK Modulated Transmission: In proposed analysis BER calculation in AWGN channel using qpsk modulation been discussed.

To generate a QPSK signal, we have to represent the binary sequence in polar form with symbols 00, 01, 10 and 11 represented by constant amplitude levels of $-j\sqrt{E_b}$, $j\sqrt{E_b}$ and $-\sqrt{E_b}, \sqrt{E_b}$ respectively.

The resulting binary wave (in polar form) and a sinusoidal carrier φ_1 (t), whose frequency $f_c = (n_c /T_b)$ for some fixed integer n_c are applied to a product modulator.

The carrier and the timing pulses used to generate the binary wave are usually extracted from a common master clock; the desired PSK wave is obtained at the modulator output.

To detect the original binary sequence of 00, 01, 10 and 11, we apply the noisy PSK signal x(t) (at the channel output) to a correlator, which is supplied with a locally generated coherent reference signal φ_1 (t), The correlator output x_1 is compared with a threshold of zero volts.

If amplitude of real and imaginary both part of x_1 <0 the receiver decides in favor of symbol 0,0. If real value >0 but magnitude of imaginary value<0 than the receiver decides in favor of symbol 1,0 and for real value<0 and imaginary>0 than the receiver decides in favor of symbol 0,1 and if both are higher than one than receiver decides in favor of symbol 1,1.

Simulated Results & Comparative Analysis

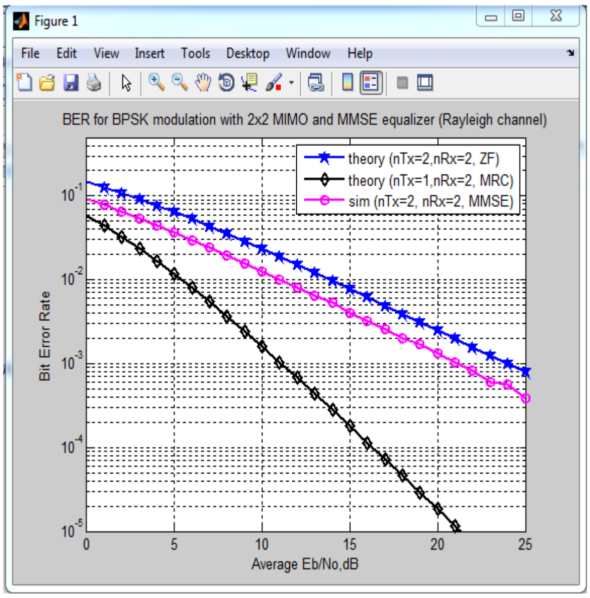

Fig.3 BER analysis using BPSK Modulation

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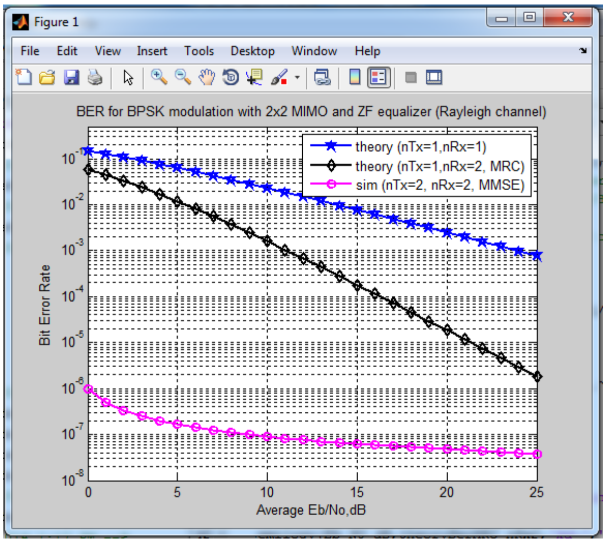

Fig.4 BER analysis using QPSK Modulation

CONCLUSION

From the comparative analysis given in this paper it can be conclude that by applying QPSK modulation technique at the place a tremendous improvement in the BER can be achieve over BPSK Modulation. A approximately constant BER achieved for values of E_b/N_o between 0 to25 is below than 10^{-6} and upto 10^{-7}.

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