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Transmit Diversity Scheme for Alamouti Space Time Block Codes

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Abstract – **Multiple Input, Multiple Output (MIMO) technology is a wireless technology that uses multiple transmitters and receivers to transfer more data at the same time. In order to utilize the huge potential of multiple antenna concepts, it is necessary to resort to new transmit strategies, referred to as Space-Time Codes, which, in addition to the time and spectral domain, also use the spatial domain. This paper shows a novel transmit diversity scheme for Alamouti space time block codes.**

Keywords – **MIMO, Alamouti, STBC.**

I. Introduction

Wireless communication systems have traditionally used a single antenna for transmission and a single antenna for reception. These systems are known as single input single output or SISO systems. In recent years however, significant progress has been made in the area of developing systems that use multiple antennas at the transmitter and receiver to achieve better performance. Such usage can be viewed as an extension of the very popular ‘smart antennas’ technology. Systems employing such technologies are known as multiple input multiple output or MIMO systems.

MIMO concepts have been under development for many years for both wireless and wire-line systems. One of the earliest MIMO-to-wireless communications applications came in 1984 with ground breaking developments by Jack Winters of Bell Laboratories. This MIMO pioneer described ways of sending data from multiple users on the same frequency / time channel using multiple antennas at the transmitter and receiver. Since then, several academics and engineers have made significant contributions in the field of MIMO.

In present scenario MIMO system has become one of the major focuses in the research community of wireless communication and information theory.

MIMO (multiple inputs, multiple outputs) is an antenna technology for wireless communications in which multiple antennas are used at both the source (transmitter) and the destination (receiver). The antennas at each end of the communications circuit are combined to minimize errors and optimize data speed. MIMO is one of several methods of smart antenna technology, the others being MISO (Multiple input, Single output) and SIMO (Single input, Multiple output). In order to implement MIMO, either the station (mobile device) or the access point (AP) needs to support MIMO.

Types of MIMO

Multi-antenna MIMO (or Single user MIMO) technology has been developed and implemented in some standard, e.g. 802.11n products. There is a number of MIMO configuration or formats that can be used. These are termed SISO, SIMO, MISO and MIMO. These different MIMO formats offer different advantages and disadvantages which can be balanced to provide the optimum solution for any given application.

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1. MIMO

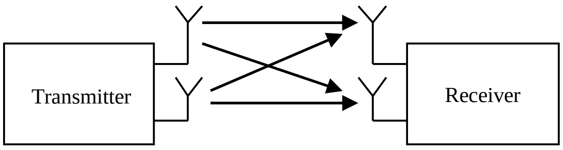

Figure 1: Multiple Inputs Multiple Outputs (2×2)

2. MISO

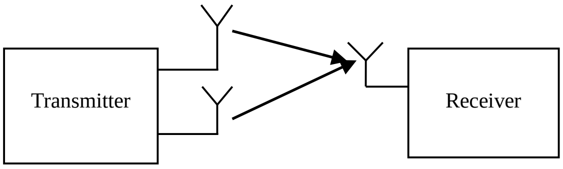

Figure 2: Multiple Inputs Single output (2×1)

3. SIMO

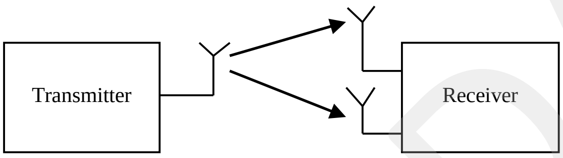

Figure 3: Single Input Multiple Outputs (1×2)

4. SISO

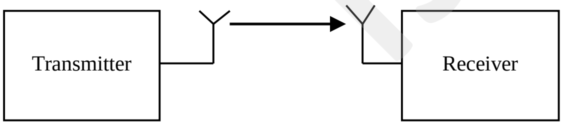

Figure 4: Single Input Single Output (1×1)

Multicarrier Modulation

As it is ineffective to transfer a high rate data stream through a channel, the signal is split to give a number of signals over that frequency range. Each of these signals are individually modulated and transmitted over the channel. At the receiver end, these signals are fed to a de–multiplexer where it is demodulated and re – combined to obtain the original signal. This process is called as multicarrier modulation.

OFDM

OFDM is one of the many multicarrier modulation techniques that provides greater spectral efficiency, low implementation complexity, less susceptibility to echoes and non – linear distortion. Owing these advantages of the OFDM system, it is massively used in several communication systems.

OFDM is a special form of multicarrier modulation which is particularly suited for transmission over a dispersive channel. Here the different carriers are orthogonal to each other, that is, they are totally independent of one another. This is achieved by placing the carrier exactly at the nulls in the modulation spectra of each other.

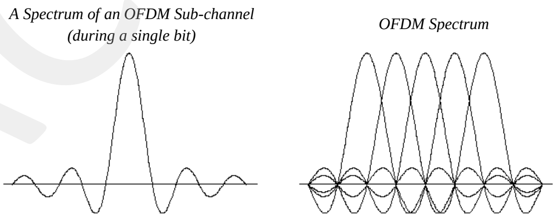

Figure 5: OFDM Spectrum

Fading makes it extremely difficult for the receiver to recover the transmitted signal unless the receiver is provided with some form of diversity, i.e. replicas of the same transmitted signal with uncorrelated attenuation.

Selective Fading Channel

In selective fading, the coherence bandwidth of the channel is smaller than the bandwidth of the signal. Different frequency components of the signal therefore experience uncorrelated fading.

Flat Fading Channel

In flat fading, the coherence bandwidth of the channel is larger than the bandwidth of the signal. Therefore, all frequency components of the signal will experience the same magnitude of fading.

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II. Methodology

Alamouti STBC

MIMO stands for Multiple Input Multiple Output and most often refers to the multiplicity of antennas at the transmitter and the receiver side. There are different schemes of MIMO. We have studied one of these schemes, which is proposed by Siavash M. Alamouti [1]. This scheme has the advantage of achieving a high spatial diversity order in the absence of channel knowledge at the transmitter while keeping the number of receive antennas at the mobile set to a small number. We have concentrated on a two transmitters and two receiver's configuration scheme with the channel model depicted in figure 6.

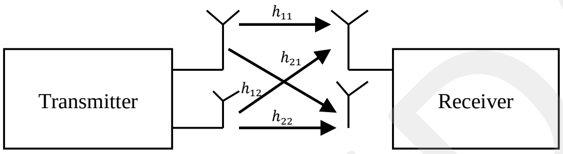

Figure 6: Channel Model for MIMO (2×2)

In figure 6, h_{11}, h_{12}, h_{21} and h_{22} denote the channels impulses responses between transmit and receive antennas.

In the Alamouti MIMO scheme [1], diversity is introduced both in space and time to combat the effects of time-varying multipath fading. The diversity is achieved using the Alamouti Space Time Coding where the signal is coded at the transmitter and decoded in the receiver. The symbols, $c0$ and $c1$ are coded at the transmitter according to table 1.

Table 1: Alamouti Space-Time coding for 2×2 MIMO system

	TX_1	TX_2
time: t	c_0	c_1
time: $t+T$	$-c_1^*$	c_0^*

III. Simulation and Results

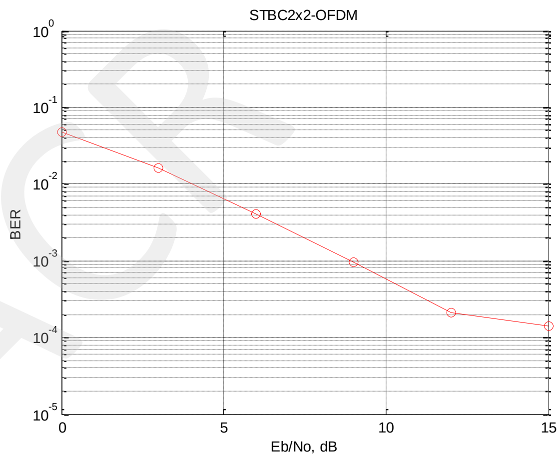

Figure 7: STBC 2×2 OFDM – QPSK

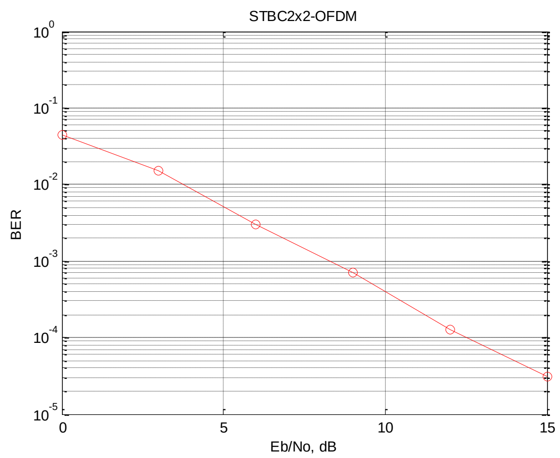

Figure 8: STBC 2×2 OFDM BPSK

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IV. Conclusion

An effective technique to improve wireless communication performance is transmit diversity. Transmitter diversity uses a new combination of space time block codes (STBC) concatenated with orthogonal frequency division multiplexing (OFDM) system in high-speed wireless data communication. OFDM is well known to be suited for high data rate applications in fading channels, due to its high spectral efficiency. The most prominent space-time block code (STBC) is the Alamouti code. By simulation results we found that, BPSK performs better than QPSK in terms of bit error rate (BER).

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