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Spatial Diversity in Wireless System to Combat Fading Effects

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Abstract- Future commercial and military wireless systems will be required to support higher data rates with reliable communication under spectrum limitations and multipath fading environments. The communication systems must maintain reliable communication under the conditions of hostile jamming and other interference without increasing emitted power. Fading is the dominating factor which not only affects the transmission of data but also made the data erroneous. This means that severe attenuation in a multipath wireless environment makes it extremely difficult for the receiver to determine the transmitted signal. Diversity is a powerful communication receiver technique that provides wireless link improvement at a relatively low cost. Diversity techniques are used in wireless communications to mitigate the effect of fading over a radio channel. In diversity technique, multiple copies of the same data are transmitted to the receiver via multiple paths or channels and the final decision is made by the receiver without knowing to the transmitter. In this thesis, we design and implement space diversity techniques for the improvement of BER in communication system. The developed system incorporating diversity schemes have been tested and performance is evaluated.

Index Terms - Almouti, STBC, Diversity, MIMO.

I. Introduction

One of the biggest challenges in wireless communication is to operate in a time varying multipath fading environment under limited power constraints. The other challenge is the limited availability of the frequency spectrum. Future commercial and military wireless systems will be required to support higher data rates with reliable communication under spectrum limitations and multipath fading environments. Military communication systems must maintain reliable communication under the conditions of hostile jamming and other interference without increasing emitted power or requiring larger bandwidth.

High speed (data rates), real-time internet protocol (IP) services (including voice) and hours of useful battery life are the main challenge of wireless and mobile communication. Wireless spectrum itself is a valuable resource that also needs to be conserved. The fundamental distinction of wireless communication is the ability to communicate on the move. This represents both a freedom to the end user and also a challenge to the system designer. However in wireless communication, the transmitting information are riding on radio (electromagnetic) waves and hence the information undergoes attenuation effects (fading) of radio waves [1-2]. These attenuation effects could also vary with time due to user mobility, making wireless a

challenging communication medium.

Multipath Fading is known to arise due to the non-coherent combination of signals arriving at the receiver antenna. Typically, this phenomenon is described as the constructive/destructive interference between signals arriving at the same antenna via different paths, and hence, with different delays and phases, resulting in random fluctuations of the signal level at the receiver. Deep-fades that may occur at a particular point in space, or at a particular time or frequency, result in severe degradation of the quality of signals at the receiver making it impossible to detect and decode. In the recent years MIMO has drawn significant attention of researchers in the field of wireless communication. Multipath fading is major bottleneck in increasing the data rate and reliability of transfer of information over wireless channel [3].

Channel coding Techniques which are used to improve reliability is insufficient to meet the requirements of modern multimedia communications. Diversity is a powerful communication receiver technique that provides wireless link improvement at a relatively low cost.

Diversity techniques are used in wireless communications to mitigate the effect of fading over a radio channel. The wireless communication channel suffers from much impairment such as Additive White Gaussian Noise (AWGN), the path loss, the shadowing and the fading. Fading is a major problem and in order to reduce it, diversity is being used. Thus in diversity technique, multiple copies of the same data is transmitted to the receiver via multiple paths or channels and the final decision is made by the receiver without knowing to the transmitter [4].

2 RELATED WORKS

The literature reviewed in Spatial Diversity and Spatial Multiplexing can be summarized as:

S. M. Alamouti [5] proposed a transmit diversity scheme in which two transmit and one receive antenna was used. The diversity order of the maximal-ratio receiver combining (MRRC) with two receive antennas and one transmit antenna and this scheme are equal.

Nidhi Sharma [6] designed an STBC for a multiuser MIMO system containing two users, transmitting independently. The transmission matrix is designed with the criterion of maximizing coding gain for the two users. Further, the proposed STBC enables independent decoding of symbols of both the users. A pair-wise maximum likelihood (ML) decoder for the proposed STBC is also derived. The performance of the proposed STBC is compared with the existing work and it is shown through simulations that the proposed code design performs significantly better than the existing STBC.

Vaibhav Hendre et al. [7] present TAS technique based on Maximal Ratio Combining (MRC) scheme with multiple antenna selection. The sub optimal antenna selection is carried out for selecting more than one subset of antenna which minimizes the

upper bound of pair wise error probability. The performance analysis of the system is carried out under Nakagami-m flat fading channel. The Bit Error Rate (BER) analysis is performed for multiple antenna selection in MIMO-OSTBC system for arbitrary values of 'm' in Nakagami-m fading channel.

3. RESULTS

The results of the developed system incorporating spatial diversity and spatial multiplexing are given in this paper. We design and implement a system model incorporating diversity to reduce fading effect exist in wireless environment. The developed model is tested and a performance is evaluated in terms of bit error rate (BER).

The developed model incorporating diversity is tested and performance is evaluated in terms of BER in Rayleigh fading channel. The modulation used is BPSK. We run the simulation over a range of Eb/No points to generate BER results that allow us to compare the different systems as shown in figure 1.

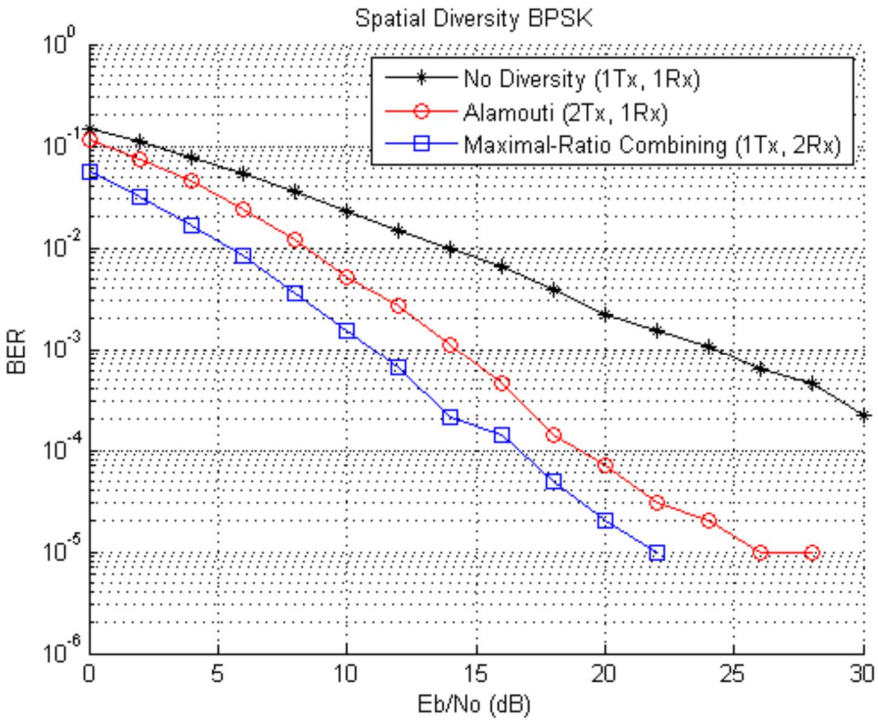

Figure 1: BER Vs Eb/No graph Spatial diversity under BPSK

We run the simulation over a range of Eb/No points to generate BER results that allow us to compare the different systems as shown in figure 2.

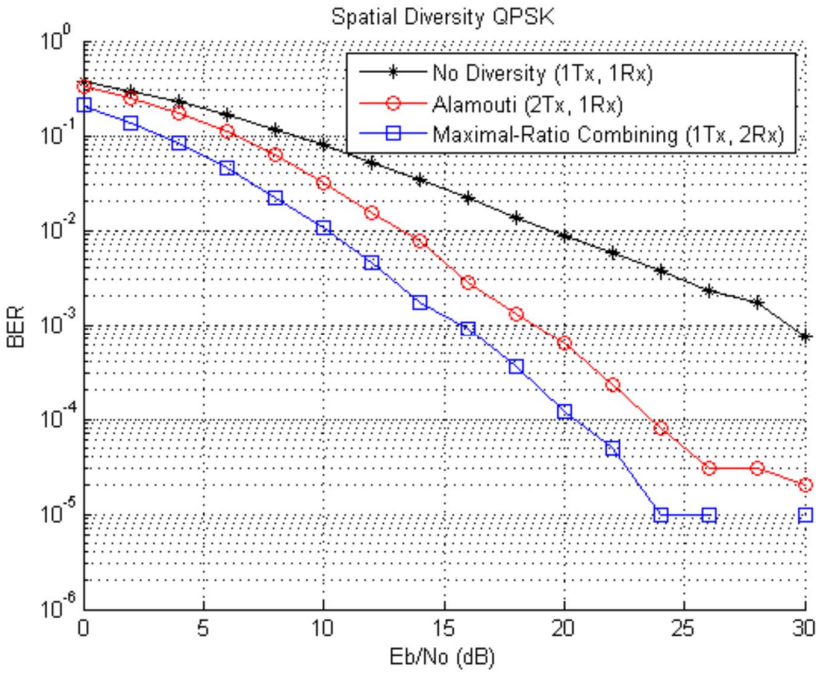

Figure 2: BER Vs Eb/No graph spatial diversity under QPSK

4. CONCLUSION

In this paper, we give the brief overview of diversity schemes in wireless system to combat fading. Incorporating diversity in wireless system, it is possible to effectively mitigate the effects of multipath fading. The implementation of diversity schemes in communication system improves Bit error rate (BER) hence diversity scheme has the ability to combat fading effects. The result reveals that the MRC scheme (1 Tx & 2 Rx) gives better result compared to alamouti (2 Tx and 1 Rx) sheme. BPSK modulation gives better result as compare other PSK modulation schemes like QPSK and QAM.

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