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Necessity of Channel Estimation in Wireless Communication System

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ABSTRACT: In wireless communication system, when the signals are transmitted through the channel the received signal will be distorted by the channel characteristics. In order to recover the transmitted signals the channel effect must be estimated and compensated at the receiver. This paper shows how the imperfection in the channel affect the estimation of information symbols at the receiver and it is concluded that the BER increases with the imperfection in the estimated channel and this shows the necessity of proper channel estimation at the receiver.

KEYWORDS: MIMO, BER, STC, STTC, STBC.

I. INTRODUCTION

In this new information age wireless communication has made a tremendous impact on the life style of human beings. In communication system there are several transmission techniques are available which includes Frequency division multiple access (FDMA),Time division multiple access (TDMA)and code division multiple access (CDMA) [1].Wired and wireless mediums are widely used in communication networks [2].In wired networks, the transmission and carrier waves used for that are limited within the medium and a channel is formed for communication system [3].The wireless communication system is considered as robust communication system which is used as an alternative to wired system[4].MIMO technology is a most significant method, which is used to improve SNR of wireless technology [5]. In MIMO system the spectral efficiency enhances through spatial multiplexing gain and link reliability enhancement is achieved through antenna diversity gain.

This paper is structured follows, section II present an overview of MIMO technology. Section III is devoted for STC technique, including description of Almouti coding scheme. Section IV describes the necessity of channel estimation. Section V represent the result of computer simulation carried out to understand how channel impairments affect the BER of the received symbol. Section VI includes the conclusion of the paper.

II. MIMO TECHNOLOGY

In this new information age the idea of using multiple antennas at transmission and reception plays a significant breakthrough in the communication system. One of the major advantage in MIMO technology is there ability to decrease the SER in multipath fading channels due to spatial diversity gain. Diversity gain result from combining signals at the receiver end which experience independent fades ,hence the signal can be received at the receiver end with minimum error. In MIMO system the enhancement of bandwidth efficiency and system reliability is achieved without using any additional bandwidth or transmitting more power in to the channel [6] .The SNR improvement in MIMO technology is utilized particularly in mobile WiMAX [7]. It is exposed that MIMO has the potential to provide higher capacity than SISO system[8].

II. STC TECHNIQUE

In wireless communication system the data transmission reliability is improved using multiple transmit antennas and space time coding technique(STC).In this scheme transmit multiple redundant copies of the data stream to the receiver end with a hope that at least some of them may survive the impairments of the physical path between the transmission

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and the reception, in good enough strength for reliable estimation.STC actually combines coding with transmit diversity to achieve high performance in wireless system. The space time encoder is designed in such a way that diversity gain should reach the maximum value [9]. Space time code can be split in to two main categories space time trellis code(STTC) and space time block code (STBC).The space time trellis code transmitting symbols are obtained by trellis code and diversity gain is equal to number of antennas used and coding gain is introduced depending upon the number of states in the trellis.[10].In STBC ,the different versions of original data are transmitted through the transmitting antenna across different time slots. The STBC is simple as compared to STTC and linear processing is used.

In this paper we used Almouti coding scheme. In this Almouti coding scheme uses two orthogonal space time code for two transmit antennas and two receive antennas. The space time code will not provide an optimal capacity but still it is considered as a promising approach for MIMO technology [11]. Information data bits are first modulated and map in to their corresponding constellation points. Consider s0,s1 be the two modulated symbols that enter the space time encoder during the first time instant t1 .symbols s0 and s1 are transmitted by first and second antenna element, during second time instant t2 the negative of conjugate of the second symbol ($-s1^*$) is sent from the first antenna and conjugate of the first symbol($s1^*$) is transmitted from the second antenna.

$$\begin{bmatrix} y_1[n] \\ y_2[n] \end{bmatrix} = \begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{bmatrix} \begin{bmatrix} x_1[n] \\ x_2[n] \end{bmatrix} + \begin{bmatrix} w_1[n] \\ w_2[n] \end{bmatrix} \tag{1}$$

The received signal in first time slot is;

$$y_1[2n] = \sqrt{\frac{E_S}{2}}(h_{11}s_1 + h_{12}s_2) + \sqrt{N_0}\,w_1[2n] \tag{2}$$

$$y_1[2n+1] = \sqrt{\frac{E_S}{2}}\left(-h_{11}s_2^* + h_{12}s_1^*\right) + \sqrt{N_0}\,w_1[2n+1] \tag{3}$$

$$y_2[2n] = \sqrt{\frac{E_S}{2}}(h_{21}s_1 + h_{22}s_2) + \sqrt{N_0}\,w_2[2n] \tag{4}$$

$$y_2[2n+1] = \sqrt{\frac{E_S}{2}}\left(-h_{21}s_2^* + h_{22}s_1^*\right) + \sqrt{N_0}\,w_2[2n+1] \tag{5}$$

In matrix form;

$$\begin{bmatrix} y_1[2n] \\ y_1^*[2n+1] \\ y_2[2n] \\ y_2^*[2n+1] \end{bmatrix} = \sqrt{\frac{E_S}{2}} \begin{bmatrix} h_{11} & h_{12} \\ h_{12}^* & -h_{11}^* \\ h_{21} & h_{22} \\ h_{22}^* & h_{21}^* \end{bmatrix} \begin{bmatrix} s_1 \\ s_2 \end{bmatrix} + \sqrt{N_0}\,w[n] \tag{6}$$

,Signals can be estimated as;

$$\begin{bmatrix} z_1 \\ z_2 \end{bmatrix} = \begin{bmatrix} h_{11}^* & h_{12} & h_{21}^* & h_{22} \\ h_{12}^* & -h_{11} & h_{22}^* & -h_{21} \end{bmatrix} \begin{bmatrix} y_1[2n] \\ y_1^*[2n+1] \\ y_2[2n] \\ y_2^*[2n+1] \end{bmatrix} \tag{7}$$

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III. CHANNEL ESTIMATION

In wireless communication system the fundamental phenomenon which makes transmission unreliable is fading. Due to reflections between the transmission and reception links signal arriving at the same antenna via different path and this leads to the constructive or destructive interference between the signals at the receiving end. Difference in delays and phases of signals at the receiving end leads to random fluctuation of the received signal strength. In order to recover the transmitted signals the channel effect must be estimated and compensated at the receiver .This accurate channel estimation is essential for coherent detection of the information symbol.

IV. SIMULATION RESULT

This section represent the simulation result obtained. the experiment have been performed by using QPSK signal and transmit these symbols in blocks and at the receiver end the estimation of information symbol occurs with imperfect channel and the symbol error associated is estimated. The next block information symbols are estimated with channel having higher imperfection and for each block imperfection of the channel at the receiver increases .From the figure1 it is observed that symbol error rate or bit error rate increases with increase in the imperfection in the estimated channel.

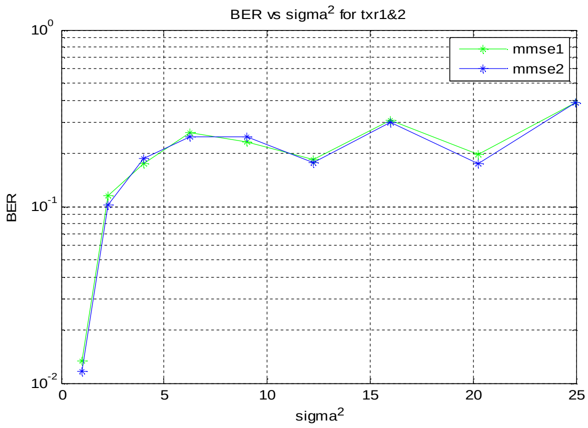

figure1. ALMOUTI Space Time Coding BER Vs channel imperfection plot

VI .CONCLUSION

This paper shows the importance of channel estimation at the receiver side .for coherent detection of the received symbol the channel effect must be estimated and compensated at the receiver. When the imperfection associated with the channel estimate increase then the estimated symbol error also increases. For better communication system the channel effect must be estimated properly at the receiver.

VII .ACKNOWLEDGMENT

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BIOGRAPHY

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