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Space Time Codes for Full Duplex Amplify and Forward Co-operation

Arya .R[1], Hari .S[2]

[1]M .Tech student, Department of Communication Engineering, Mount Zion College of Engineering, Kadammanitta, Kerala, India.

[2]Assistant Professor, Department of Electronics and Communication Engineering, Mount Zion College of Engineering, Kadammanitta, Kerala, India

Abstract: ***In Wireless communication systems, there are different types of transmission techniques or schemes are present. One of the important scheme is STBC, that is Space Time Block Codes. In STBC, different classifications are used. Most important one is OSTBC, Orthogonal Space Time Block Codes. As the name suggests the Orthogonal nature of this scheme is the main fame factor. Due to this nature ,we can reduce the associated interference during communication. Then apply an OSTBC scheme in a Full Duplex mode and combining it with Bit interleaver is analyzed here to prove the validity of Full duplex mode, comparing it with half duplex mode of operation with one and two relay strategies. With the help of simulation results, the findings of this paper suggest that ,In FD mode of operation when SNR is increased then SER is reduced and correspondingly diversity order is increased.***

Keywords: Bit Interleaver, Diversity order , Full duplex, Half duplex, Orthogonality

1. Introduction

The last decade, we have witnessed an extraordinary growing interest in the field of wireless communications. Wireless technology known as Multiple Input Multiple Output(MIMO) to minimize errors and optimize data speed .This is done by using multiple transmit and receive antennas, as well as appropriate Space Time Block Code techniques. The channel state varies over the number of signal intervals and in such cases the orthogonality of the STBC will be destroyed leading to irreducible error floor. This paper deals with Orthogonal Space Time Block Coding schemes with Full duplex mode of operation. Several transmission schemes have been proposed that utilize the MIMO channel in different ways. Example, spatial multiplexing, Space time coding or beam forming. Space Time Coding introduced first by Tarokh,is a promising method where the number of transmitted code symbols per time slot are equal to the number of transmit antennas. These code symbols are generated by the space time encoder in such a way that diversity gain, coding gain, as well as high spectral efficiency are achieved. Space Time Coding finds its application in cellular communication as well as in wireless local area networks.

Space Time Block Coding provides an exceptional link between Orthogonal designs and wireless communications. Since this coding scheme achieves full transmit diversity and has a very simple maximum likelihood decoding algorithm at the receiver. Orthogonal Space Time Block Codes achieves high transmit diversity and have a low complexity decoding algorithm at the receiver using any number of transmit and receive antenna.

2. Motivation and Related Works

Study of Full duplex mode of operation from a diversity perspective and investigate several protocols [4]that extract diversity gain over a block fading channel .This investigated approach introduces a block by block transmission and requires data code words that span several independent realization of channel fading. In distributed space time coding for full duplex asynchronous co-operative communication [1] proposes two distributed linear convolutional STC scheme for the FD asynchronous cooperative communications. The DLC-STC scheme one, is for the case of the complete loop channel cancellation. Which achieves the full asynchronous co-operative diversity. The DLC-STC scheme two, is for the case of the partial loop channel cancellation and amplifying.

Outage probability of amplify and forward co-operation with full duplex relay[2] specifies the existence of non-negligible direct link or residual self -loop interference. And FD relaying turns the effective channel into a frequency selective channel.

From the detailed study of related data, it is observed that, In existing systems mainly done the comparison of full duplex and half duplex mode of operation with different coding schemes such as Distributed STBC. But during the transmission phases the signals undergoes some loop interference specially self -loop interference, which is produced by the relay itself. The main reason of this interference is due to the non-orthogonality of transmitted signals. So these thoughts help to reach the concept of OSTBC scheme.

3. System Model

The proposed system consisting of an Orthogonal space time block codes for full duplex AF co-operation. Consider the system model of full duplex OSTBC ,which is illustrated in Fig 1.From the block diagram it can be seen that ,which mainly consisting of a transmitter section and a receiver section. In transmitter section, main parts are bit interleaver, BPSK modulator and an OSTBC encoder. In receiver section, main parts are OSTBC combiner, demodulator and a deinterleaver. In between this transmitter and receiver section

a relay section is also presented ,that is relay 1 and relay 2.Here the channel usage is IR-UWB channel. It's a highly frequency selective channel.

The relay network used in this system model is satisfy an AF protocol. That is Amplify and Forward protocol. When the signal transmitted from the source , it first reaches the relay and then it's just amplify the signal and retransmitted to the destination. Thereby boost up the strength of the received signal at the destination. Here used two relay and one relay cases for performance comparison.

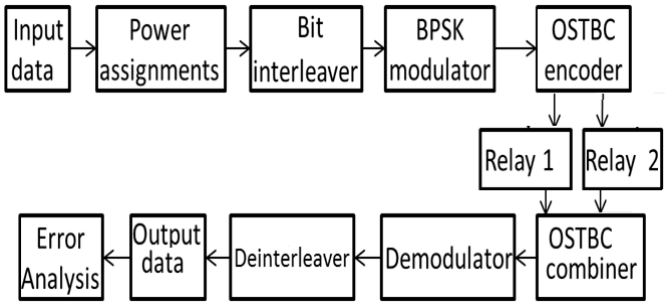

Figure 1: Block diagram of proposed system.

When the input data is given ,here considering bits of data. It undergoes some power assignment process and then reaches an interleaver, specifically bit interleaver. Then undergoes some bit by bit processing. BICM is a popular technique, to the fact that this bit level interleaver may be chosen independently allowing for a flexible and simple design. It then reaches BPSK modulator .In this proposed system mainly consider the BPSK modulation, why because it has more bandwidth efficiency. Then the signal reaches the OSTBC encoder. In OSTBC encoder ,the signals undergoes some encoding process. Due to the orthogonal nature of this combiner influences of interference is reduced. Then the signal separated into two parts.one part goes to relay 1 and other part goes to relay two. That is each of 2 copies of the same signal goes to two different relays for performance improvements. Then relay 1 and relay 2 processed the signals separately and reaches to the OSTBC combiner section .Here the signals combined together. Then combination of these signals reaches the demodulator ,then deinterleaver and get the output data.

4. OSTBC Performance Analysis

In most of the existing systems ,specified about the FD and HD mode of operations with distributed STBC scheme. The main demerit of this type of system is the non orthogonality of the signals. So during transmission times, it undergoes dangerous interferences. Which reduces the efficiency of the entire system. This paper presents an OSTBC scheme instead of DSTBC, that is Distributed STBC. Compare the performance of FD and HD mode of operations .Then prove the validity of FD operations with the help of one relay and two relay strategies

a) One Relay Case :
In Half Duplex mode corresponding matrix is

$$X^{(HD,1)} = \begin{bmatrix} X1 & X2 & X3 & X4 \\ X3 & X4 & 0M & 0M \end{bmatrix}$$

In Full Duplex mode corresponding matrix is

$$X^{(FD,1)} = \begin{bmatrix} X1 & X2 & 0M \\ 0M & X1 & X2 \\ X3 & 0M & X1 \end{bmatrix}$$

Where the first row of x^(FD,1) indicates the symbols transmitted by source. The second row indicates the symbols transmitted by relay 1,while third row stands for the residual self- loop interference. Then we can say that ,it sufficient to incorporate 3 symbols in each code word rather than 4 symbols as in HD.

b) Two Relay Case:
In Half Duplex mode corresponding matrix is

$$X^{(HD,2)} = \begin{bmatrix} X1 & X2 & X3 & X4 & X5 & X6 & X7 & X8 \\ 0M & 0M & X1 & X3 & 0M & 0M & 0M & 0M \\ 0M & 0M & 0M & 0M & 0M & 0M & X5 & X7 \end{bmatrix}$$

In Full Duplex mode corresponding matrix is

$$X^{(FD,2)} = \begin{bmatrix} X1 & X1 & X1 & X1 \\ 0M & X2 & X2 & X2 \\ 0M & 0M & X3 & X3 \\ 0M & 0M & 0M & X4 \end{bmatrix}$$

In X^(HD,2)where Relay 1 receives in slots 1 and 2 and transmitted in slots 3 and 4 while Relay 2 receives in 5 and 6 slots and transmits in slots 7 and 8.Then we can say that ,it is sufficient to incorporate 4 symbols in each code word rather than 8 symbols in HD.

5. Comparison between FD-OSTBC and HD-OSTBC

According to co-operative systems, both codes are totally real, do not introduce any data rate reduction and fully diverse. The FD mode outperforms the HD mode because of higher coding gain .Which helps to decrease the influence of self- interference. And compared to HD mode ,FD mode provide an additional advantage of lower decoding delays and lower peak to average power ratio.

6. Simulation Results

As specified in the above sections, the full duplex mode is outperforms the existing half duplex mode of operations in all practical levels. So to prove the performance betterment of full duplex mode of operation , compare its performance with the help of one relay and two relay strategies.

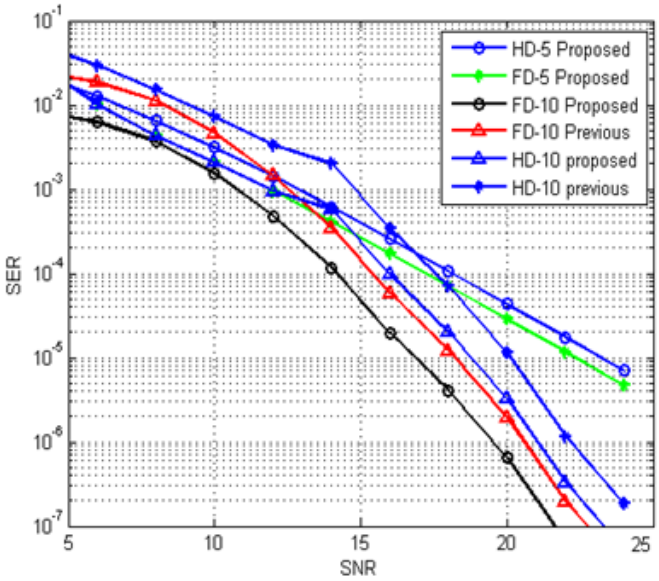

Figure 2: One relay 2 BPSK

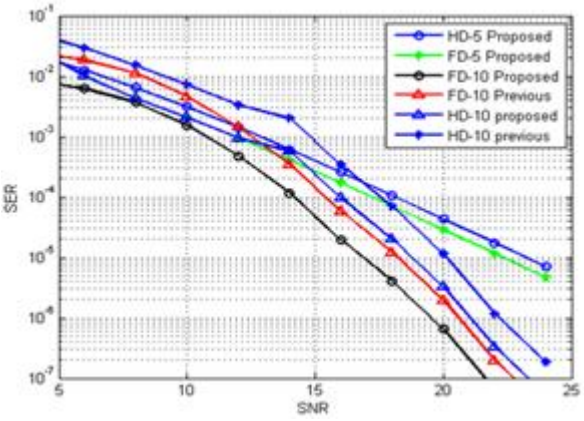

Figure 3: Two relay 4 BPSK

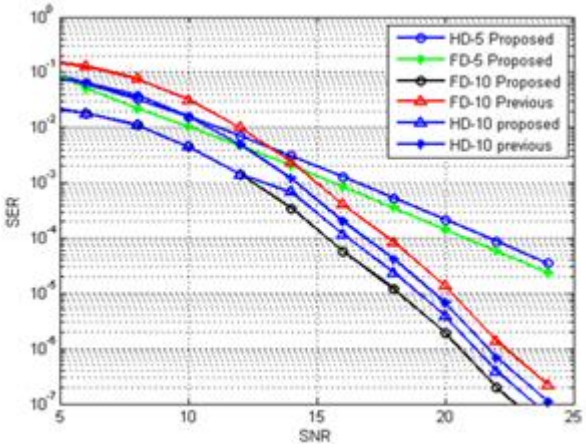

Figure 4: Two relay 2 BPSK

In figure 2.illustrates the one relay 2 BPSK case. In which x –axis represents signal to noise ratio and y-axis represents symbol error rate. As a conclusion we can say that when SNR increases symbol error rate decreases.

In figure 3 .illustrates the two relay four BPSK case. From the figure it is observed that when diversity order increases from 5 to 10, the full duplex with OSTBC scheme shows better performance than others.

In figure 4. Illustrates the two relay 2 BPSK case. From this figure it is observed that there is almost 2.3 dB performance gain shows by full duplex orthogonal space time block codes. Also concluded that the highest performance enhancement are observed from full duplex mode of operation .

From these simulation results ,it is observed that the orthogonality enables us to achieve full transmit diversity and at the same time ,it allows the receiver by means of simple maximal ratio combining to decouple the signals transmitted from different antennas and consequently it allows a simple maximum likelihood decoding.

7. Conclusion

The performance analysis of FD –OSTBC and HD-OSTBC is considered for detailed analysis and study. Here the main scheme used for the analysis is Orthogonal STBC. The study progressed with the combination of bit interleaver. According to the peculiar characteristics of OSTBC, we can say that the resulting system is more diverse ,simple decoding ,achieve maximum data rate etc compared with existing systems. Here mainly considered the BPSK modulation due to its higher bandwidth efficiency. The detailed study of simulation results shows the performance excellence of FD-OSTBC.

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Author Profile

Arya. R received the B. Tech degrees in Electronics and Communication Engineering from M. G University, Kerala at Musaliar College of Engineering in 2013. And now she is pursuing her M.Tech degree in Communication Engineering under the same university in Mount Zion College of Engineering.