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Performance Analysis of Two-Ways Amplify and Forward in Cooperative Communication Using Pre-coder

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Abstract: In this paper, a Bit Error rate analysis is presented for multiple-input–multiple-output (MIMO) system with two way multiple relay system with amplify and forward (AF) considered in QPSK modulation technique, where a transmitted signal consists of a pre-coders followed by an space–time block code (STBC), such as dirty paper code (DPC). DPC primarily helps transmit data efficiently even though the communication channel offers interference. Its objective is always to send as much readable information on a channel with interference as you can. The BER performance of this method is compared with the pre-coder based methods like Minimum Mean Square Error (MMSE) and zero-forcing beam forming (ZF-BF). This paper considers both one-way and two -way relaying systems with multiple relays between two terminal nodes where all nodes have MIMO antennas. Simulation effects we advise a fresh practical scheme leads with low computation complexity and BER performance and faster convergence with better system utilization.

Keywords: Amplify-and-forward, MIMO, Space time block coding, Pre-coder (DPC), two ways relay, CSI, MMSE.

I. INTRODUCTION

Recently, there has been a big desire for wireless multiple-input, multiple output (MIMO) AF two-way relays communication systems due to their promising improvement with regards to performance and reduce the BER (bit error rate) and in addition help the convergence rate. The Two -way relay networks (TWRNs) [2], promise spectral efficiency improvements for wireless networks Moreover, multiple-input multiple-output (MIMO) [5], technologies can further enhance the performance of single-antenna TWRNs Consequently, amplify and-forward (AF) MIMO [2]. TWRNs may use zero-forcing transmit beam forming and ZF receive equalization strategies. The amplify-and-forward (AF), [1] relaying protocols, when compared to the regenerative decode-and-forward (DF), [1] relaying protocols, are equipped for providing merits of a simpler relaying strategy. The best way of linear pre-coding is Zero forcing beam forming [2].

The Transmit/receive zero- forcing is studied for MIMO amplify-and-forward (AF) two-way relay networks [1], [5]. A cooperative two-way relaying scheme is studied for the two-source system with multiple half-duplex AF relaying. In a two-way relay network consisting of multiple pairs of single-antenna users and multiple distributed single-antenna relays is recognized as.

II. COOPERATIVE COMMUNICATION

The cooperative communication [10] may be proposed to supply a different implementation of multiple antennas which can allow future communication systems to overcome the previously mentioned drawback [1]. Such cooperation can significantly increase the toughness for signal transmission from each user.

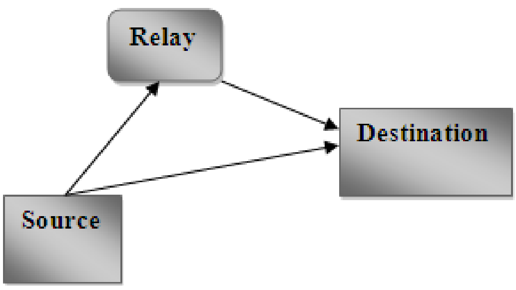

Fig.1 Cooperative Communication

Specifically, one user, known as the source user, desires to send its information signal to a new user, called destination user. Another user, which represents the relay also receives the transmit signal. The relay processes the received signal somehow, and then retransmits to the destination. The designs of cooperative protocols or strategies [10], for the cooperative systems, there are mainly two types of cooperative protocols uses.

A) Fixed relaying schemes such as amplify-and-forward (AF) and decode-and-forward (DF) protocols [1], [10].

B) Selection relaying schemes [10], which adaptively select the relays for transmission of the data based upon channel measurements between the cooperating terminals.

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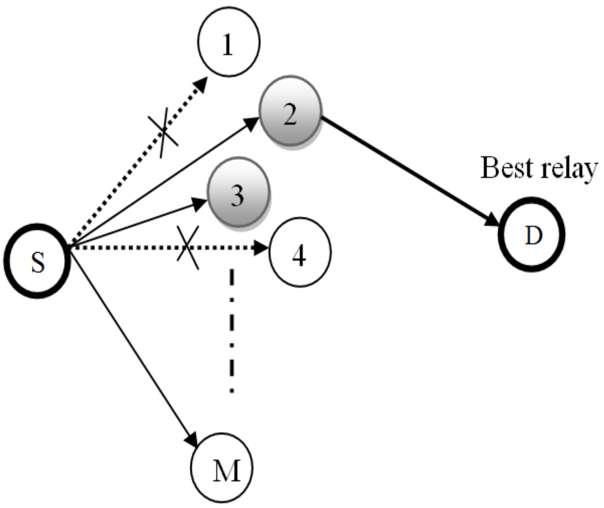

Fig.2 Selection scheme

First, the source node transmits the information signal to both relay and destination terminals. Then, the destination terminal sends out a single bit of feedback to the source and relays to indicate whether the direct transmission succeeds or fails. If your reception in the signal is successful, a bit is transmitted in the destination for an origin and relays indicating the achievements of the direct transmission.

C) Cooperative Two-Way MIMO Relay Network
The MIMO systems are able to support high-data rates by combating interference and fading, it is reasonable to exploit the advantages of MIMO systems by accommodating multiple antennas in the relay node.

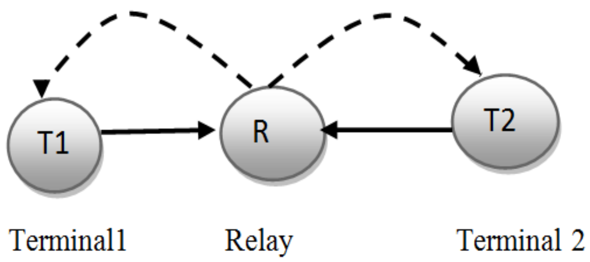

Fig.3 Two way relay network

III. MIMO

MIMO is usually effectively a radio antenna technology [3], since it uses multiple antennas at the transmitter and receiver to enable a range of signal paths to carry your data, choosing separate paths per antenna to enable multiple signal paths to be used.

One of the core ideas behind MIMO [7], wireless systems space-time signal processing through which time (natural dimension of digital communication data) is complemented using the spatial dimension built into the usage of multiple spatially distributed antennas, i.e. the use of multiple antennas found at different points.

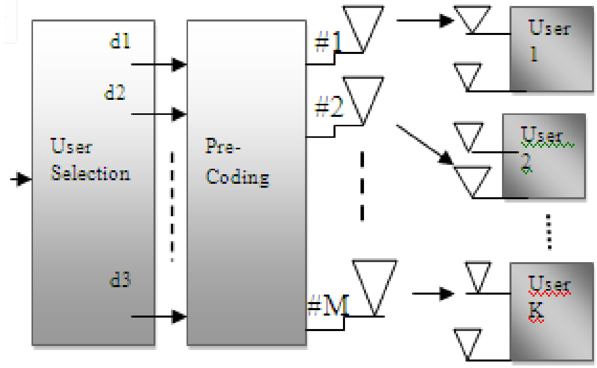

Fig.4 MIMO System

The two main formats for MIMO are given below:
A) Spatial diversity Spatial diversity found in this narrower sense often refers to transmit and receive diversity. Both of these methodologies are employed to provide improvements in the signal to noise.
B) Spatial multiplexing this form of MIMO is employed to deliver additional data capacity by utilizing the different paths to handle additional traffic, i.e. helping the data throughput capability.

Within a multiuser MIMO (MU-MIMO) [12] system, a base station communicates with multiple users. About the downlink, called the MIMO broadcast channel, the bottom station sends different information streams to the users. Around the uplink, the bottom station receives different information from the users. Communication schemes for MU-MIMO systems include both uplink MU-MIMO [12], and downlink [13]. In the Case of uplink communication, users transmit signals towards the base station. However, when it comes to downlink communication, base station transmits signals to users

IV. RELAY PROTOCOLS

A) Amplified and forward protocol
Amplify-and-forward (AF) [8], the relays simply amplify their received messages before forwarding to the destination [1]-[5]. For an AF protocol, the relay nodes retransmit a scaled version of the signal that is received from the source node to the destination node.

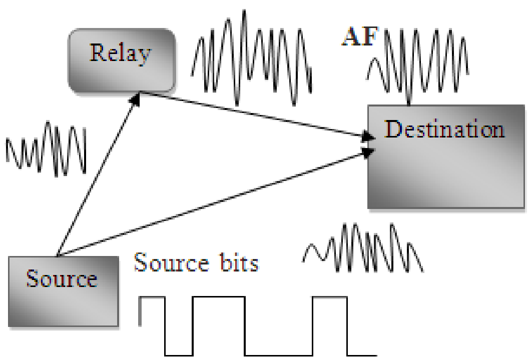

Fig.5 Amplified and forward

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B) Decode and forward protocol

Decode-and-forward (DF) the relays firstly attempt to decode its received signal, then re-encode it and forward the decoded one to the destination [5]-[8]. For a DF protocol, the relay nodes decode the message first then check if errors have occurred or not. If the message is successfully decoded, it re-encodes the data symbol using a different code book and transmits it to the destination.

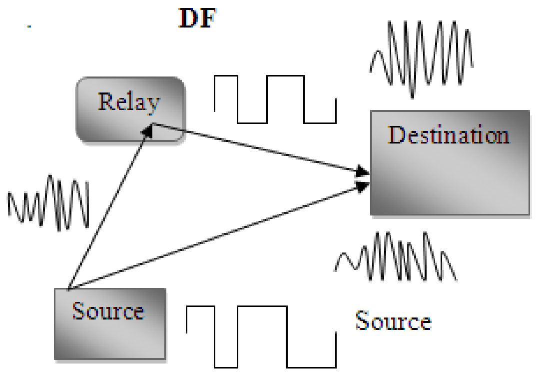

Fig.6 Decode and forward protocol

V. BASIC PRE-CODING TECHNIQUE

A) Zero Forcing Filters (ZF)

The ZF pre-coder completely eliminates the multiuser interface at the cost of noise enhancement [5]. The most intuitive approach for pre-coding is a zero forcing filter (ZF) [2], [7] which eliminates all interference at the user terminals. Assuming single antenna terminals, the decoding matrix becomes

$$I_k = G \text{ and}$$
$$M_R = k$$

The pre-coding matrix is W

$$W = \beta W_a$$

The pre-coding matrix w_a and scaling vector b is

$$W_{a\,=}\ \arg\min E\{||HW_a x\text{-}x||\}$$

Such that

$$HW_a = I_K \text{ --------- } (1)$$

In the same as the decoding ZF filter, the transmit ZF filter also suffers from the noise enhancement problem and required increase in transmit power. It is suboptimal and results in significant performance degradation.

B) Minimum Mean-Square-Error (MMSE)

This pre-coding improves the system performance by allowing a certain amount of interference especially for users equipped with a single antenna. However, it suffers a performance loss when it attempts to mitigate the interference between two closely spaced antennas, situation always occurring when the user terminal is equipped with more than one receive antenna. The ZF pre-coder completely eliminates the multiuser interface at the cost of noise enhancement. The MMSE [1]-[5], pre-coder balances the multiuser interface mitigation with noise enhancement and minimizes the total error so compare to ZF pre-coder, the MMSE [3], and pre-coder cannot design in a straightforward way [7].

$$W_a = \text{argmin } E\{||\beta^{-1}\ y\text{-}x||^2\}$$

Such that

$$\beta^2\,||\ Wax\ ||^2 \leq P_T \text{ ----------- } (2)$$

The MMSE pre-coder is defined as

$$Wa = (H^H + \alpha I_{MT}\, H^H)^{-1} H^H \text{ ---------- } (3)$$

Where the parameters α and β are equal to

$$\alpha = \sigma n2\ /\ PT \text{ and } \beta = \sqrt{PT/||Wa||2}$$

The MMSE pre-coder, in the same way received signal MMSE filter, approximates a match filter at low SNRs and is near optimal. At high SNRs the MMSE pre-coder converges to a ZF pre-coder.

VI. DIRTY PAPER CODING (DPC)

In the dirty paper coding (DPC) is a technique for efficient transmission of digital data through a channel subjected to some interference known to the transmitter [9]. The technique consists of pre-coding the data in order to cancel the effect caused by the interference. In this case the dirt is interference, the paper is the channel, the writer on the paper is the transmitter, and the reader is the receiver. The pre-coding could both the sender as well as the receiver. DPC coding is a technique of cancelling known interference at the transmitter.

A) Dirty paper Coding with Zero Forcing Equalizer

Within this paper, we design zero-forcing DPC (ZF-DPC) [9], scheme using pre-codes for any MIMO with two transmit antennas, four relay as well as users (receivers), each with one antenna. The DPC code design is the introduction of a 1 block delay that permits the channel encoder (and decoder) along with the shaping encoder (and decoder) to work independently. Inside the ZF-DPC method, the MIMO pre-coder makes sure that one user has interference. Another user uses DPC to combat interference. We design zero-forcing DPC (ZF-DPC) scheme using pre-codes for a MIMO with two transmit antennas and two users each with four relay. BER performance of the proposed DPC scheme is compared with the Minimum Mean Square Error (MMSE) and ZF-BF techniques [1], [9].

B) Dirty Paper Coding with MMSE

The Zero Forcing equalizer neglects the effect of noise. A more robust equalizer is proposed based on the Minimum Mean Square Error (MMSE) criterion. The MSE equalizer is designed to minimize the error variance.

VII. BEAM FORMING

In beam forming [9], the same signal is emitted from of the transmit antenna. Beam forming can be a signal processing technology utilized to direct the reception or transmission (the signal energy) using a transducer array.

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A) Space Time Block Coding (STBC)

To attenuate decoding complexity, space time block code (STBC) has been seen. Space–time block code is a technology used in wireless communications (MIMO systems) to transmit multiple copies of a data stream across a number of antennas and to exploit the various received versions of the data to improve the reliability of data-transfer.

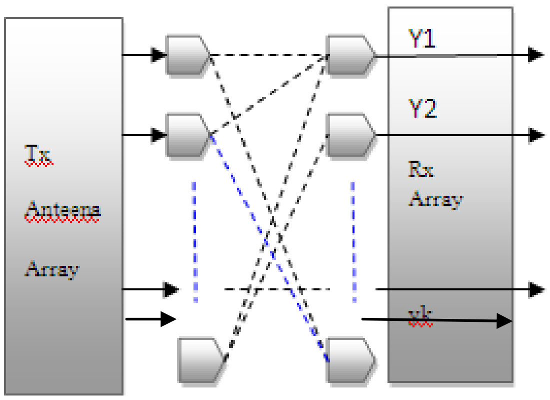

Fig.7 Block Diagram of Multiple Transmit and Receive Antenna

A space time block code is usually represented through a matrix. Each row represents a time slot and each column represents one antenna's transmissions over time.

$$S = \begin{bmatrix} S_{11} & S_{12} & \cdots & S_{1n} \\ S_{21} & S_{22} & \cdots & S_{2n} \\ S_{m1} & S_{m2} & \cdots & S_{mn} \end{bmatrix}$$

Y_1 to Y_k impulse response of channels. The fact that the transmitted signal must traverse a potentially difficult environment with reflection, scattering, refraction and so on and may then is further corrupted by thermal noise in the receiver means that some of the received copies of the data will be better than others.

B) Spatial Multiplexing

The MIMO (Multiple Input Multiple Output) [3], spatial multiplexing accustomed to provide additional data bandwidth in multipath radio scenarios. One of the key attributes of MIMO spatial multiplexing is always that with the ability to provide additional channel capacity. Both multiple transmit and multiple receive antennas (i.e., a MIMO channel) provides an additional spatial dimension for communication and yields a degree-of- freedom gain.

VIII. RESULT

By investigation of ZF-MMSE and ZF equalizer (ZF-DPC) coding algorithm in a MIMO-AF with two ways relays system. We realize that SNR is increased to a large extent with simultaneous decrease in bit error rate. This is only possible with QPSK, PAM and QAM as in bit error rate increases to a large extent. After doing MATLAB coding and running the program, we obtained the following result:

The bit-error-rate (BER) performance of those system was evaluated for several spectral efficiencies as being a purpose of the normal SNR per receive antenna. All performance comparisons are manufactured for any SNR vary from 0 to 12 db.

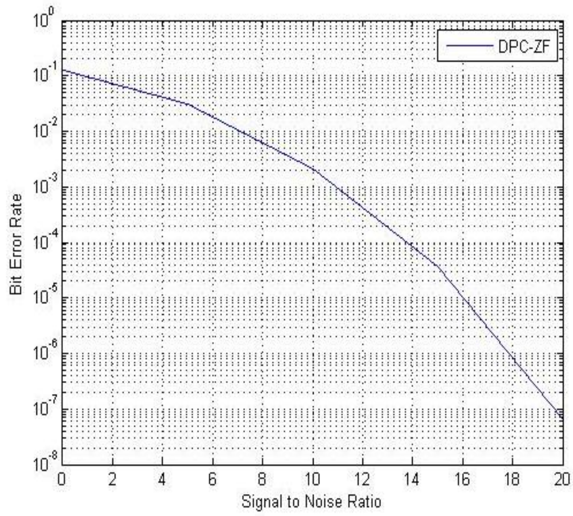

Fig.8 the BER performance of using ZF-DPC pre-coder

The above graph shows the BER performance of MU-MIMO 2×4 (two users, four relay) for ZF system with two transmit antenna and two receive antennas. Here the value of bit error rate (BER) is decreases exponentially when the value of SNR increases. As the SNR increase, BER constantly decreases proving the system to be efficient.

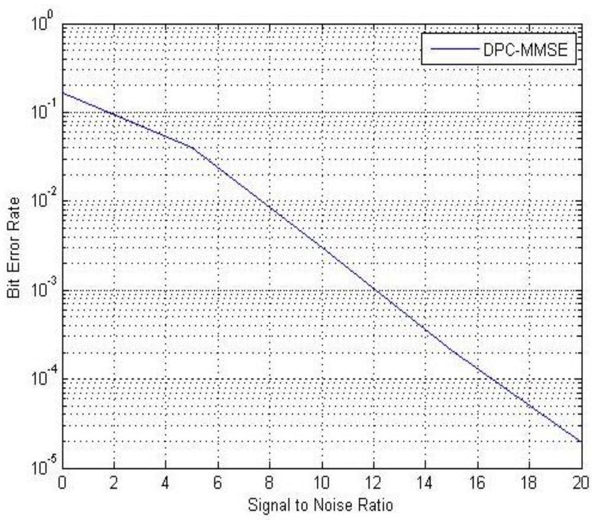

Fig.9 the BER (bit error rate) performance DPC pre-coding with MMSE equalizer

As we can see in the graph that SER is decreasing with the increase in SNR. BER is $10^{-1.0}$ when SNR = 2 db. It decreases to $10^{-4.8}$ when SNR = 20 db. In the case of BER, it also decreases exponentially with the increases in SNR.

BER = $10^{-1.3}$ for SNR = 2 db. It decreases to $10^{-4.9}$ when the SNR = 20 db.

IX. CONCLUSION

With this letter, a pre-coding optimization is studied in AF-MIMO two-way multiple-relay systems under correlated fading channels. We developed a ZF-DPC scheme for the MIMO system and studied its BER performance using simulations. Is generally considerably our scheme is that we have integrated a shaping technique like a ZF-DPC. This removes the requirement of joint shaping and channel coding. We also compare our method with MMSE and ZF equalizer methods.

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BIOGRAPHIES

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