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Performance Analysis of OSTBC MIMO Using Precoder with ZF & MMSE Equalizer

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Abstract
In this paper, a bit error rate analysis is presented for multiple-input–multiple-output (MIMO) system with finite-bit feedback is considered in PSK modulation technique, where a transmit signal consists of a rotational precoder followed by an orthogonal space–time block code (OSTBC) which achieve full diversity when a linear receiver, such as, zeroforcing (ZF) or minimum mean square (MMSE), is used. By choosing different parameters, codes with different symbol rates and orthogonally can be obtained .In this paper, we compare the performance of a family of space-time codes. Simulations show how the precoders obtained by our proposed criterion and method perform better bit error rate reduction compared to the existing ones.

Index Term- Finitebit feedback, multiple-input-multiple output (MIMO) systems, Orthogonal space-timeblock code (OSTBC), rotational based precoders.

I. Introduction

MIMO (Multiple-Input Multiple-Out)wireless system design focus on multiple-input multiple-output (MIMO) techniques to provide capacity (data rate) gains, closed-loop techniques to offer capacity gains or bit-error rate (BER) performance improvements, and orthogonal space time block code(OSTBC)[1] to facilitate the utilization of these performance gains on frequency-selective channels.

Multiple-input and Multiple-output[1], or **MIMO** can be the usage of a number of antennas in both the transmitter along with radio to boost conversation efficiency. It can be on the list of sorts of sensible antenna technological innovation. The particular conditions suggestions along with output consider the air funnel hauling this indication, not to these devices having antennas.

MIMO technological innovation possesses attention throughout wi-fi sales and marketing communications, since it delivers major improves throughout facts throughput along with hyperlink array devoid of more bandwidth or perhaps improved send energy. That defines this aim by simply distributing exactly the same entire send energy above the antennas to obtain a selection acquire which enhances this spectral effectiveness (more bits every second every hertz of bandwidth) and/or to obtain a new diversity acquire which enhances the url trustworthiness (reduced fading). Because of these kind of components, MIMO is surely an essential component of current wifi conversation specifications such as IEEE 802. 11n (Wi-Fi), 4G, WIMAX.1.1

II. MIMO channel model

In MIMO systems, a transmitter sends multiple streams by multiple transmit antennas. This transmit channels move through a new matrix funnel which in turn includes all routes between transmit antennas in the transmitter as well as obtains antennas in the radio. Then, the actual radio offers the been given transmission vectors through the numerous acquire antennas as well as decodes the actual been given transmission vectors into the unique information. The small companies level diminishing MIMO process-

$$Y=Hx+n \quad ....(1)$$

Exactly where and therefore are the particular receiver and send vectors, respectively, and therefore are the particular channel matrix along with the sound vector, respectively. In order to implement these kinds of many antenna programs, the results along with RF must be divide along with modified along with move through distinct trails. MIMO technology is made up of several main parts: pr-coding, spatial multiplexing, along with selection code.

2.1 Function of MIMO

MIMO can be dividing in three main categories-

- Pre-coding
- Spatial multiplexing or SM
- Diversity coding

The next generation wireless systems [4]are required to have high voice quality as compared to current

cellular mobile radio standards and provide high bit rate (up to 2 M bits/s). There is always a need for methods to send more bits per Hz. A particular solution is the use of multiple antennas at both transmitter (TX) and receiver (RX). In MIMO, the transmit
antennas at one end and the receive antennas at the other end are connected and combined in such a way that, the bit error rate (BER) for each user is improved. Advantages of MIMO system include [2], [3]:

A)Precoding- A generalization of beam forming to support multi-layer transmission in multi-antenna wireless communications. When the receiver has multiple antennas, single-layer beam forming cannot simultaneously maximize the signal level at all of the receive antennas. In order to maximize the throughput in multiple receive antenna systems, multi-layer beam forming[5] is required.

B) Diversity coding-A signal can be coded through the transmit antennas, creating redundancy, which reduces the outage probability[5].

C) Spatial multiplexing-A transmission technique in MIMO wireless communication to transmit independent and separately encoded data signals, so-called *stream*, from each of the multiple transmit antennas[5].
MIMO system consumes no extra power due to its multiple antenna elements. The total power through all antenna elements is less than or equal to that of a single antenna system

III. Orthogonal Space-Time Bock Coding-

To minimize decoding complexity, space time block code (STBC) has been discovered. The orthogonal design of this scheme linear processing at the receiver. In this paper, emphasis within space-time coding is placed on block approaches. STBC based on orthogonal design obtains full diversity gain with low decoding complexity therefore is widely used. An OSTBC1 matrix is composed of linear combinations of constellation symbols S1, S2, . . . ,SP and their conjugates, and encoding therefore only requires linear processing. The most important special case is the Alamouti codes for two transmit antennas. It is used to achieve space-time transmit diversity (STTD), and has been adopted in several third generation (3G) cellular standards because it maximizes diversity gain. The code matrix for OSTBC satisfies for all complex code symbols. For example, the Alamouti code is an OSTBC with 2 transmit antennas, for which the transmit matrix i.e., a pair of emblems s*1 in addition to s*2 in addition to their own conjugates usually are carried over a pair of moment slot machine games. With initially slot machine game, s1 in addition to s2 usually are carried on the antenna 1 in addition to 2, respectively; throughout the following mark time period, −s*2 is carried on the antenna 1, in addition to s*1 is on the antenna 2. Much more normal OSTBC set ups usually are discussed throughout. As an illustration, signal matrices with regard to rate 1/2 in addition to 3/4 signal making use of a number of antenna receive by simply.

$$S=\begin{bmatrix} s_1 & s_2 \\ -s_2^* & s_1^* \end{bmatrix}$$

At each time slot, a column of the codeword matrix is transmitted across different antennas. At the end of a block, the receiver employs zero forcing (ZF) and minimum mean square Error (MMSE) decoding to separate different transmitted symbols contained in a codeword.

IV. Limited Feedback Pre-coding-

Your pre-coding approaches described preceding were being according to possessing perfect funnel express info at the transmitter. On the other hand, in real systems, receivers may just responses quantized info which is described by a confined volume of bits. If your identical precoding approaches are employed, nevertheless currently according to wrong funnel info, additional disturbance looks. That is an example in confined responses pre-coding. The received signal in multi-user MIMO with limited feedback precoding is mathematically described as

$$y_k = h_k^H \sum_{i=1}^{k} w_{i\, s_i} + n_k$$

In this case, the beam-forming vectors are distorted *as*

$$\hat{w_i} = s_i + w_i$$

Where w_i is the optimal vector and e_i is the error vector caused by inaccurateCSI(channel state information). The received signal can be written as

$$y_k = h_k^H \sum_{i=1}^{k} w_i\, s_i + h_k^H \sum_{i=1}^{k} e_i\, s_i + n_k$$

Where k =1,2,3....

$$h_k^H \sum_{i=1}^{k} w_i\, s_i$$

Where is the additional interference at user k according to the limited feedback precoding[7]. To reduce this interference need higher accuracy in the channel state information feedback is required, which is to turn reduces the throughput in the process of uplink.

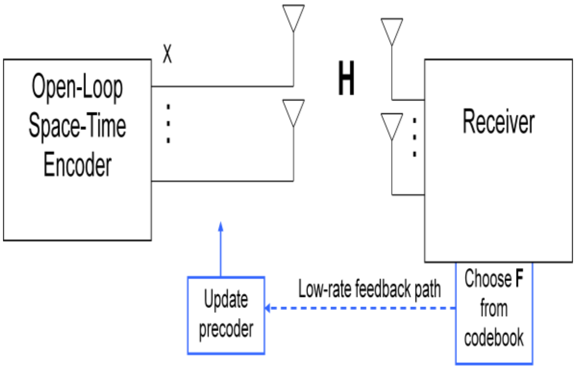


Fig1. Limited Feedback Pre-coding.

V. EQUALIZER

Equalizer provides an approximate inverse of channel frequency response because is a digital filter. Equalization decrease to effect of ISI probability of error that occurs without suppression of ISI, noise power enhancement, reduction of ISI effects has to be balanced. In our paper zero forcing and MMSE equalizer is used[8].

5.1 MMSE & Zero Forcing Equalizer.

The term equalization is used to describe any signal processing operation that minimize or a compensate inter symbol interference (ISI) created by multipath with time dispersive channels ($W>B_C$). Basically equalization is a technique is used to improve receiver signal quality.Equalizer must be "adaptive", since channels are time varying. there are 2 types of equalization .

1. Linear equalization
2. Non linear equalization

A couple of operation modalities on an adaptive equalizer: coaching and also tracking. Several aspects have an effect on enough time comprising in excess of that a equalizer converges: equalizer algorithm, equalizer construction and also time period charge associated with adjust with the multipath airwaves funnel. TDMA instant methods usually are especially well suited for equalizers. Equalizer is usually implemented at baseband or at IF in a receiver

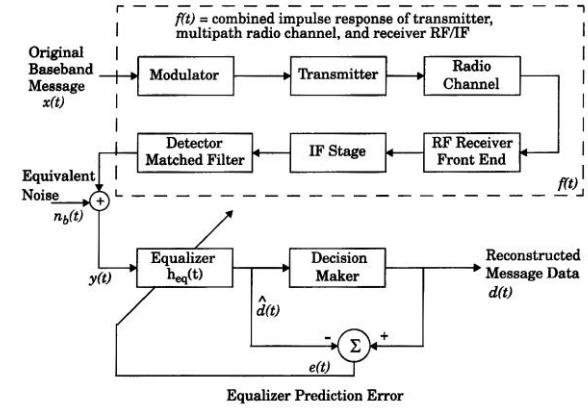
$$Y(t)=x(t)*f^*(t)+n_b(t)$$

$f^*(t)$:it is the complex conjugate of f(t)

$n_b(t)$:it is the baseband noise at the input of the equalizer

$h_{eq}(t)$:it is the impulse response of the equalizer

Block diagram- this block diagram show the communication sys.with adaptive equalizer at receiver



Block diagram of a simplified communications system using an adaptive equalizer at the receiver.

Fig 2

In Fig. 1, if d(t) is not the feedback path to adapt the equalizer, the equalization is *linear* In Fig. 1, if d(t) is feed back to change the subsequent outputs of the equalizer, the equalization is nonlinear in nature .

If the channel is frequency selective, the equalizer increases the frequency components with small amplitudes and attenuates the strong frequencies in the received frequency response. For a time-varying channel, an adaptive equalizer is needed to track the channel variations.

5.1.1 Zero forcing equalizer.

We can say complete elimination of ISI (inter symbol interference) require the use of an inverse filter to F(z) which is cause by channel. This filter is called zero forcing filters. The ZF equalizer is an inverse filter; it amplifies noise at frequencies where the channel transfer function has high attenuation.

In communication system Zero-Forcing equalizer [8]is a linear equalization algorithm used, zero forcing work which invert the frequency response of the channel. Inversion of channel, Zero-Forcing equalizer applies to the received signal, to restore the signal before the channel. Bringing down the ISI to zero in a noise free case so this is called Zero-Forcing. When ISI is significant compared to noise so this well use full. C(f) = 1/F(f) when channel with frequency response F(f) the zero forcing equalizer C(f). If F(f)C(f) = 1 combination of channel and equalizer gives a flat frequency response and linear phase. Input signal is multiplied by the reciprocal of this when channel response for a particular channel is A(s)[8]. Equation as

$$Y=Ax+n \quad ....(1)$$

To solve for x, we need to find a matrix W which satisfies WA=I the Zero Forcing (ZF) detector for
W = (AAA)-1 AA
Where W - Equalization Matrix

A- Chanel matrix

Note that the off diagonal elements in the matrix AAA are not zero value , because off diagonal elements are non zero in values. Zero forcing equalizer performing well but is not the best equalizer [6]. It is simple way and easy to implement. BPSK Modulation use Rayleigh fading channel, the BER is defined as

$$p_b = \frac{1}{2}\left(1-\sqrt{\frac{(\frac{Eb}{N0})}{(Eb/No)+1}}\right) \quad \text{....... (2)}$$

Where

p_b - Bit Error Rate

E_b/No -Signal to noise Ratio

5.1.2 Minimum Mean Square Error (MMSE) Equalizer.-

The supreme target involving equalizer it is not just minimizing ISI along with little bit mistake possibility. Your minimum necessarily means sq. Mistake criteria use in system.

A minimum mean square error (MMSE) describes the approach which minimizes the mean square error (MSE), and also describes common measure of estimator quality. Basically MMSE equalizer is that it does not usually eliminate ISI completely but, minimizes the total power of the noise and ISI components in the output. Let x is unknown random variable, and let y is known random variable [8]. Estimator x^ (y) is any function of the measurement y, than mean square error is given by

MSE = E{(X^(y) – X2)} ....(3)

Expectation is taken over both x and y. An estimator achieving minimal MSE [8]. The Minimum Mean Square Error (MMSE) approach tries to find a coefficient W which minimizes E{[Wy-x][Wy-x] H}......(4)

Where W - Equalization Matrix

H - Channel Matrix and

n - Channel noise

y- Received signal.

VI. SIMULATION RESULTS

In this section, we present simulation results for MIMO ZF equalizer with different number of transmit and receive antenna. The bit-error-rate (BER) performance of these system was evaluated for various spectral efficiencies as a function of the average SNR per receive antenna. All performance comparisons are made for a SNR of the range from 0 to 25 db.

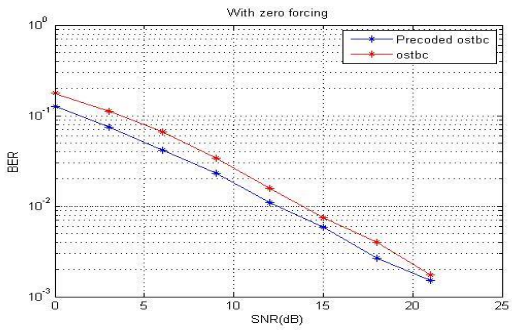


Fig.2. BER performance of PSK Modulation scheme for precoded Ostbc

VII. Conclusion

As a final remark, in this project, we only consider the case when the feedback channel is error free. In practice, the feedback channel may have errors, and there are some studies in the literature, on this issue. We believe that the coding proposed in this paper should experience the same performance degradation the existing precoding scheme of the same kind.

References

[1] A. Molisch, Wireless Communications. Wiley-IEEE Press, 2005.

[2] D. Gesbert, M. Shafi, D. Shiu, P. Smith, and A. Naguib, " *an overview of MIMO space-time coded wireless systems*," IEEE Journal on selected areas in Communications, vol. 21, no. 3, pp. 281–302, 2003.

[3] G. Tsoulos, MIMO system technology for wireless

[4] *Modern Digital & Analog communication system*- B.P LATHI.communications. CRC Press, 2006.

[5] International Journal of Electrical and Electronics Research (IJEER)Vol. 1, Issue 1, pp: (26-31), Month: October-December 2013

[6] David J. Love, *Member, IEEE*, and Robert W. Heath, Jr., **"***Limited Feedback Unitary Precoding for Spatial Multiplexing Systems*" *Member, IEEE* stems," *IEEE J. Sel. Areas Commune.* , vol. 26, no. 8, pp.

[7] David J. Love, *Student Member, IEEE*, and Robert W. Heath, Jr., *Member, IEEE* "*Diversity Performance Precode Orthogonal Space-Time Block Codes Using Limited Feedback*"

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