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Performance Analysis of Precoding Design for Space Time Block Coding System in MIMO

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Abstract: The paper presents the analysis and design of space time block coding (STBC) and joint diversity based on STBC-DPC and STBC-THP in MIMO system. In the paper, the outage capacity,ergodic capacity and symbol error rate of STBC with joint diversity is derived. From the results, we derive the outage capacity of the instantaneous signal to noise ratio (SNR) for the combination of STBC and joint diversity. It has exact average post-processingSNR, the better outage probability and ergodiccapacity using Nakagami fading channels. The results shows the better SER and BER performance of the joint diversity is derived for both M-PSK and MQAM over MIMO fading channels. Also, we derive the number of nagakami fading index and users to improve the diversity order of the different modulation types. On the other hand, the number of nagakami fading index and users degrade the SNR gain of joint diversity for outage capacity.

Index Term: -Multiple-input multiple-output (MIMO), space-time block coding (STBC), diversity order, SNR gain, symbol error rate (SER), outage probability, ergodic capacity, outage capacity, arbitrary Nakagami fading channels.

I. INTRODUCTION

It is well known that one-way relaying (OWR) [1] suffers fromspectral loss, compared with direct transmission, because of thehalf-duplex constraint of the relay. Two-way relaying (TWR)[2, 3] has attracted much attention recently because it circumventsthe spectral loss of OWR while keeping the relay gain in wirelessnetworks. The self-interference cancellation at source nodesenables the use of network coding at the relay and thus we canoverlap two transmissions towards the other sources into a singlephase to reduce the usage of spectral resource. Both decode and-forward (DaF) protocol and amplify-and-forward (AaF)protocol can be employed at the relay and the network coding isimplemented at the physical layer signal level for AaF [4]. Incooperative relaying with multiple antennas [5], the transmissionperformance can be further improved beyond the gain that singleantenna relaying offers. Multiple input multiple output (MIMO)techniques like beam forming (BF) [6] or space–time block coding(STBC) [7, 8] can be considered to provide reliability andthroughput gain over relay channels.The performance of OWR has been analyzed in many papers[5, 9].

The symbol error probability and the capacity of AaF relaysingle input single output (SISO) network with relay selection ispresented in [9]. Orthogonal STBC [7] coded AaF MIMO relaynetwork is analyzed in [5]. However, the works onperformance analysis of TWR are limited. The performances ofSISO TWR and MIMO TWR in Nakagami fading channels arepresented in [10], respectively. Approximations of the averagesum rate of SISO TWR and orthogonal STBC coded MIMO TWRare analyzed. The outage performance of SISO TWR ispresented in [5]. The BF techniques in [11] and the antennaselection scheme in [6] can enhance the performance of TWRsystems when all the transmit nodes have the channel statusinformation (CSI) between the relay and themselves. However,such assumption requires a considerable amount of overhead fortraining and CSI feedback, unless the channel stays fixed for long time duration. Hence, it is more practical to assume that theCSI is available only at the reception (CSIR) side but not at thetransmit side (CSIT). In the CSIR case, STBC should be apreferred choice for the multiple antenna transmission over the BFtechnique.

In this paper is organized as follows.System model in section II. measurements in section III.results in section IV. concluding remarks are made in Section V.

II. SYSTEM MODEL

The block diagram of proposed method as shown in Fig.1 Each block can be explained in this section. In Fig.1 multi user detection with multiple transmission signals is shown. N multiple antenna sources (S1, S2 … Sn) communicateSignal to each other with the help of the STBC with joint diversity. Let the number of antennas at S1, S2 …Sn be M1, M2…Mn, respectively. In the first phase, two signals S1 and S2 embedded the signal vectorsx1 and x2 of length L1 × 1 and L2 × 1, respectively, into STBC matrices X1 and X2 of length M1 × T1and M2 × T2, respectively, and transmit these signal matricesthrough their transmit antennas during T1 (and T2) symbol duration.Since the fading channels are guaranteed to be constant for single transmission duration, we assume that each signal embeds a pilotsignal along with the STBC matrix so that the signal can learn the channel vectors (h, g) during the transmissionperiod.
Two signals can use same block lengths in practice. Suppose that the signal transmit power is Ps, then the 1 × T received source vector is given by

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Y=sqrt(P)(hX1+gX2)+nr

Where the 1 × T vector nr is the complex additive white Gaussian noise with zero mean and unit variance. Assume that the embedded pilot's signals from the two signals are orthogonal to each other, then the STBC can learn the fading channel vectors (h, g) towards itself. The transmits the signal by in the second phase.

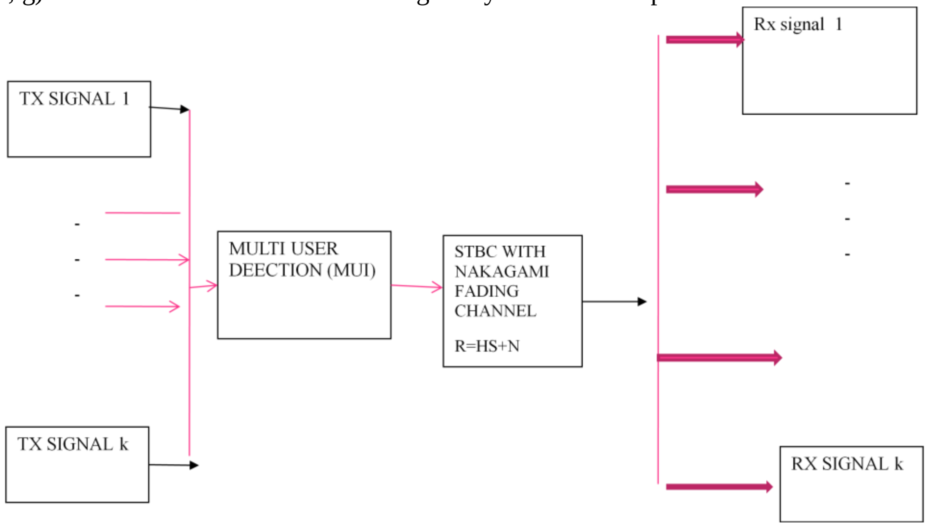

Fig.1 Block diagram of proposed methodology

2.1 Multi User Detection (MUD)

Multi User Detection in MIMO is one of the important role in OFDM system which had been studied for several years. The first ever used MUD algorithm is the basic concept of conventional filter or matched filter. The matched filter is, source signal received from a target user is correlated with a signature source of that target user, thus the transmit signal is demodulated, and this process is done for every transmit user using the same fading channel.

Multi User Detection overcome the MAI, such as reduces energy minimization, reduce Mean Square Error (MMSE). This can also support different data rates because MIMO OFDM is interference limited, the MUD employs Optimal and MMSE Multi-user Detection to eliminate Multiple – Access Interference. The Multi-user detection has better performance when we have use more number of users. Gradient projection algorithm is less efficient than the optimal multi-user detection when the number of users' signals is large.

2.2. Nakagami Fading Channels

The Nakagami-m distribution is more suitable for describing statistics of signal and mobile communications in complex media such as the urban environment . In practice, fading channel has proved very useful in simple manipulation and a wide range of applicability of various approximations. Since the Nakagami-m random channel is defined as an envelope of the sum of 2m independent Gauss random processes, the Nakagami-m distribution channel is described by probability distribution function:

$$p_z(z,\Omega)=\frac{2}{\Gamma(m)}\left(\frac{m}{\Omega}\right)^m z^{2m-1}\exp\left(-\frac{m}{\Omega}z^2\right),$$

$$z>0, m\geq\frac{1}{2}$$

where z is the received signal level, Γ(.) is the gamma function, m is the parameter of fading depth (fading figure), defined as:

$$m=\frac{E^2[z]}{Var[z^2]}$$

while Ω □ is average signal power:

$$\Omega=E[z^2]\quad .$$

III. MEASUREMENTS

From the results, we derive the outage capacity and ergodic capacity of the instantaneous signal to noise ratio (SNR) for the combination of STBC and joint diversity

3.1 Ergodic Capacity

The ergodic capacity of the joint diversity with real-valued *m* can be written as follows:

$$C_{MIMO}^{av}=\int_0^{\infty}\log_2\left(1+\frac{\gamma}{N}\cdot\gamma_{ISI}\cdot\lambda\right)\sum_{i=0}^{m-1}\frac{i!}{(i+n-m)!}\left[L_i^{n-m}(\lambda)\right]^2\lambda^{n-m}e^{-\lambda}d\lambda$$

The formula of the ergodic capacity is more complicated for the MIMO OFDM with Rayleigh fading channel. However, when m is small, such as that in SISO, SIMO, MISO, MI2O and 2IMO systems, much better performance can be easily in above formula. For a largem, the ergodic capacity can also be approximated with high accuracy in MIMO OFDM systems.

3.2. Outage Capacity

The Outage Capacity is approximated through Gaussian and Gamma approximation techniques. When the distribution of capacity is Gaussian and the *q*% outage capacity is defined as the transmission rate that guaranteed for $1 - q/100$, the *q*% outage capacity *Gaussian JD* (*q*) for the joint diversity can be approximated as,

$$C_{JD}^{Gaussian}(q) \approx C_{JD} + \sigma_{C_{JD}} \sqrt{2} erfc^{-1}\left(2 - \frac{q}{50}\right)$$

where *erfc*($\cdot$) is the complementary error function and the ergodic capacity of the joint diversity for real and integer valued *m*.

IV. EXPERIMENTAL RESULTS

We have implemented the proposed segmentation by using the MATLAB environment.The proposed algorithm has better SER, outage and ergodic capacity in MIMO OFDM systems.In Fig.2 the comparative results of Outage capacity,in Fig.3 the comparative results of BER and in Fig.4 the comparative results of Ergodic capacity are shown.In table.1 observations of Outage capacity,in table.2 observations of BER and in table.4 observations of Ergodic capacity are shown.

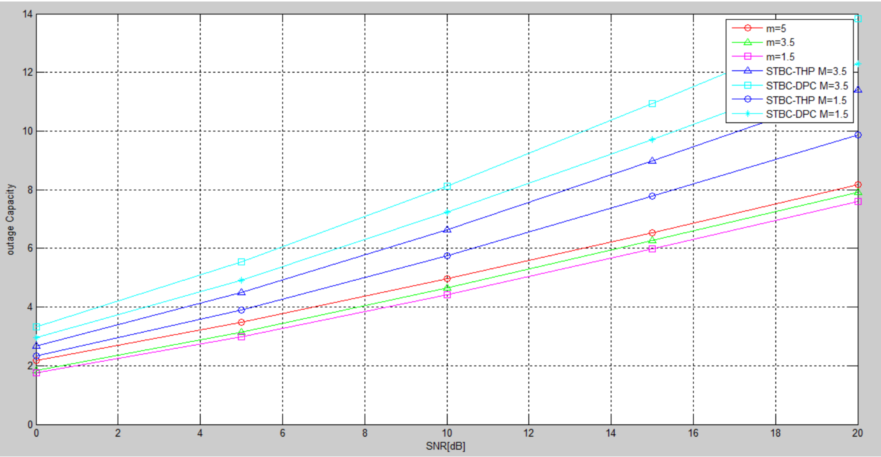

Fig.2 Comparitive results of Outage capacity.

Table.1 observations of Outage capacity.

SNR(dB)	Outaga Capacity(b/s) of Diversity coding technique (m=3.5)	Outaga Capacity(b/s) of Precoding technique (M=3.5)
4	3	4.5
6	4	6
10	6	8
16	7	10
20	8	14

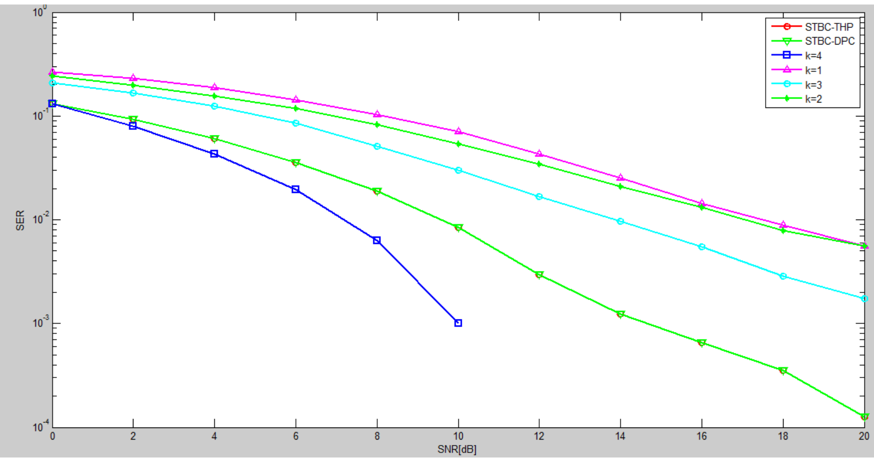

Fig.3 Comparitive results of BER.

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Table.2 Observations of BER.

SNR(dB)	SER of Diversity coding technique (k=3)	SER of Precoding technique (k=3)
4	$10^{-0.8}$	$10^{-1.3}$
6	$10^{-1.2}$	$10^{-1.8}$
10	$10^{-1.5}$	$10^{-2.1}$
14	$10^{-1.8}$	$10^{-2.5}$
16	$10^{-2.3}$	10^{-3}
20	$10^{-2.8}$	10^{-4}

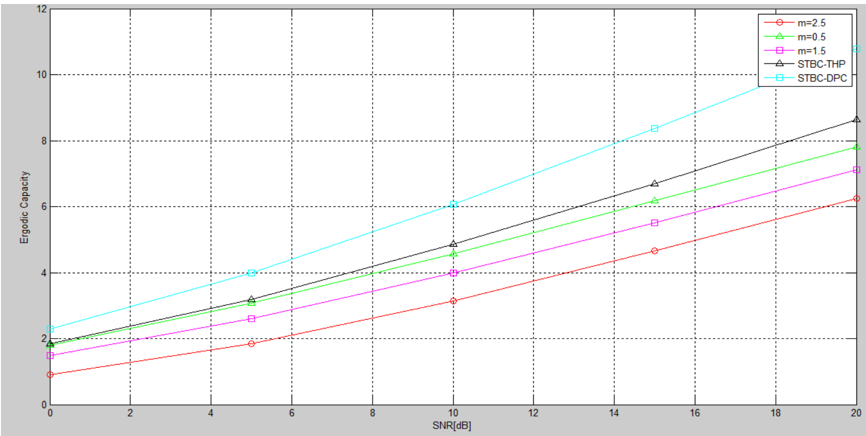

Fig.4 Comparitive results of Ergodic capacity.

Table.3 Observations of Ergodic capacity.

SNR(dB)	Ergodic Capacity(b/s) of Diversity coding technique (m=2.5)	Ergodic Capacity(b/s) of Precoding coding technique (m=2.5)
2	2.5	3.5
4	3	5
8	4	6
12	5	6.5
16	7	8
18	7	10
20	8	11

V. CONCLUSION

The paper proposed the outage capacity of the instantaneous signal to noise ratio (SNR) for the combination of STBC-THP and STBC-DPC. It is better outage probability and ergodic capacity using Nakagami fading channels. The results shows the better SER and BER performance of the joint diversity is derived for both M-PSK and MQAM over OFDM fading channels compare to existing methods. Also, we derive the number of nagakami fading index and users to improve the diversity order of the different modulation types. On the other hand, the number of nagakami fading index and users degrade the SNR gain of joint diversity for outage capacity.

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