Available Online at www.ijcsmc.com

International Journal of Computer Science and Mobile Computing

A Monthly Journal of Computer Science and Information Technology

ISSN 2320–088X

IJCSMC, Vol. 3, Issue. 1, January 2014, pg.533 – 538

RESEARCH ARTICLE

PERFORMANCE EVALUATION FOR FEEDBACK ROTATE- QUASI- ORTHOGONAL SPACE-TIME BLOCK CODES IN MULTIPLE TRANSMIT ANTENNAS

[1]K. Deepak Babu, [2]Rajesh Durgam, [3]P. Anil Kumar

[1, 2, 3] Assistant professor, Mallareddy College of Engineering, Hyderabad, India

Abstract

SPACE-time coding is a transmit diversity scheme with optional receive diversity to achieve high data rate and to improve the reliability of a wireless channel. In the past, STBC has full rate and full diversity for four transmit antennas. This technique has high cost and high complexity due to the more feedback information. In this paper, feedback-rotated QOSTBC technique is used to improve its transmit diversity with one bit feedback.. The experimental result shows that the bit error rate of feedback-rotated QOSTBC has better performance compare to other techniques.

Index terms: QOSTBC, feedback, closed-loop, rotation, circulant.

1. INTRODUCTION

A space-time code [1] is in general any modulation scheme which is designed for a multiple transmitter wireless system that tries to achieve antenna (space) diversity. The very first designs of space-time codes were in the form of trellis coded modulation, and suffered from exponential decoding complexity as the number of transmit antennas increased. After a while, Alamouti [2] proposed a simple transmitter diversity scheme which benefited both full diversity of a two-transmit antenna channel as well as simple Maximum-Likelihood (ML) decoding. The good properties of this code inspired Tarokh et al. [3] to inspect the existence of similar designs for more numbers of transmit antennas. In the case of complex codes, i.e. modulation schemes using complex constellation members, the authors proposed a structured modulation scheme, called Orthogonal Space-time Block Code that could send on average one symbol in every two time slots, and achieved full diversity as well as simple ML decoding. They presented examples for three and four transmit antennas with average rate of 3/4, or in case of real constellations they presented rate1 codes for any number of transmit antennas.

In complex constellations there is no square rate-1 code, i.e. a code for which the time length of the block equals the number of transmit antennas like that of Alamouti, for more than two transmit antennas. Meaning that Alamouti code was the only square full-rate complex orthogonal space time block code. Later in [4] it was shown that the same applies to non-square designs. Then Jafarkhani [5] proposed another scheme that was inspired by Alamouti code and could achieve full rate by pair wise decodabality for four transmit antennas.1 A modified version of this code which used rotated constellations could achieve maximum diversity of the channel in addition to the described properties of the original design [6].

II. ROTATE QUASI- ORTHOGONAL SPACE-TIME BLOCK CODES

Rotate-QOSTBC with 4 antennas is proposed with lower decoding complexity than QOSTBC. Rotate-QOSTBC can achieve full diversity when rotated QOSTBC based on S_j. For BPSK, the angle is found to be ∏/4. The problem is to attempt to justify this rotation angle analytically. The (4*4) QOSTBC is given by

$$S_J = \begin{bmatrix} S_{12} & S_{34} \\ -S_{34}^* & S_{12}^* \end{bmatrix}$$

Where S_{12} and S_{34} are the two (2*2) building blocks based on the Alamouti scheme of two transmit antennas. The rotated QOSTBC based on SJ is introduced as below

$$S_{RJ} = \begin{bmatrix} s_1 & s_2 & \mu s_3 & \mu s_4 \\ -s_2^* & s_1^* & -(\mu s_4)^* & (\mu s_3)^* \\ -(\mu s_3)^* & -(\mu s_4)^* & s_1^* & s_2^* \\ \mu s_4 & -\mu s_3 & -s_2 & s_1 \end{bmatrix}$$

Here

$\mu = e^{j\prod/4}$ is the rotate factor. It is optimal for QPSK constellation. For 16-QAM, rotate factor is equal to ∏/8.

In this paper, based on optimal rotated QOSTBC for QPSK constellation. The received signal is given by

$R=H_JS+N$

Here

HJ represents the independent samples of a zero-mean complex Gaussian random variable with zero 1.

S=sampled signals
N=noise
R is a T * Nr matrix representing the received symbols.
S is a T * Nt matrix representing the transmitted data.
H is an Nt* Nr matrix representing quasi-static flat fading.

N is a T * Nr matrix representing additive white Gaussian noise (AWGN).
where r is the (4 x 1) vector of signals received in four consecutive symbol periods, s Is the (4 x 1) vector containing 4 transmitted symbols mapped by S, n is the (4 x 1) complex Gaussian noise vector, and 'H' is the (4 x 4) equivalent channel matrix containing the path gains $h_{j,i}$ (and their conjugate versions $h_{j\ i}^{*}$) from j^{th} transmit antenna to j^{th} receive antenna, which are modeled as the samples of zero-mean independent complex Gaussian random variable with equal variance of σ^2 per complex dimension.

III. FEEDBACK-ROTATE QUASI- ORTHOGONAL SPACE-TIME BLOCK CODES

The block diagram of feedback-rotate QOSTBC shown in fig.1. In Feedback-QOSTBC flat fading channel with four transmit antennas and one receive antenna is considered. With this assumption, Jafarkhani QOSTBC is first described in order to facilitate the introduction of the new scheme.

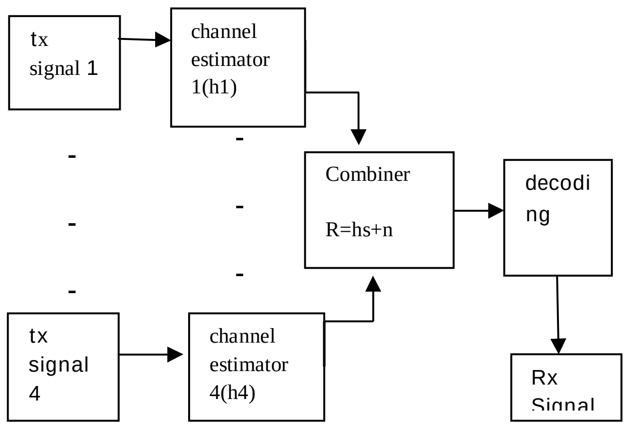

Fig.1. shows the block diagram of feedback-rotate QOSTBC

After multiplying the S_J (see in QOSTBCs) by four phase factors is given by

$$S_P = \begin{bmatrix} s_1 e^{j\alpha} & s_2 e^{j\beta} & s_3 e^{j\gamma} & s_4 e^{j\theta} \\ -s_2^* e^{-j\alpha} & s_1^* e^{-j\theta} & -s_4^* e^{-j\gamma} & s_3^* e^{-j\beta} \\ -s_3^* e^{-j\alpha} & -s_4^* e^{-j\beta} & s_1^* e^{-j\gamma} & s_2^* e^{-j\theta} \\ s_4 e^{j\alpha} & -s_3 e^{j\theta} & -s_2 e^{j\gamma} & s_1 e^{j\beta} \end{bmatrix}$$

The received signal of feedback QOSTBC is given by

$$\begin{bmatrix} r_1 \\ r_2^* \\ r_3^* \\ r_4 \end{bmatrix} = \begin{bmatrix} h_1e^{j\alpha} & h_2e^{j\beta} & h_3e^{j\gamma} & h_4e^{j\theta} \\ h_2^*e^{j\theta} & -h_1^*e^{j\alpha} & h_4^*e^{j\beta} & -h_3^*e^{j\gamma} \\ h_3^*e^{j\gamma} & h_4^*e^{j\theta} & -h_1^*e^{j\alpha} & -h_2^*e^{j\beta} \\ h_4e^{j\beta} & -h_3e^{j\gamma} & -h_2e^{j\theta} & h_1e^{j\alpha} \end{bmatrix} \cdot \begin{bmatrix} s_1 \\ s_2 \\ s_3 \\ s_4 \end{bmatrix} + \begin{bmatrix} n_1 \\ n_2^* \\ n_3^* \\ n_4 \end{bmatrix}$$

$R=H_PS+N$

Here

R represent as received signal

H_P represents the independent samples of a zero-mean complex Gaussian random variable with zero 1.

S=sampled signals
N=noise
R is a T * Nr matrix representing the received symbols.
S is a T * Nt matrix representing the transmitted data.
H is an Nt* Nr matrix representing quasi-static flat fading.
N is a T * Nr matrix representing additive white Gaussian noise (AWGN).
ω can be interpreted as the channel dependent interference parameter, and given by
$\omega = ej(\alpha-\beta)\cdot 2Re(h^*_1h_4) - ej(\gamma-\theta)\cdot 2Re(h_2h^*_3)$,

To achieve the minimal absolute value of ω by adjusting the value of the two factors ej(α−β) and ej(γ−θ) , namely: when $Re(h^*_1\ h_4) \cdot Re(h_2h^*_3) \geq 0$, here $e^{j(\alpha-\beta)} \cdot e^{j(\gamma-\theta)} = 1$; when $Re(h*1\ h4) \cdot Re(h2h*3) < 0$, here $e^{j(\alpha-\beta)} \cdot e^{j(\gamma-\theta)} = -1$. Assuming, the channel information at the receiver, and adopt one bit k = 0 or 1 to indicate $Re(h^*_1\ h_4) \cdot Re(h_2h^*_3) \geq 0$,or $Re(h^*_1\ h_4) \cdot Re(h_2h^*_3) < 0$ respectively. Then this one bit information will be fed back to the transmitter.

Supposing the system channel is quasi-static flat fading channel, at the transmitter the value of k , if $k = 0$, we set $\alpha = \gamma = \pi$ and $\beta = \theta = 0$, which ensure $e^{j(\alpha-\beta)} \cdot e^{j(\gamma-\theta)} = 1$, if $k = 1$, we set $\alpha = \beta = \theta = 0$ and $\gamma = \pi$ which ensure $e^{j(\alpha-\beta)} \cdot e^{j(\gamma-\theta)} = -1$. Hence, the solution for this closed-loop scheme as follows:

If $Re\ (h^*_1\ h_4) \cdot Re\ (h_2h^*_3) \geq 0$ feedback k=0 setting $\alpha=\gamma=\pi$, $\beta=\theta=0$

If $Re\ (h^*_1\ h_4) \cdot Re\ (h_2h^*_3) < 0$ feedback k=1 setting $\alpha=\beta=\theta=0, \gamma=\pi$.

IV. EXPERIMENTAL RESULTS

The performances of the proposed closed loop QOSTBC schemes with ML receiver are shown below. The performance of the orthogonal STBC with rate 1/2, the Jafarkhani's QOSTBC, and its optimal rotated scheme are also shown for comparison.

In fig.2. 16-QAM for the orthogonal STBC and QPSK for other QOSTBC schemes is adopted. Comparing the BER of QOSTBC and its corresponding closed-loop scheme, namely, the feedback QOSTBC, their curves are nearly the same at low SNR. However, with the increase of SNR, the performance of the closed-loop scheme is much better than the open-loop QOSTBC. Simulation results also show that the performance of feedback QOSTBC is similar with the performance of optimal rotated QOSTBC, nevertheless, the combination of one bit feedback and the optimal constellation rotation can achieve the best performance.

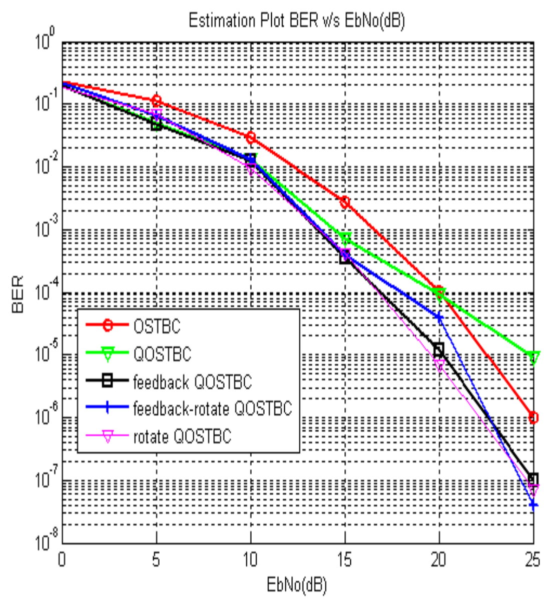

Fig. 2. BER performance of QOSTBC systems

In 3G technology diversity reception is used. So, more than one antenna is arranged at the mobile unit. So if the closed loop QOSTBC system is implemented practically, that system should be compatible with the existing system. So closed loop QOSTBC system is combined with the receiver diversity systems.

V.CONCLUSION

For systems with four transmit antennas and multiple receive antennas, it can enhance the performance with the feedback information as few as 1 bit. In particular, the presented closed-loop scheme can be applied in any existing QOSTBC without increasing the design complexity. Moreover, one important advantage of the proposed scheme is that it needn't to sacrifice the optimal rotated phase for the feedback variable.

REFERENCES

[1] V. Tarokh, N. Seshadri, and A.R. Calderbank , \Space time codes for high data rate wireless communications: Performance Criterion and code construction,"IEEE Trans. on Inform. Theory, vol. 44, no. 2, March 1998.

[2] S. M. Alamouti \A simple transmitter diversity scheme for wireless communications," IEEE J. Select. Areas Commun., vol. 16, pp. 1451- 1458, October 1998.

[3] V. Tarokh, H. Jafarkhani, and A. R. Calderbank, \Space-time block codes from orthogonal designs," IEEE Trans. Inform. Theory, vol. 45, pp. 1456-1467, July 1999.

[4] X. Liang and X. Xia, \On the Non-existance of Rate-One Generalized Complex Orthogonal Designs," IEEE Trans. on Inform. Theory, vol. 49, no. 11, November 2003.

[5] H. Jafarkhani, \A Quasi-Orthogonal Space-Time Blcok Code," IEEE Trans.comm., vol 49, no. 1, January 2001.

[6] S. M. Alamouti, \A simple transmit diversity techique for wireless communications," IEEE J. Select Areas Commun., vol. 16, pp. 3072{3082, Oct. 1998.

K Deepak Babu received the B.Tech. Degree in Electronics and Communication Engineering from Vidhya Jyothi Institute of Technology, Hyderabad in India, and the M.Tech. Degree in Telecommunication Engineering from National Institute of Technology Durgapur, West Bengal in India. He is currently working as Assistant Professor with the Department of Electronics and Communication Engineering, Malla Reddy College of Engineering, Secundrabad, India.

Rajesh Durgam received the B.Tech. degree in electronics and communication engineering from sindhura college of Engg and technology in India, and the M.Tech. degree in VLSI SD from vignan institute of technology and science, in India. He is currently working as Assistant Professor with the Department of Electronics and Communication Engineering, Malla Reddy college of engineering and technology, Secundrabad, India.

P Anil Kumar received the B.Tech. degree in electronics and communication engineering from Mother Therisha college of Engg and technology in India, and the M.Tech. degree in VLSI SD from vignan institute of technology and science, in India. He is currently working as Assistant Professor with the Department of Electronics and Communication Engineering, Malla Reddy college of engineering and technology, Secundrabad, India.

