SER Vs SNR Performance Comparison of 3-Time Slot QSTBC for Rician Fading Channel

Narendra Singh Thakur, Ritu Chauhan

Abstract— ***In this paper, we evaluate and compare the SER performance of few quasi-orthogonal space-time block codes (QOSTBCs) with three time slots for two transmit antennas. The decoding used is ML and fading channel is Rician. We observe that codes proposed in [14] performs better than the codes of [6].***

Index Terms— ***Orthogonal space-time block codes (OSTBCs), Quasi-orthogonal space-time block codes (QOSTBCs), Quasiorthogonal space-time block codes with 3 time slots (3TSQOSTBCs), Maximum-likelihood (ML) decoding, Bit error rate (BER), Long term evolution-Advanced (LTE-A).***

I. INTRODUCTION

Alamouti [1] introduced a simple transmit diversity scheme which employs two transmit antennas to combat flat fading by increasing diversity at the receiver while maintaining the same transmission rate as on a single transmit antenna.

V.Tarokh [2], generalized the scheme to any number of transmit and receive antennas using theory of orthogonal designs, which provide full diversity and have simple maximum likelihood (ML) decoding that decouple every transmitted symbol at the receiver. Relaxing the constraint of orthogonality, many QOSTBcs have been presented [3], [9]-[12] that provide partial diversity, full rate and linear ML decoder that decouples the pair of transmitted symbols instead of single symbol. Recently, Alamouti scheme has been identified as a potential diversity scheme for uplink transmission for a next generation wireless system called Long Term Evolution-Advanced (LTEA) [4], [5]. LTE-A is major enhancement of Long Term Evolution(LTE) by a standard body called 3rd Generation Partnership Project (3GPP) which is working on the standardizing cellular systems worldwide.

However, it is difficult to implement an OSTBC in the LTEA frame structure, because even number of time slots are normally not available for data transmission.

In many cases, there are 3 time slots available for data transmission, instead of 2 time slots as required by the orthogonal Alamouti scheme for two antennas.

Therefore, research has been focused on STBCs with 3 time slots for two transmit antennas. In [6], a scheme has been proposed which combines 2-time-slot Alamouti STBC with conventional transmit diversity scheme of symbol repetition. The scheme requires a linear decoding at the receiver. However, it does not provide full-diversity due to the 3rd-time-slot symbol repetition. We call this scheme as AL scheme/code in the rest of this paper

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In [8], a full-rate full-diversity QOSTBC with 3 time slots (3TS-QOSTBC) and two transmit antennas has been presented. However, its decoding requires a pair-wise detection of two symbols.

Few full-rate or even higher rate and full-diversity 3TSQOSTBCs have been proposed in [7] for two transmit antennas.

In this paper, we are having SER VS SNR for 3-TS-QOSTBCs for two transmit antennas for QPSK and 8PSK. The organization of this paper is as follows, section II provides system model and brief overview of 3TS-QOSTBCs for two transmit antennas. In section III, we are having QOSTBCs and corresponding decoder. Simulation results and conclusion are presented in section IV and V respectively.

II. SYSTEM MODEL AND REVIEW OF QOSTBCS WITH 3 TIME-SLOTS

A. System Model

We consider a wireless communication system with 2 transmit and 1 receive antenna. Signal received by receive antenna at time-slot t is given by

$$r_t = \sum_{i=1}^{2} h_i c_t^i + \eta_t \qquad (1)$$
$$1 \le i \le 2, 1 \le t \le 3$$

where η_t are noise samples. The coefficients *hi* are the path gains from i^{th} transmit antenna to the receive antenna. These path gains do not change during a codeword but may vary from one codeword to another codeword therefore the channel is quasi-static flat Rayleigh fading channel. C_t^i is the transmitted code symbol from i^{th} transmit antenna at time-slot t. From (1), received signal vector at the receive antenna can be written as are channel vector, complex white Gaussian noise vector and received signal vector of the receive antenna, respectively.

$$R = ch + \eta \qquad (2)$$

Where

$$C = \begin{pmatrix} c_1^1 & c_1^2 \\ c_2^1 & c_2^2 \\ c_3^1 & c_3^2 \end{pmatrix} \qquad (3)$$

is the QOSTBC and

$$h = (\mathrm{h}_1\ \mathrm{h}_2)^T$$
$$\eta = (\eta_1\ \eta_2\ \eta_3)^T$$
$$R = (\mathrm{r}_1\ \mathrm{r}_2\ \mathrm{r}_3)^T \qquad (4)$$

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Where superscript '*T*' in (4) represents the matrix transpose operation.

Equation (2) can be rewritten as

$$R = HX + \eta \quad (5)$$

Where *H* is defined as channel matrix corresponding to the receive antenna and X is the transmitted signal vector both of them depend upon used QOSTBC.

$$H = \begin{pmatrix} H_{11} & H_{12} & H_{13} \\ H_{21} & H_{22} & H_{23} \\ H_{31} & H_{32} & H_{33} \end{pmatrix}$$

$$X = (x_1\ x_2\ x_3)^T \quad (6)$$

Where *Ht,s*, $1 \le t \le 3, 1 \le s \le 3$ is the channel path gain Corresponding to symbol x_s, $1 \le s \le 3$ transmitted at timeslot t. *R* and η in equation (5) can be obtained from *R* and η in equation (4) by simple processing such as conjugating few elements.

B. Review of QOSTBCs with 3 Time-Slots

In this Section, we briefly review existing QOSTBCs with three time slots and two transmit antennas. First 3TS-QOSTBC was proposed in [6] for two transmit antennas

$$X_{AL} = \begin{pmatrix} x_1 & x_2 \\ -x_2^* & x_1^* \\ x_3 & x_3 \end{pmatrix} \quad (7)$$

We can observe from above code that it utilizes Alamouti scheme for the first two time slots, however, for the third timeslot, same symbol is transmitted by both antennas.Few other 3TS-QOSTBCs for two transmit antennas have been proposed in [7] and [8].

Two additional codes in the same category and corresponding decoders are proposed in [14].

1) *Code-I:*

$$Q_1 = \begin{pmatrix} x_1 & \frac{x_2 + x_3}{\sqrt{2}} \\ \frac{(x_2 + x_3)^*}{\sqrt{2}} & -x_1^* \\ \frac{(x_2 - x_3)^*}{\sqrt{2}} & 0 \end{pmatrix} \quad (8)$$

2) *Code-II:*

$$Q_2 = \begin{pmatrix} x_1 & \frac{x_2 + x_3}{\sqrt{2}} \\ \frac{(x_2 + x_3)^*}{\sqrt{2}} & -x_1^* \\ (x_2 - x_3)^* & 0 \end{pmatrix} \quad (10)$$

III. SIMULATION RESULTS

Computer simulation results of 3TS-QOSTBCs codes are shown in figures.

Fig. 1 shows BER performance curves of Alamouti code code [1], AL code [6] and our codes for QPSK modulation for flat Rican fading channel. Similarly, Fig. 2 depicts corresponding results for 8-psk modulation.

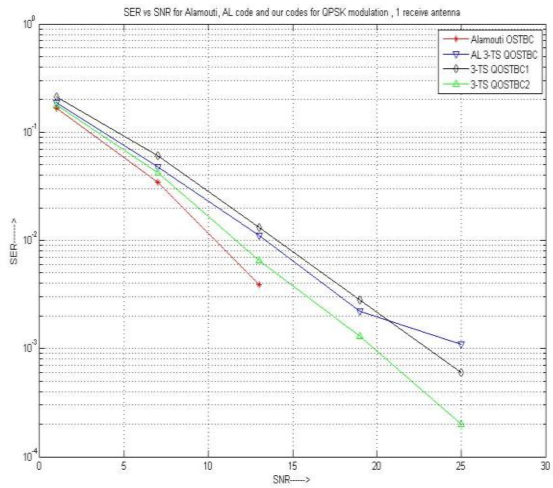

Figure:1 SER Performance Comparison

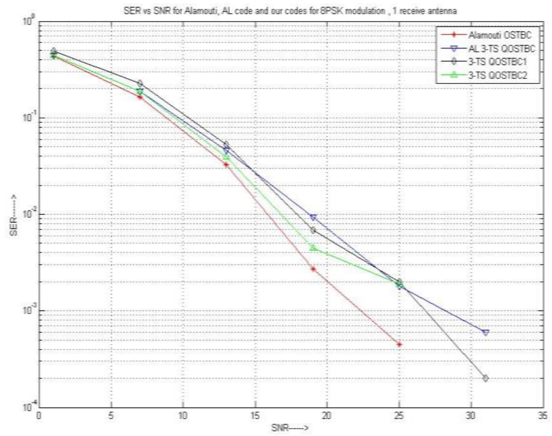

Figure:2 SER Performance Comparison

IV.CONCLUSION

We evaluate the SER for QOSTBCs with 3 time slots for two transmit antennas in frequency - flat quasi-static Rician fading channel. The codes given in [14] outperforms the AL code [6] with ML decoding.

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