Simulation of New 3-Time Slot QOSTBC for QPSK, 8-PSK and 16-QAM

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ABSTRACT

In this paper, we propose new 3-Time slot Quasi-orthogonal space time block code for LTE-A. and simulate this code, has better symbol error rate performance as compared to AL code [6] for Rayleigh fading channels.

Keywords — Orthogonal space-time block codes (OSTBCs), Quasi-orthogonal space-time block codes (QOSTBCs), Quasi-orthogonal space-time block codes with 3 time slots (3-TS-QOSTBCs), Maximum-likelihood (ML) decoding, symbol error rate (SER), Long term evolution-Advanced (LTE-A).

1. 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 numbers 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. 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 3TS-QOSTBCs have been proposed in [7] for two transmit antennas.

In this paper, we propose a new 3-TS-QOSTBC which is having better SER VS SNR for two transmit antennas and one receive antenna for QPSK,8PSK,16-QAM . The organization of this paper is as follows, section II provides system model and brief overview of 3TS-QOSTBCs for two transmits antennas. In section III, new QOSTBC is explained. Simulation results and conclusion are presented in section IV and V respectively.

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

2.1. System Model

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

$$r_t = \sum_{i=1}^{2} h_i c_t^i + \eta_t \quad (1)$$

$$1 \le i \le 2, 1 \le t \le 3$$

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

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

Where

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

is the QOSTBC and

$$h = (\mathrm{h}_1 \ \mathrm{h}_2)^T$$

$$\eta = (\eta_1 \ \eta_2 \ \eta_3)^T$$

$$R = (\mathrm{r}_1 \ \mathrm{r}_2 \ \mathrm{r}_3)^T \quad (4)$$

are channel vector, complex white Gaussian noise vector and received signal vector of the receive antenna, respectively. 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.

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

$$X = (\mathrm{x}_1 \ \mathrm{x}_2 \ \mathrm{x}_3)^T \quad (6)$$

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.

2.2 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

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

Few other 3TS-QOSTBCs for two transmit antennas have been proposed in [7] and [8].

3. PROPOSED CODE

Our proposed code with 3-TS-QSTBC is given below.

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

4. SIMULATION RESULTS

Simulation results of 3TS-QOSTBCs code are shown in figure. Fig. 1 shows curve between SER and SNR for Alamouti code [1], AL code [6] and our code for QPSK modulation for Rayleigh fading channel. Similarly, Fig. 2,3 shows SER Vs. SNR performance curves of Alamouti code , AL code [6] and our code for 8-PSK,16 QAM for Rayleigh fading channel.

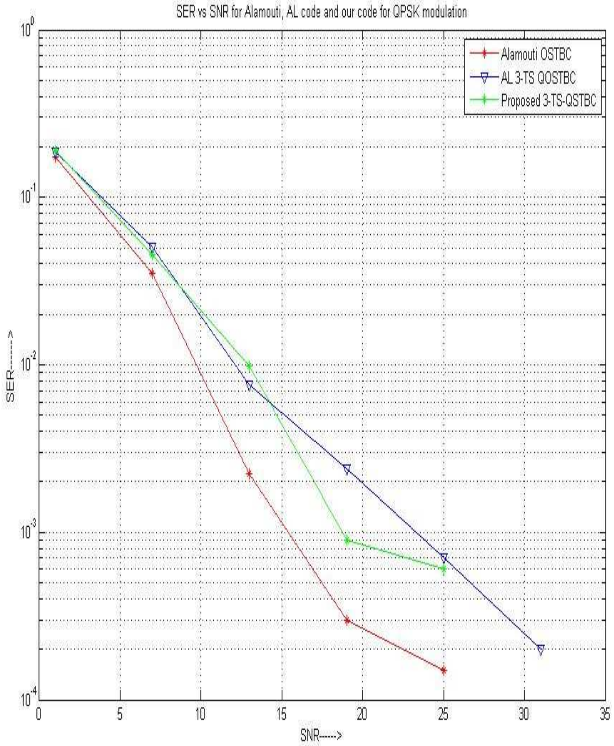

Figure:1 SER Performance Comparison for Rayleigh fading channel for QPSK.

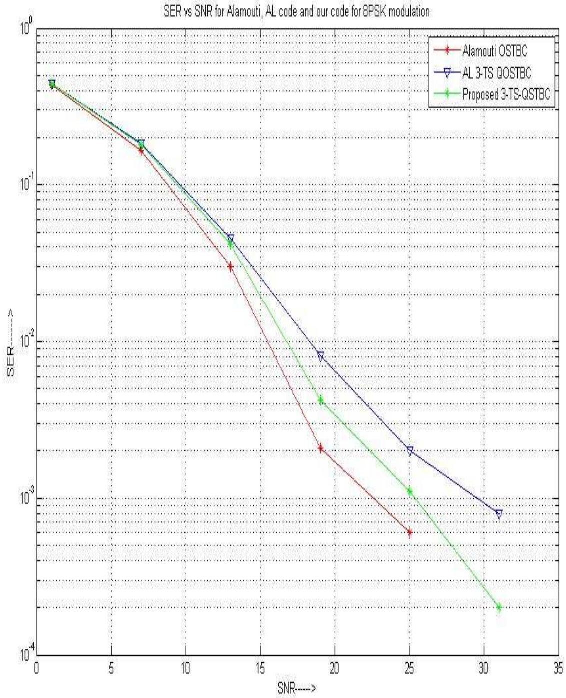

Figure:2 SER Performance Comparison for Rayleigh fading channel for 8PSK.

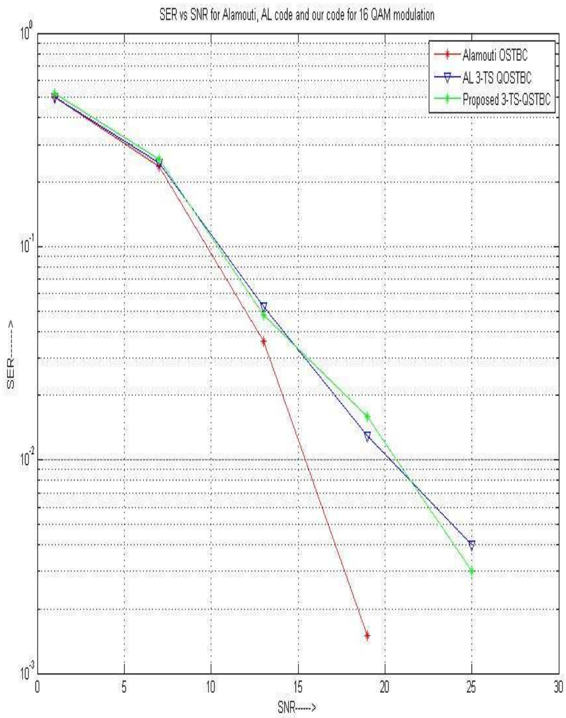

Figure:3 SER Performance Comparison for Rayleigh fading channel for 16QAM.

5. CONCLUSION

We evaluate the SER vs SNR for QOSTBC with 3 time slots for two transmit antennas and one receive antenna in Rayleigh fading channel. We find that, proposed code is working and outperforms the AL code [6] with different modulation techniques.

REFERENCES

[1] S. M. Alamouti, "A simple transmit diversity technique for wireless communications," IEEE Journal on Selected Areas in Communications, vol. 16, pp. 1451-1458, Oct. 1998.

[2] 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.

[3] H. Jafarkhani, "A quasi-orthogonal space-time block code," IEEE Trans. Commun., vol. 49, pp. 1-4, Jan. 2001.

[4] 3rd Generation Partnership Project, Evolved Universal Terrestrial Radio Access (E-UTRA); Physical Channels and Modulation(Release 8), 3GPP TS 36.211, Nov. 2008.

[5] Alcatel Shanghai Bell, Alcatel-Lucent,,"STBC-II scheme for uplink transmit diversity in LTE-Advanced, R1-082500, 3GPP TSG RAN WG 1Meeting 53 no bis, Jun-Jul. 2008

[6] Alcatel Shanghai Bell, Alcatel-Lucent, "STBC-II scheme with nonpaired symbols for LTE-Advanced uplink transmit diversity, R1- 090058, 3GPP TSG RAN WG 1 Meeting no 55 bis, Jan. 2009

[7] T.P. Ren, C. Yuen, Y.L. Guan, and K.H. Wang, "3-Time-Slot Group-Decodable STBC with Full Rate and Full Diversity, IEEE Commun.letters, vol. 16, issue 1, pp. 8688, Jan 2011.

[8] Z. Lei, C. Yuen, and F. Chin, "Quasi-orthogonal space-time block codes for two transmit antennas and three time slots, IEEE Trans. Wireless Commun., vol. 10, no. 6, pp. 19831991, June 2011

[9] Thakur, N.S.; Thakur, S.S.; Gogoi, A.K.,"Few More Quasi Orthogonal Space-Time Block Codes for Four Transmit Antennas" IEEE Intern. conference on Computational Intelligence an CommunicationNetworks (CICN), vol. 47, pp. 367-374, Oct.2011.

[10] O. Tirkkonen, A. Boariu, and A. Hottinen, "Minimal nonorthogonality rate 1 space-time block code for 3+ Tx antennas," in Proc. IEEE 6th Int. Symp. Spread-Spectrum Techniques and Applications (ISSSTA 2000), Sept. 2000, pp. 429-432.

[11] C. B. Papadias and G. J. Foschini, "Capacity-approaching space-time codes for systems employing four transmitter antennas," IEEE Trans. Inform. Theory, vol. 49, pp. 726-732, Mar. 2003.

[12] J. Hou, M. H. Lee, and J. Y. Park, "Matrices Analysis of quasiorthogonal space time block codes," IEEE Communications Letters, vol. 7, NO. 8, Aug. 2003

[13] P.V. Bien, W. Sheng, X. Ma, H. Wang,"Improved Decoder Schemes forQOSTBCs Based on Single-Symbol Decoding,"IEEE intern. Conference on Advanced Technologies for Communications(ACT), pp. 7-10,Oct. 2010.

[14] Thakur, N.S. ; Bhatia, R. ; Thakur, S.S., "Two New Quasi-Orthogonal Space-Time Block Codes with 3-Time Slots for LTE-Advanced" IEEE Intern. conference on Computers and Devices for Communication (CODEC), pp. 1-4, Dec.2012.

