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AN EFFICIENT SPACE-TIME CODING FOR WIRELESS COMMUNICATIONS WITH OFFSET 4 - PHASE SHIFT KEYING

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ABSTRACT

Channel capacity has long been a block in wireless communications. Various approaches are present in the literatures which are very effective in enhancing signal reception quality in fading channels. Various multiple antenna approaches have been used in wireless communications to combat the fading effect, which enhances both the channel capacity and performance greatly. Transmit Antenna Selection (TAS) is a well-known approach to improve diversity in multi-input multi-output (MIMO) communications. But the main drawback of TAS is that, it is very sensitive to feedback errors. Hence, Space-Time Coding (STC) is a communication approach for wireless systems that inhabit multiple transmit antennas and single or multiple receives antennas. In this paper, Space-Time Coding (STC) is employed in MIMO signaling scheme which helps in providing better knowledge at the receiver and no knowledge at the transmitter. Space-time trellis codes, space-time block codes and space-time differential coding are the STCs used in this paper. In this approach, the performance of the STC code is improved by the proposed Extended Balanced Space-Time Block Codes (EBSTBC). Also, this paper uses Offset 4- Phase-Shift Keying (O4-PSK) instead of 4- Phase-Shift Keying (4-PSK). This will help in reducing the bit error rate. The experiment is done with different PSK and with different bit rates. When the frame error probability is evaluated, the proposed EBSTBC system shows lesser error probability when compared to the previous STC codes.

Keywords: wireless communications, space-time coding, diversity, multiple transmit antennas.

INTRODUCTION

The longing for connectivity has caused an exponential growth in wireless networks. These networks support a wide variety of bandwidth demanding services with high quality of service while maintaining low power consumption and increasing spectrum efficiency. Depending on the Quality-of-Service requirements and different applications per user, many broadband wireless communication systems have been proposed. In these systems, data rates may exceed 100 Mbps while mobile units may move as fast as a high-speed train with user bandwidths that are fixed or dynamically allocated. In order to support wireless multimedia services, research efforts are carried out to develop efficient coding and modulation schemes along with sophisticated signal and information processing algorithms to improve the quality and spectral efficiency of wireless communication links. However, these developments must cope with critical performance-limiting challenges that include mobile radio channel impairments, multiuser interference (MUI) and size/power limitations at the mobile units.

Mobile radio channels are related to time-selective and frequency-selective fading [1] that are induced by carrier phase/frequency drifts, Doppler shifts and multipath propagation, respectively. Channel fading [2] leads to performance degradation and renders reliable high-data-rate transmissions a challenging problem. The exploitation of diversity is considered as effective method for combat fading. Based on the domain where the diversity is created, diversity techniques may be divided into three categories, namely, temporal diversity, frequency diversity and spatial diversity. Temporal and frequency diversity usually set up redundancy in time and/or frequency domain, and therefore induce loss in bandwidth efficiency. Typical examples of spatial diversity are multiple transmit- and/or receive-antenna communications [3]. By the usage of antennas at the transmitter or the receiver, multiple-antenna communications inherit space diversity to mitigate fading without necessarily sacrificing precious bandwidth resources; thus, they become attractive solutions for broadband wireless applications [4]. Compared to single-antenna transmissions, multiple antenna transmissions increase the channel capacity by an order of magnitude or more. An implementation of multiple-antenna [5] communications has been the layered space-time architecture [6, 7] whose capacity grows linearly with the minimum number of transmit-receive antennas under the assumption that the underlying propagation channels are independent, flat and known at the receiver. Without requiring channel estimates at either the transmitter or the receiver, the unitary space-time modulation was shown to be able to achieve substantial fraction of channel capacity.

Based on whether multiple antennas are used for transmission or reception, two types of spatial diversity can be used: receive-antenna diversity and transmit-antenna diversity. In receive antenna diversity technique; multiple antennas are deployed at the receiver to acquire separate copies of the transmitted signals which are then properly combined to mitigate channel fading. Because of size/power limitations at the mobile units, receive-antenna diversity appears less practical for the down-link transmissions. Transmit-antenna diversity relies on multiple antennas at the transmitter and is suitable for down-link transmissions because having multiple antennas at the base station is certainly feasible.

Among several transmit-antenna diversity schemes, particularly popular recently is space-time (ST) coding [8, 9] that relies on multiple antenna transmissions and appropriate signal processing at the receiver to provide diversity and coding gains over uncoded single-antenna transmissions. ST coding [10] has been recently adopted in third generation cellular standards and has been proposed for many wireless applications [11]. In [12], full rate balanced space-time block codes (BSTBCs) have been proposed which achieve full diversity for arbitrary number of transmit antennas when one or more feedback bits are transmitted via feedback channel. This paper focuses on space-time coded transmissions through time-selective fading channels. Finally, an Extended Balanced Space-time Block codes (EBSTBC) is proposed to improve the performance of the system. In order to reduce the bit rate error, this paper uses Offset 4- Phase-Shift Keying (O4-PSK) instead of 4- Phase-Shift Keying (4-PSK).

REVIEW OF LITERATURE

Space-Time Coding (STC) has been studied from early time and lots of advanced techniques have been proposed for implementing this communication technique for wireless systems. This section of the paper discusses the related work that was earlier proposed in literature for space-time turbo coding. Tarokh *et al*., in [13] described a space-time code that is applicable for high data rate wireless communications. Generally it is well known that space-time coding [14, 15] is a bandwidth and power efficient method of communication over fading channels that realizes the remunerations of multiple transmit antennas. Precise codes have been constructed using design criteria consequent for quasi-static flat Rayleigh fading, where channel state information is accessible at the receiver. It is apparent that the reasonableness of space-time codes [12] will be significantly improved if the derived design criteria continue to be applicable in the absence of perfect channel state information. It is even more enviable that the design criteria not be disproportionately sensitive to frequency selectivity and to the Doppler spread. They presented a theoretical study of these issues beginning with the effect of channel estimation error. They also assumed that the channel estimator extracts fade coefficients at the receiver and for constellations with constant energy, it is proved that in the absence of perfect channel state information the design criteria for space-time codes is still valid. They also derived the maximum-likelihood detection metric in the presence of channel estimation errors. They studied the effect of multiple paths on the performance of space-time codes for a slow changing Rayleigh channel. It is proved that the presence of multiple paths does not decrease the diversity order guaranteed by the design criteria used to construct the space-time codes.

Alamouti in [16] proposed a simple two branch diversity scheme. The diversity created by the transmitter utilizes space diversity and either time or frequency diversity. Space diversity is affected by redundantly transmitting over a plurality of antennas, time diversity is affected by redundantly transmitting at different times, and frequency diversity is affected by redundantly transmitting at different frequencies. The scheme makes use of two transmitter antennas and one receiver antenna. Even then the proposed scheme provides the same diversity order as maximal-ratio receiver combining (MRRC) with one transmit antenna, and two receive antennas. The principles of this invention are applicable to arrangements with more than two antennas, (i.e., similarly it was proved) that the scheme can be generalized to two transmit antennas and M receive antennas, such that it may provide a diversity order of 2M. The most important advantage of the proposed scheme is that it does not require any bandwidth expansion or any feedback from the receiver to the transmitter. Additionally, the computational complexity of the proposed scheme is very much similar to MRRC.

METHODOLOGY

Space-time coding

The general system model of space-time coding for flat fading channels is provided in Figure-1 with ST encoder and ST decoder [17] which involves various transmitters and receivers.

Consider a wireless system equipped with N_t transmit-antennas and N_r receive-antennas, as shown in Figure-1. At the transmitter, information data symbols s (n) belonging to the constellation set A are parsed into blocks s (n):=[s (nN_s)…s (nN_s+Ns-1)] ^{T} of size N_sx1. The block s (n) is then encoded by the ST encoder M (.)K which uniquely maps s (n) to the following N_txN_d code matrix:

$$c(n) := \begin{bmatrix} c_1(nN_d) & c_1(nN_d+1) & \dots & c_1(nN_d+N_d-1) \\ c_2(nN_d) & c_2(nN_d+1) & \dots & c_2(nN_d+N_d-1) \\ . & . & \dots & . \\ . & . & \dots & . \\ c_{N_t}(nN_d) & c_{N_t}(nN_d+1) & \dots & c_{N_t}(nN_d+N_d-1) \end{bmatrix} \qquad (1)$$

where the code symbol c_i(n) belongs to the constellation set B. The constellation sets A and B may be identical or different depending on different ST coding schemes. The N_d columns of c (n) are generated in successive time intervals T_c with each of N_t coded symbols in a given column sent through one of the N_t transmit-antennas simultaneously.

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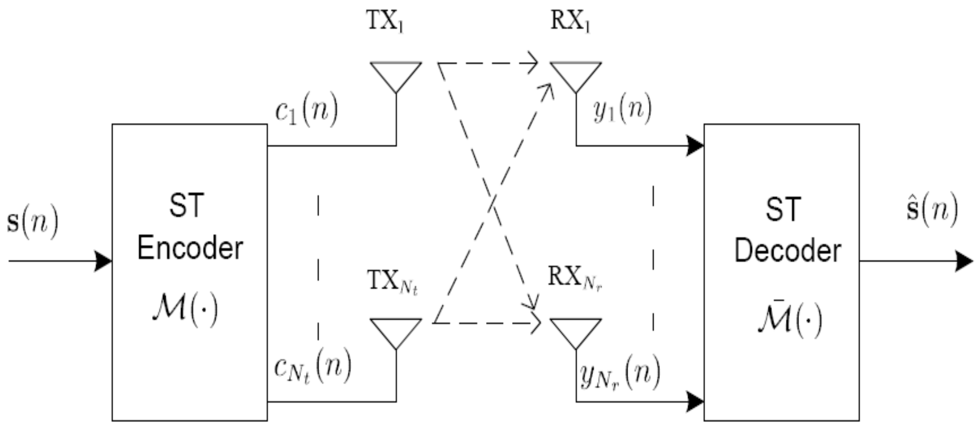

Figure-1. General system model of ST coding for flat fading channels.

Because N_d coded symbols from each transmit-antenna correspond to N_s information symbols, the overall transmission rate R is:

$$R = \frac{N_s}{N_d} log_2 |A| \; \frac{\frac{bits}{sec}}{Hz} \tag{2}$$

where |A| denotes the cardinality of A. Let E_c and E_s denote the average energy of c_i (n) and s (n), respectively. In order to constrain the total transmission power to be independent of the ST encoding, E_c and E_s related such that $E_c = \gamma E_s$, where $\gamma := N_s/(N_d N_t)$. Letting $y_i(n)$ be the baseband received signal at the jth receive antenna, the model is derived as:

$$y_j(n) = \sqrt{\gamma E_s} \sum_{i=1}^{N_t} h_{ij} c_i(n) + v_j(n), \qquad j = 1, \ldots, N_r \tag{3}$$

Given the received signals y_i (n) in (3), the ST decoder M (.) will decode s(n) using the unique mapping between C(n) and s(n). Different space-time coding schemes distinguish themselves with different encoding and decoding schemes.

Design of space-time coding

The design of space-time coding mainly involves two criterions:

- Rank criterion
- Determinant criterion

Rank criterion: In order to achieve the maximum diversity advantage, the matrix ΔC equivalently the matrix C-C' has to be full rank over all possible C and C' (C≠C')

Determinant criterion: Suppose ΔC is full rank. In order to achieve the maximum coding advantage, the minimum determinant of ΔC over all possible C and C' (C≠C') should be maximized.

Space-time trellis coding

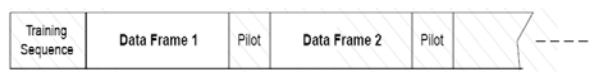

Figure-2. Signaling structure.

Figure-2 depicts the signaling structure of ST-TC where the information data symbols are transmitted frame by frame with pilot and training sequences inserted periodically. The pilot and training sequences are used for channel estimation, timing and synchronization. The data frames considered is s (n) and fit the ST-TC under the model. ST-TC does not change symbol constellation, i.e., A = B and $N_s = N_d$. If the pilot and training sequences are neglected, the transmission rate R = log_2|A| bits/sec/Hz can be easily seen which implies no bandwidth efficiency loss in ST-TC as compared to the uncoded case. ST-TC employs ML decoding and its encoding is optimal in terms of maximizing both diversity and coding advantages. In order to facilitate low-complexity Viterbi decoding, a trellis is designed to perform encoding in ST-TC.

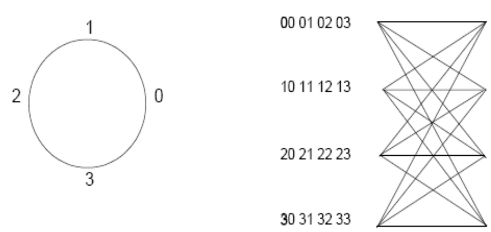

Figure-3. 4-PSK constellation label and encoding trellis.

For example, considering 4-PSK 4 states ST-TC with two transmit-antennas ($N_T = 2$). Figure-3 depicts the corresponding 4-PSK constellation labeling and encoding trellis. Using the encoding trellis, the ST encoder maps the data frame s(n) to the code matrix C (n). Consider an example, where s(n) = [1, 3, 2, 3, 0, 1 …] ^{T}, the code matrix is given by:

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$$C(n) = \begin{bmatrix} 0\,1\,3\,2\,3\,0\,1\ldots \\ 1\,3\,2\,3\,0\,1\ldots \end{bmatrix} \quad (4)$$

ST-TC achieves the maximum diversity advantage (A_d=N_tN_r) and the maximum coding advantage. However, for a fixed number of transmit antennas, its decoding complexity increases exponentially with the transmission rate.

The performance can be improved by using the Offset 4- phase-shift keying technique rather than 4-PSK technique.

Offset 4- Phase-Shift Keying (O4-PSK)

Offset 4- Phase-Shift Keying (O4-PSK) is a variation of phase-shift keying modulation which uses 4 different values of the phase to broadcast. It is occasionally called Staggered Phase-Shift Keying (S4-PSK).

Taking four values of the phase (two bits) at a time to build a 4-PSK symbol can permit the phase of the signal to jump by as much as 180° at a time. When the signal is low-pass filtered (as is typical in a transmitter), these phase-shifts result in large amplitude fluctuations, an undesirable quality in communication systems. By offsetting the timing of the odd and even bits by one bit-period, or half a symbol-period, the in-phase and quadrature components will never change at the same time. In the constellation diagram shown on the right, it can be seen that this will limit the phase-shift to no more than 90° at a time. This yields much lower amplitude fluctuations than non-offset QPSK and is sometimes preferred in practice.

Figure-4 represents the difference in the behavior of the phase between ordinary 4-PSK and O4-PSK. It can be seen that in the first plot the phase can change by 180° at once, while in O4-PSK the changes are never greater than 90°. It can be noted that the half symbol-period offset between the two component waves. The sudden phase-shifts occur about twice as often as for 4-PSK (since the signals no longer change together), but they are less severe. In other words, the magnitude of jumps is smaller in O4-PSK when compared to 4-PSK.

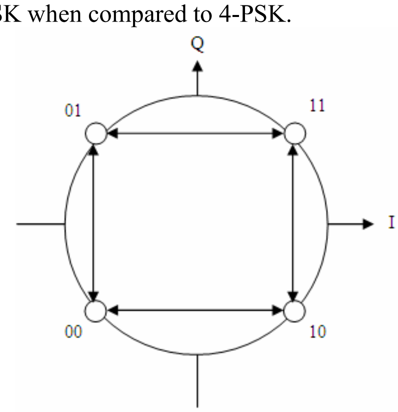

Figure-4. Difference in the behavior of the phase between ordinary 4-PSK and O4-PSK.

Space-time block coding

ST-BC was first proposed for two transmit-antennas and was later generalized to any number of transmit-antennas. One property of ST-BC is its decoding simplicity which makes it attractive especially when receiver complexity is at a premium. Compared to ST-TC, it turns out that ST-BC achieves maximum diversity advantage (A_d=N_tN_r), but it does not gain as much coding advantage as ST-TC and loses bandwidth efficiency when more than two transmit antennas are employed. To compensate for this loss, one method is to increase the constellation size at the expense of coding advantage.

The signaling structure of ST-BC is the same as that of ST-TC (Figure-2). Unlike ST-TC, the block length N_s in ST-Bc is equal to N_t and cannot be arbitrary. Accordingly, ST-BC divides each data frame into blocks s (n) of size N_sx1which are then encoded by ST encoder M (·) (Figure-1). As a simple but practically important example for ST-BC, ST-BC with two-transmit antennas (N_T=2) and one receive-antenna (N_r=1) are discussed next. Note that ST-BC with N_T=2 is the only ST-BC with 100% bandwidth efficiency.

When s(n):=[s (2n) s (2n+1)] ^{T}, the ST encoder maps s (n) into:

$$C(n) = \begin{bmatrix} s(2n) & -s^*(2n+1) \\ s(2n+1) & s^*(2n) \end{bmatrix} \quad (5)$$

Since complex conjugation is involved in (7), the constellation set A may not be preserved in ST-BC. Substituting (5) into (3), it follows that two consecutive received samples are given by:

$$y(2n) = \sqrt{E_s/2}\,.\,[\boldsymbol{h_1}s(2n) + \boldsymbol{h_2}s(2n+1)] + v(2n) \quad (6a)$$

$$y(2n+1) = \sqrt{E_s/2}\,.\,[-\boldsymbol{h_1}s^*(2n+1) + \boldsymbol{h_2}s^*(2n)] + v(2n+1) \quad (6b)$$

where index j is dropped because there is only one receive-antenna. To decode s(2n) and s(2n+1), the ST decoder is designed by forming the two consecutive output samples, z (2n) and z (2n+1) as:

$$\begin{bmatrix} z(2n) \\ z(2n+1) \end{bmatrix} = \begin{bmatrix} \boldsymbol{h_1^*} & \boldsymbol{h_2} \\ \boldsymbol{h_2^*} & -\boldsymbol{h_1} \end{bmatrix} \begin{bmatrix} y(2n) \\ y^*(2n+1) \end{bmatrix} \quad (7)$$

Here, $\begin{bmatrix} \boldsymbol{h_1^*} & \boldsymbol{h_2} \\ \boldsymbol{h_2^*} & -\boldsymbol{h_1} \end{bmatrix}$ is H_{12}

Substituting (6a) and 6(b) to (7), the following equation is obtained:

$$\begin{bmatrix} z(2n) \\ z(2n+1) \end{bmatrix} = \sqrt{\frac{E_s}{2}}\,.\,(|h_1|^2 + |h_2|^2)\,.\begin{bmatrix} s(2n) \\ s(2n+1) \end{bmatrix} + H_{12}\begin{bmatrix} v(2n) \\ v^*(2n+1) \end{bmatrix} \quad (8)$$

and decode s (n) from z (n). Exploiting the fact that H_{12} defined in (8) is unitary, it can be readily deduced that the decoding in (7) is ML and maximum diversity advantage A_d = 2 is obtained.

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Space-time differential coding

The (coherent) decoding in both ST-TC and ST-BC requires channel estimates at the receiver that are acquired either through training, or, via blind estimation algorithms. Since multiple N_tN_r channels have to be estimated, channel estimation implicitly assumes that the underlying channels remain invariant for a long time, which may not be true for a number of applications. Motivated by the conventional (single-antenna) differential coding where the need of channel estimation is circumvented, several ST differential coding (ST-DC) schemes have been proposed recently to achieve maximum diversity advantage without requiring knowledge of channel estimates. The basic idea behind these schemes is to introduce proper encoding between two consecutive code matrices so that the decoding at the receiver is independent of the underlying channels. As expected, the price paid for is code advantage in addition to 3 dB loss in SNR compared to coherent decoding.

DSTM has parameters: $N_s=1$, $NT=N_d$ and therefore $R = (1/N_t)\log_2|A|$. The differential encoding in DSTM relies on a finite group $\mathcal{G}$ of $N_t x N_t$ unitary matrices where $\forall G \in \mathcal{G}$. $GG^H=G^HG=I$. To ensure unique correspondence between $\mathcal{G}$ and A, their cardinalities are equated, i.e., M: $=|\mathcal{G}|=|A|$. Let $\mathcal{G}$ be defined as $\mathcal{G}$:={ $G0 \ldots GM_{-1}$} and A :={ $s0 \ldots sM_{-1}$} and establish, without loss of generality, the following one-to-one (ordered) mapping between elements of A and $\mathcal{G}$:

$$s_i \leftrightarrow G_i, \quad \forall_i = 0,0,\ldots M-1 \tag{9}$$

According to (9), s (n) is mapped to G (n) where G (n)$\in \mathcal{G}$. The differential encoding between C (n) and c (n-1) obeys:

$$C(n) = C(n-1)G(n), C(0) = I \tag{10}$$

Exploiting the recursion (10), decoding of s (n) and equivalently G (n) is performed by choosing:

$$G(n) = \arg\min_{G\in\mathcal{G}} ReTr\{GY^H(n)Y(n-1)\} \tag{11}$$

Where Y (n) is the received data matrix with $(j,i)^{th}$ entry $y_j(nN_d+i)$ and ReTr denotes the real part of the trace. It can be seen from (11) that the decoding does not require knowledge of the channels.

Extended space-time block codes (EBSTBC)

The EBSTBCs can be obtained when an extension matrix is multiplied with an OSTBC.

Orthogonal space-time block codes (OSTBC)

OSTBC is a unique instance of linear codes, where the codeword X is intended to be a unitary matrix. Such modulation matrices exist for limited values of K, M_t and T. For instance, the orthogonal block code for $M_t = 2$, T = 2 is the Alamouti code [16] consisting of four matrices shown below:

$$X = \begin{bmatrix} s_1 & -s_2^* \\ s_2 & s_1^* \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \Re s_1 + \begin{bmatrix} j & 0 \\ 0 & -j \end{bmatrix} \Im s_1 + \begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix} \Re s_2 + \begin{bmatrix} 0 & j \\ j & 0 \end{bmatrix} \Im s_2 \tag{12}$$

Extended balanced space-time block codes (EBSTBC)

The EBSTBCs can be obtained when an extension matrix is multiplied with an OSTBC. As Alamouti's code is the only orthogonal code with rate one and minimum delay, the EBSTBCs can be obtained as an extension of the Alamouti's code.

$$C = XW \tag{13}$$

X represents the Alamouti's code and W represents the 2xN matrix where N≥2 and the rank of W must be 2. The following instance shows how to generate the EBSTBCs for three transmitters. Consider the EBSTBC pair with transmission matrix.

$$C_1 = \begin{bmatrix} s_1 & s_2 & a s_2 \\ -s_2^* & s_1^* & a s_1^* \end{bmatrix} \tag{14}$$

where $a = e^{\frac{j2\pi m}{q}}$, q is the extension level and m= 0, 1,..., q-1. The columns and rows of C_1 denote symbols transmitted from three transmit antennas in two signaling intervals, respectively. C_1 is obtained from the Alamouti code using (13) where:

$$X = \begin{bmatrix} s_1 & -s_2^* \\ s_2 & s_1^* \end{bmatrix} \; W = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & a \end{bmatrix} \tag{15}$$

Arbitrary number of the EBSTBCs can be generated in this way. BSTBC has limited number of codes is limited since q is equal to 2 and $a = \pm 1$. the number of possible EBSTBCs is $q^{N-2}(2^{N-1}-1)$. Because of this reason, the destination needs N + d feedback bits (N ≥ 3) to chose any possible EBSTBCs where $d = \lceil (N-2)\log_2 q \rceil - 1, N-2$ feedback bits are needed to achieve full diversity as in BSTBCs [12]. The rest of the d+2 feedback bits provide coding gain. In BSTBCs, the extension level is only two, then, the number of available codes is $2^{N-2}(2^{N-1}-1)$ [12].

As demonstrated in [12], in MISO systems with BSTBCs, the SNR contains the terms $\sum_1^N |\mathbf{h}_i|^2$, which give diversity of order N, and non-negative additional terms which give coding gain on the strength of their amount. By increasing the extension level, EBSTBCs generate higher coding gains whose properties are given below.

Property 1: The diversity order of the EBSTBCs is N for MISO system that consist of N transmit antennas and one receive antenna.

Proof: The diversity order of BSTBCs is N for MISO system where the transmitter is equipped with N antennas

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[18]. Since the BSTBCs are the subset of EBSTBCs, the diversity order of the EBSTBCs cannot be lower.

Property 2: The coding gain of the proposed EBSTBCs is greater than or equal to the coding gain of the BSTBCs.

Proof: For one bit extension of the feedback $(k = 1)$, the EBSTBCs are the same as BSTBCs. When more than one bit extension is available $(k \geq 1)$, the EBSTBCs family includes all of the BSTBCs and additional $2^{(k-1)(N-2)}\,(2^{N-1} - 1)$ extended codes. Since the mobile user selects the code which gives the maximum coding gain; the coding gain of the EBSTBCs is greater than or equal to the coding gain of the BSTBCs.

Property 3: The rate of EBSTBCs is full (R = 1).

Proof: Since each EBSTBC matrix transmits two symbols (s_1 and s_2) in two time intervals, the rate of EBSTBC is full (R =1).

Considering three transmit antennas are present in the base station, then, C_1, C_2 and C_3 are available EBSTBC matrices. These matrices are:

$$C_1 = \begin{bmatrix} s_1 & s_2 & as_2 \\ -s_2^* & s_1^* & as_1^* \end{bmatrix}, C_2 = \begin{bmatrix} s_1 & s_2 & as_1 \\ -s_2^* & s_1^* & -as_2^* \end{bmatrix} \quad (16)$$
$$C_3 = \begin{bmatrix} s_1 & as_1 & s_2 \\ -s_2^* & -as_2^* & s_1^* \end{bmatrix}$$

The mobile user selects the EBSTBC $Cj, j = 1,2,3$, that gives the maximum coding gain and the feedback a. Two bits of feedback is needed to select the EBSTBC matrices and k bits of feedback is needed to select the feedback a where $k = \lceil log_2\, q \rceil$

The decoding of the EBSTBCs is similar to the decoding of BSTBCs [18]. After combining, the estimates of the PSK symbols s_1 and s_2 at the mobile user can be expressed as
follows:

$$\hat{s_i} = \sqrt{\frac{P}{3}\left[\left(|b_1|^2 + |b_2|^2 + |b_3|^2 + 2\max\left(Re\{ab_2^*b_3\}, @Re\{ab_1^*b_3\}, Re\{ab_1^*b_2\}\right)\right)\right]}\, s_i + \eta_i, \qquad i = 1,2 \quad (17)$$

n_1 and n_2 represents the noise. The contribution of the $2\max\left(Re\{ab_2^*b_3\}Re\{ab_1^*b_3\}, Re\{ab_1^*b_2\}\right)$ in (17) will always be positive and the gain will be greater than the sum of the magnitude squares of all path gains. $(|h_1|^2 + |h_2|^2 + |h_3|^2)$ It can be seen from (5) that the EBSTBC always achieves full diversity and a coding gain.

EXPERIMENTAL RESULTS

The proposed Extended Balanced Space-Time Block Code (EBSTBC) is experimented with different PSK and with different bit rates. Also the number of receiver and transmitter is varied for testing. The experimental results shows that the proposed approach obtains less frame error probability when compared to existing space time block code.

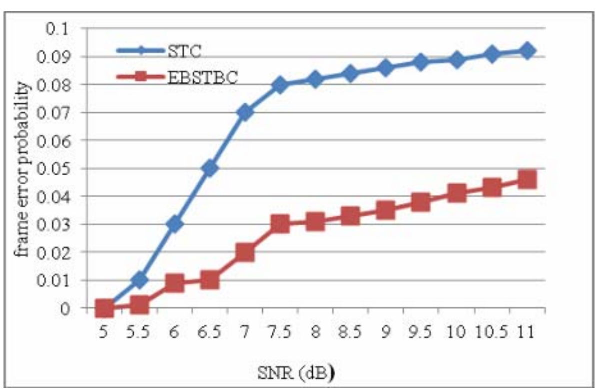

Figure-5. Codes for O4-PSK with two receive and two transmit antennas for STC and EBSTBC.

Figure-5 shows the Frame Error Probability with the signal to noise ratio (SNR) for STC and the proposed EBSTBC. The values in Figure-4 are obtained by chosing 4-PSK with rate 2b/s/Hz that achieve diversity 2 wuth two receiver and two transmitter antennsa. It can be clearly observed from the Figure that the proposed appraoch which uses the EBSTBC results only lesser frame error probability when compared to standard Space time block algorithm. This in case increases the perfomance of the wireless network to transmit and receive the data with very fewer errors.

CONCLUSIONS

In this paper, a novel technique of codes called the Space-Time codes for transmission using multiple transmit antennas over Rayleigh or Rician wireless channels is discussed. The performance of these codes was shown to be excellent, and the decoding complexity comparable to codes used in practice on Gaussian channels. The novel EBSTBC is proposed in this paper. The performance of STCs is improved by means of extending available number of codes to provide improved coding gain. The proposed coding technique helps in achieving better transmission data with less errors. The experimentation is conducted on multiple reciever and multiple tranamitter wireless system. The expeirmental results shows that the frame error probability is lesser for the proposed technique when compared to the existing methods. This shows that the proposed coding scheme results in better perfomanec and error free tranamission off data.

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