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Channel Estimation In The STTC For OFDM Using MIMO With 4G System

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Abstract: *This paper presents performance of the STTC based MIMO-OFDM system. The goal was to reach 10^{-5} Bit error rate & achieve high Signal to noise ratio (SNR) to evaluate the performances of the system. The results of this dissertation are based on PSK modulation technique over fast Channel Estimation. We have simulated the proposed approach for 2-PSK, 4-PSK, 8-PSK, 16-PSK and the number of OFDM subcarriers. In our result we have considered that is transmitter and receiver so that maximum illustrates the noise reduction in balanced STTC for OFDM based MIMO channel with 2-PSK, 4-PSK, 8-PSK and 16-PSK modulation schemes in terms of Bits error rate and signal to noise ratio(SNR) gain. We simulate the result with 2 x 2 antennas and decoding of the signal STTC codes are simulated by using three different techniques, these are MMES(minimum mean square error), ZF(zero forcing), and ML(maximum likelihood) with viterbi algorithm.*
Keywords: *Channel Estimation, STTC, OFDM, MIMO, MATLAB, PSK Modulation.*

I. Introduction

In Recent year, the wireless communication industry is facing new challenges due to constant evolution of new standards (2.5G,3G, and4G). Wireless system are expected to require high data rates with low delay and low bit-error-rate (BER). In addition, high data rate transmission and high mobility of transmitter and/or receivers usually result in frequency-selective and time-selective, i.e., doubly selective, fading channels for future mobile broadband wireless system.

Orthogonal frequency division multiplexing (OFDM) is a method of encoding digital data on multiple carrier frequencies. OFDM has developed into a popular scheme for wideband digital communication, whether wireless or over copper wires, used applications such as digital television & audio broadcasting, DSL Internet access, wireless networks, power-line network, and 4G mobile communication [4]. An orthogonal frequency division multiplexing(OFDM) is an efficient high data-rate, having advantages of high spectrum efficiency, simple & efficient implementation by using the fast Fourier transform(FFT) & the inverse FFT(IFFT), mitigation of inter symbol Interference by inserting a cyclic prefix (CP) and robustness to frequency selective fading channels transmission technique for wireless communication[3].

Multiple-input & multiple-output or MIMO is the use of multiple antennas at both the transmitter & receiver to improve communication performance. It is one of several forms of smart antenna technology. MIMO technology has attracted attention in wireless communications, because it offers significant increases in data throughput and link range without adding bandwidth or increased transmit power. It achieves this goal by spreading the same total transmit power over the antennas to achieve an array gain that improves the spectral efficiency and/or to achieve a diversity gain that improves the link reliability (reduced fading)[6]. Because of these properties MIMO is an important part of modern wireless communication standards.

Space-time-trellis-coding(STTC) is an attractive & promising solution, which achieves bandwidth efficient transmit diversity by using specially designed channel codes at the transmitter end in combination with some additional signal processing at the receiver. Use with MIMO-OFDM for improves the data-rate and the reliability of wireless communication. The decoding of signal STTC codes are simulated by using three different decoding techniques, these are MMES (minimum mean square error), ZF(zero forcing), ML(maximum likelihood) using soft decision decoding with viterbi algorithm.

II. MIMO-OFDM System Model

Multiple antennas can be used at the transmitter and receiver, an arrangement called a multiple-input multiple- output (MIMO) system. A MIMO system takes advantage of the spatial diversity that is obtained by spatially separated antennas in a dense multipath scattering environment. MIMO systems may be implemented in a number of different ways to obtain either a diversity gain to combat signal fading or to obtain a capacity gain. Generally, there are three categories of MIMO techniques. The first aims to improve the power efficiency by maximizing spatial diversity. Such techniques include delay diversity, space–time block codes (STBC) and space–time trellis codes (STTC). The second class uses a layered approach to increase capacity. One popular example of such a system is V-BLAST where full spatial diversity is usually not achieved. Finally, the third type exploits the knowledge of channel at the transmitter. It decomposes the channel coefficient matrix using singular value decomposition (SVD) and uses these decomposed unitary matrices as pre- and post-filters at the transmitter and the receiver to achieve near capacity.

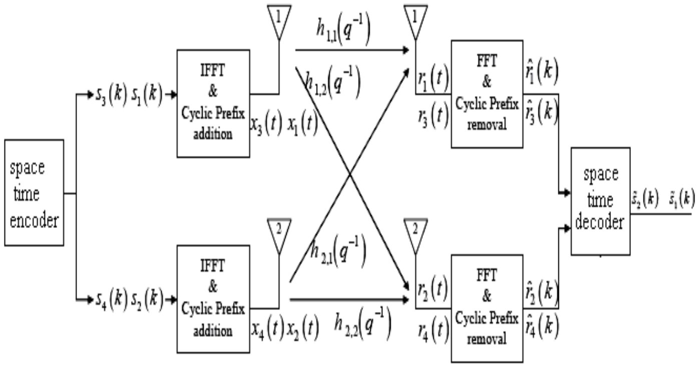

Fig 1 MIMO-OFDM

Assuming that the channel characteristics remain constant over two consecutive OFDM symbols, the received signals are expressed by

$$r_1(t) = h_{11}(q^{-1})x_1(t) + h_{21}(q^{-1})x_2(t)$$
$$r_2(t) = h_{21}(q^{-1})\, x_1(t) + h_{22}(q^{-1})\, x_2(t)$$
$$r_3(t) = h_{11}(q^{-1})x_3(t) + h_{21}(q^{-1})x_4(t)$$
$$r_4(t) = h_{21}(q^{-1})\, x_3(t) + h_{22}(q^{-1})\, x_4(t)$$

Where $h_{i,j}(q^{-1})$, i = 1,2 and j = 1,2 are the discrete-time filter representations of the channel from the j-th transmit antenna to the i-th the receive antenna.

III. STTC And Channel Estimation

A. Space Time Trellis Coded

Space Time Trellis Coded Modulation (STTCM) is obtained by combining channel coding with the Multiple Input Multiple Output (MIMO) concept to improve the data rate and the reliability of wireless communications. Many performance criteria have been established to maximize both diversity and coding gain of STTC. The rank and determinant criteria for slow fading channels and the Euclidian distance and the product distance criteria for fast fading channels.Convolution encoders with the same structure but with different weighting coefficients are assigned to transmitting multiple branches in STTC [2]. The state transitions of the encoders are therefore the same, but their outputs differ, according to the past inputs. A maximum-likelihood series estimator (i.e., a Viterbi decoder) can be applied at the receiving side. We consider the case of 2^n-PSK space-time trellis encoder as shown on Fig 2

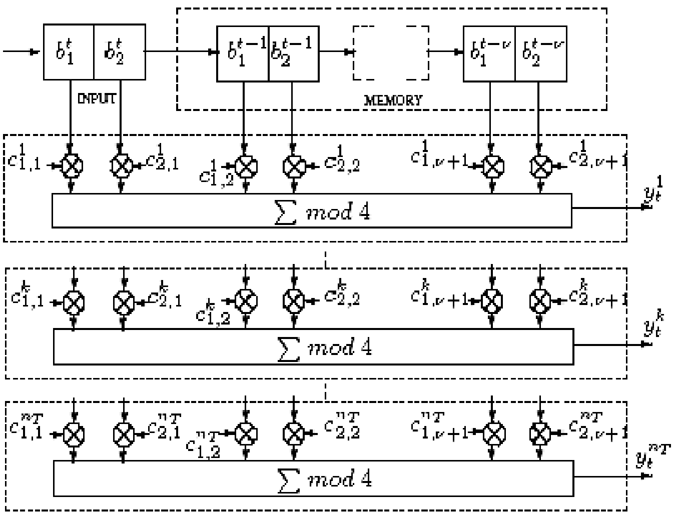

Fig 2 ST trellis encoder with 4-PSK and n_T Transmit antennas

This encoder is composed of one input block of n bits and ν memory blocks of n bits. At each time t, all the bits of a block are replaced by the n bits of the previous block. The i[th] bit b^{t-j+1} i, i = 1. .... . n, of the j[th] block, j = 1. … . ν + 1, is associated to n_T multiplier coefficients $c^k{}_{i,j}$, k = 1. ... . n_T where n_T is the number of transmit antennas. A ST trellis encoder is thus classically defined by its generator matrix **C** of $n_T \times n(\nu + 1)$ coefficients

$$C = \begin{bmatrix} c^1_{1,1} & c^1_{n,1} \cdots\cdots\cdots & c^1_{n,v+1} \\ c^k_{1,1} & c^k_{n,1} \cdots\cdots\cdots & c^k_{n,v+1} \\ \vdots & \vdots & \vdots \\ c^{nT}_{1,1} & c^{nT}_{n,1} \cdots\cdots\cdots & c^{nT}_{n,v+1} \end{bmatrix}$$

The encoder outputs for the k[th] antenna are computed

$$y_t^k = \sum_{i=1}^{n} \sum_{j=1}^{v+1} b_t^{t-j+1} c_{i,j}^k \mod 2^n \quad \text{……..4.6}$$

A typical S'TTC based wireless system has an encoder, pulse shaper, modulator and multiple transmit antennas at the transmitter, and the receiver has one or more receive antennas, demodulator, channel estimator and STTC decoder. We consider a mobile communication system with n_T transmit antennas and n_R receive antennas. The space-time trellis encoder encodes the data s(t) coming from the information source and the encoded data is divided into n_T streams of data.

$$C_T^1 \ \ C_T^2 \ldots\ldots\ldots\ldots C_T^{nT}$$

Each of these streams of data passes through a pulse shaper before being modulated. The output of modulator i at time slot t is the signal C_T^T, which is transmitted through transmit antenna i . Here n_T $1 \le i \le n_T$. The transmitted symbols have energy E_T. We assume that the n_T signals are transmitted simultaneously from the antennas. The signals have transmission period T. In the receiver, each antenna receives a superposition of n_T transmitted signals corrupted by noise and multipath fading. Let the complex channel coefficient between transmit antenna i and receive antenna j have a value of $h_{ij}(t)$ at time t, where $1 \le i \le n_R$. The received signal at antenna j, j=1,2,......., n_R is

$$r_t = \sqrt{E_s} \sum_{i=1}^{n} h_{i,j}(t) c_t^i(t) + n_t^j \quad \text{…………4.7}$$

Where η_t^j is additive white Gaussian noise (AWGN) at receive antenna j **,** which has zero mean and power spectral density N_0 and, $h_{ij}(t)$ channel coefficient between transmit and receive antennas. Time, frequency and spatial diversity are the traditional strategies to combat multipath fading, which is a major obstacle to high data rates over mobile communication channels. STTCs are represented in a number of ways, such as the trellis form or generator matrix form most codes are presented in trellis form but for a systematic code search, the generator matrix form is preferable. The generator matrix representation is also used for convolution codes. However the generator matrix notation of space time trellis codes (STTC) is little different than that used for convolution codes. Two input bits enter the encoder every symbol period.

Let the input symbol stream to the encoder is [2 3 2 1 0 1 ……..]. Initially the encoder is in state "0". Thus "0" will be transmitted from the first antenna, the second antenna transmits "2" and the encoder goes into state "2" In this way for this input symbol stream the output for the 4-PSK STTC is as follows in table 1.

Table 1: PSK 4-State STTC

	Output symbols			
State	Input 0	Input 1	Input 2	Input 3
0	00	01	02	03
1	10	11	12	13
2	20	21	22	23
3	30	31	32	33

It is assumed that the STTC codeword is given by

$$C = (C_1^1 C_1^2 \ldots\ldots C_1^{nt} C_2^1 C_2^2 \ldots\ldots C_2^n \ldots\ldots\ldots C_L^1 \, C_L^2 \ldots\ldots\ldots C_L^{nt}) \quad \text{………………4.8}$$

Where l is the frame length. We consider a maximum likelihood receiver, which may possibly decide on an erroneous code word **e,** given by
$e=(e_1^1 e_1^2 \ldots\ldots e_1^{nt} e_2^1 e_2^2 \ldots\ldots e_2^{n} \ldots\ldots e_L^1 e_L^2 \ldots\ldots e_L^{nt})$ 4.9

We can write the difference code matrix, the difference between the erroneous codeword and the transmitted codeword as follows [5]

$$B(c,e) = \begin{bmatrix} e_1^1 - c_1^1 & e_2^1 - c_2^1 & \cdots & e_L^1 - c_L^1 \\ e_1^2 - c_1^2 & e_2^2 - c_2^2 & \cdots & e_L^2 - c_L^2 \\ e_1^3 - c_1^3 & e_2^3 - c_2^3 & \cdots & e_L^3 - c_L^3 \\ \vdots & \vdots & & \vdots \\ e_1^{nt} - c_1^{nt} & e_2^{nt} - c_2^{nt} & \cdots & e_L^{nt} - c_L^{nt} \end{bmatrix}$$

The difference matrix B(c, e) has dimension n_t x l. we know that to achieve the maximum diversity order $n_T n_R$ (n_R receive antennas, n_T transmit antennas) matrix B(c,e)must have full rank for all possible codewords c and e . If B(c,e) has minimum rank r over the set of pairs of distinct codewords then the diversity will be r n_R .

B. Channel Model for MIMO-OFDM

The channel model of MOMO-OFDM can be represented by following discrete time model

$$\begin{bmatrix} y_1 \\ \vdots \\ y_{Nr} \end{bmatrix} = \begin{bmatrix} h_{11} & \cdots & h_{1Nt} \\ \vdots & \ddots & \vdots \\ h_{Nr} & \cdots & h_{NrNt} \end{bmatrix} \begin{bmatrix} x_1 \\ \vdots \\ x_{Nt} \end{bmatrix} + \begin{bmatrix} n_1 \\ \vdots \\ n_{Mr} \end{bmatrix}$$

Or simply it can be represented as

$$\mathbf{y=H\ x + n}$$

Where N_t is the total number of transmitted antennas and N_r is the total number of receiving antennas. here x represents the N_t dimensional transmitted symbol, n is the N_r dimensional noise vector, and H is the N_t N_r matrix of channel gains. h_{11} is the gain from transmit antenna 1 to receive antenna1 and x is the space time coded signal. The channel bandwidth is assumed to be B and complex Gaussian noise with zero mean. In the system design, both discrete Rayleigh and Nakagami fast fading MIMO channel models are assumed, where N_t and N_r are the number of transmit and receive antennas respectively. In the transmitter, a data stream is demultiplexed into N_t independent sub streams. Each sub stream is encoded into transmit symbols using a modulation scheme (e.g. BPSK, QPSK, M-QAM, etc.) at symbol rate 1/T symbol/sec with synchronized symbol timing.

The baseband N_r dimensional received signal vector

$$r(k) = [r_1(k),r_2(k),\ldots\ldots rN_R(K)^T]$$

At sampling instant k may be expressed as

$$r(k) = H.x(k) + n(k)$$

Where

$$H=\begin{bmatrix} h_{11} & \cdots & h_{N_T1} \\ \vdots & \ddots & \vdots \\ h_{1N_r} & \cdots & h_{N_TN_r} \end{bmatrix}, r(K)=\begin{bmatrix} r_1(K) \\ \vdots \\ r_{NR}(K) \end{bmatrix} X(K)=, n(K)=\begin{bmatrix} n_1(K) \\ \vdots \\ n_{NR}(K) \end{bmatrix}$$

$$X(K) = [X_1(K),X_2(K),\ldots\ldots.,XN_T(K)^T]$$

The transmit symbol vector with equally distributed transmitted power across the transmitted signal. Here, the superscript T is transposition. H denotes the N_tN_r channel matrix, whose elements $h_{m\,n}$ at the m^{th} row and nth column is the channel gain from the m^{th} transmit antenna to the nt^{h} receive antenna and they are assumed to be independent and identically distributed (I.I.D) circularly symmetric complex Gaussian random variables with zero-mean and unit-variance, having uniformly distributed phase and Rayleigh or Nakagami distributed magnitude or amplitude. A commonly used channel model in MIMO wireless communication systems is a block fading (also known as quasi-static) channel model where the channel matrix elements, which are I.I.D complex Gaussian (Rayleigh or Nakagami fading) random variables, are constant over a block and change independently from block to block. The index k for the channel gain. The elements of the additive noise vector,

$$n(K) = [n_1(K),n_2(K),\ldots\ldots..,nN_T(K)]^T$$

are assumed to be also white I.I.D complex Gaussian random variables with zero-mean and unit-variance. From this normalization of noise power and channel loss, the averaged transmitted power which is equal to the average SNR at each receiver antenna and is to be not greater than N_t .

B. Simulations

The main goal was improve the Signal to Noise Ratio at 10^{-5} Bit Error Rate (BER) for improve the performance of the system. Therefore for each SNR information bits were simulated for each system. The modulation technique used in system is Phase Shift Key (PSK). For simulation process the 2-PSK, 4-PSK, 8-PSK and 16-PSK modulation are used and number of OFDM subcarriers are assumed to be 124. The following simulation parameters are shown in table 2.

Table 2: various simulation parameters

Modulation scheme	2-PSK, 4-PSK, 8PSK, 16-PSK
Number of subcarrier for OFDM	124
Symbol length	64
Channel estimation	Perfect
Signal estimation	Correlated
Channel	Fast channel
Decoding techniques	MMSE, ZF, ML

C. Simulation Result

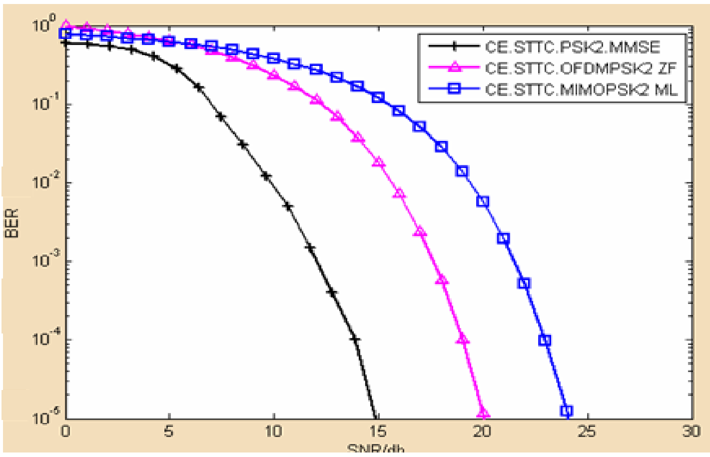

Fig.3. Channel estimation in the STTC for OFDM- MIMO with fourth Generation wireless system with 2-PSK

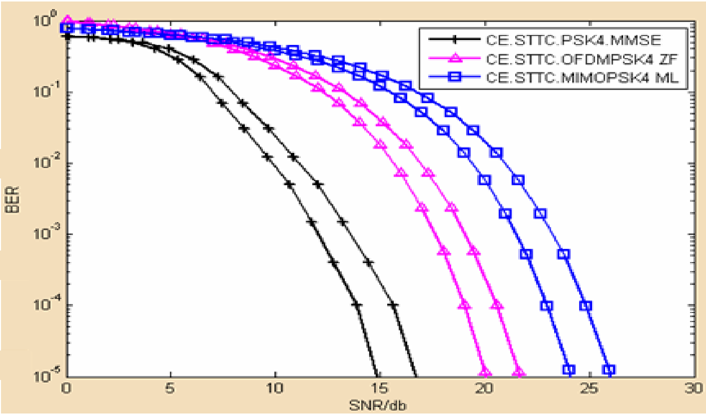

Fig.4. Channel estimation in the STTC for OFDM-MIMO with fourth Generation wireless system with 4-PSK

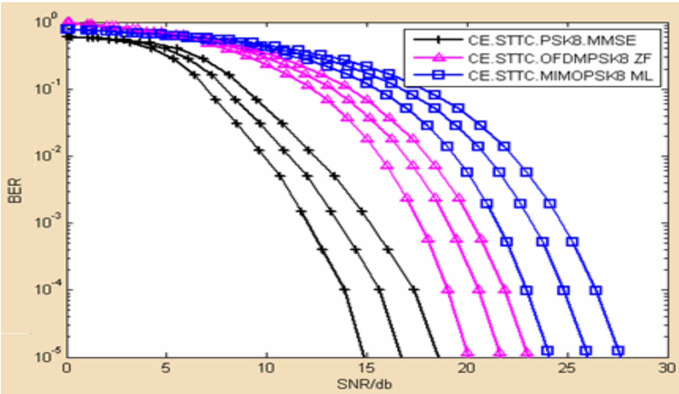

Fig.5. Channel estimation in the STTC for OFDM-MIMO with fourth Generation wireless system with 8-PSK

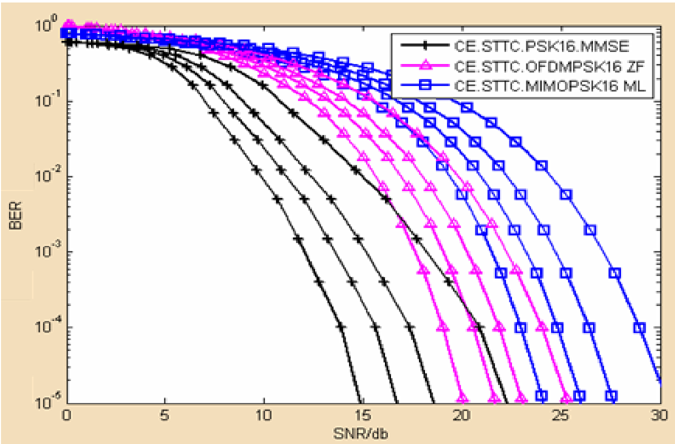

Fig.6. Channel estimation in the STTC for OFDM-MIMO with fourth Generation wireless system with 16-PSK

IV. Conclusion

In this paper, the channel estimation based on Space-time-trellis-code (STTC). The STTC are used three different decoding techniques for reduce the Bit Error Rate (BER) and improve the Signal to Noise Ratio (SNR). These techniques are Minimum Mean Square Error (MMSE), Zero Forcing (ZF), and Maximum Likelihood (ML). After observing all simulation result that the value of SNR are improve.

Algorithm	BER	SNR
Least Mean Square (LMS) algorithm	10^{-3}	30dB
Space time trellis code (STTC) & Viterbi Algorithm	10^{-5}	30dB

V. Future Work

In wireless system the most important part is channel estimation, which is increase by reduced to BER and increase the SNR values. These both value can be more decrease and increase by the use of more different technique and algorithms, which provide more reliable system and high accuracy for data transmission. Technique which is used in future will be more accurate and provide the high performance of the system.

References

[1]. Navid daryasafar, Aboozar lashkari, Babak ehyaee, "Channel estimation in MIMO-OFDM systems based on comparative methods by LMS algorithm", IJCSI International Journal of Computer Science Issues, Vol. 9, Issue 3, No 3, May 2012,pp. 188-192.

[2]. Jitendra Kumar Daksh, Ravi Mohan, Sumit Sharma, " Performance Analysis with Space-Time coding in MIMO-OFDM Systes with Multiple Antennas", International Journal of Advanced Computer Research, Vol. 3, No. 2, June 2013, pp 2249-7277.

[3]. A. v. Z. a. T. C. W. Schenk, "Implementation of MIMO OFDM –based Wireless Lan System," IEEE transmission on signal processing, vol. 52, februray 2004.

[4]. Baoguo Yang, Khaled Ben Letaief, Roger S. Cheng And Zhigang Cao, "Channel Estimation For OFDM Transmission In Multipath Fading Channels Based On Parametric Channel Modeling", IEEE Transactions On Communications, Vol. 49, No. 3, March 2001.

[5]. V. Tarokh, H. Jafarkhami, and A.R, Calderbank, "Space-time block codes from orthogonal designs", IEEE Transactions on information theory, Vol. 45, No. 5, July 1999, pp 1456-1467.

[6]. Zimran Rafique and Boon-Chong Seet, "Energy Efficient MIMO-OFDM Systems", handbook on green information and coomunication.