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Research Article

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Improving Wireless MIMO System Performance with Channel Estimation Based Block Coding

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ABSTRACT

In modern wireless communication systems, a combination of multiple-input multiple-output (MIMO) system with the space time block coding (STBC) can be used in conjunction with receiver and transmitter diversity to achieve high data rate and & better spectral efficiency in order to increase the communication system's performance. In this paper, block-type and comb-type channel estimation algorithms based block coding for STBC MIMO systems over recian fading channels are used to minimize the error rate and ISI at the receiver end. The channel estimation using pilot carriers is carried out with conventional Least Square (LS) and Minimum Mean Square (MMSE) estimation algorithms. The performance of STBC MIMO system is evaluated on the basis of Symbol Error Rate (SER) level. The comparison of SER between estimated channel and without estimated channel is also observed.

KEYWORDS: ***MIMO, STBC,SFBC, AWGN, fading, , antenna, BER, M-PSK***

Introduction

MIMO systems make use of multiple antennas at the transmitter and receiver so as to increase the data rates by means of spatial diversity. So MIMO systems are well-known in wireless communications for high data rates. [1] The capacity of wireless systems can be increased by varying the number of antennas. The two primary reasons for using wireless communication over wired communication: • First is multi-path fading i.e. the variation of the signal strengths due to the various obstacles like buildings, path loss due to attenuation and shadowing [2]. Second, for the wireless users, the transmission media is air as compared to the wired communication where each transmitter–receiver pair is considered as an isolated point-to point link. MIMO system utilizes the feature of spatial diversity by using spatial antennas in a dense multipath fading environment which are separated by some distance [3]. MIMO systems are implemented to obtain diversity gain or capacity gain to avoid signal fading. The idea to improve the link quality (BER) or data rate (bps) is the basic consideration behind the development of MIMO systems by using multiple TX/RX antennas [4]. The core scheme of MIMO is space-time coding (STC). The two main functions of STC: diversity & multiplexing. The maximum performance needs tradeoffs between diversity and multiplexing.

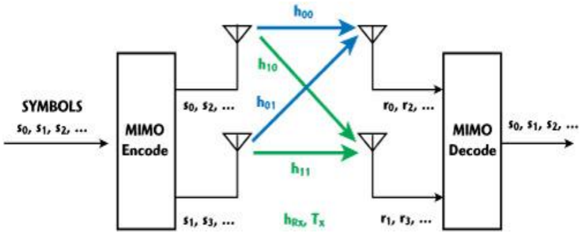

Fig 1 MIMO System (2X2 MIMO Channel)

MIMO system employs various coding techniques for multiple antenna transmissions have become

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one of the desirable means in order to obtain high data rates over wireless channels [5]. However, of considerable concern is the increased complexity incurred in the implementation of such systems. MIMO antenna systems are used in recent wireless communications like WiMAX, IEEE 802.11n and 3GPP LTE etc. The rest of the paper is organized as follows. Section II outlines the literature review of MIMO system with blocking codes. Sections III describe the fast time varying channel estimation. Proposed technique is described in Section IV. Simulated results of channel estimationare discussed in Section V. The conclusions are given in Section VI.

Literature Survey

Amir Hossein et.al [1] observed that enhancement in performance is obtained when STBC coding schemes are used in MIMO scheme, as compared to MISO and MRC schemes over the Rayleigh faded channel.

MISO scheme shows a degraded result than the MRC scheme for both the cases. .Akansha Gautam et.al [2] shown that the performance can be better than MISO used with 16-PSK modulation and Alamouti STBC, and it is also definite that with the more efficient modulation technique like QAM instead of PSK, the proposed system will perform .Mahdi Abdul Hadi et.al has been proposed a new channel estimation method to enhance the performance of the most popular channel estimators (LS d MMSE) based on comp type pilot arrangement in MIMO-OFDM system. MMSE estimator shows butter performance than LS estimator due to its ability to minimize the MSE using the weight matrix W, farther improvement on LS and MMSE estimators using DFT-based estimation technique due to the ability of this method to reduce the noise effect outside the maximum channel delay.ParismitaGogoi et.al a channel estimation technique has been proposed based on two different Artificial Neural network (ANN) structures, namely MLP and RNNs for use in STBC MIMO system in Rayleigh Faded channel. Estimate of the channel is calculated in terms of synaptic weights and bias values of theneural network. Different training algorithms have been used to analyze the calculation of weight and bias values.Gerhard Bauch et.alhave analyzed the suitability of orthogonal space-time block codes and space-frequency block codes in a 4G OFDM system. While even for high vehicular speed channel variations in time do not significantly degrade the performance of space time block codes, severe frequency-selectivity is shown to limit the performance of space-frequency block codes unless in wireless broadband systems the available time, frequency and spatial diversity can he exploited using complex space-time-frequency codesA. I. Sulyman [6] describes the performance of MIMO systems over nonlinear fading channels. The effects of antenna selection on its performance are also considered. The author has derived expressions for the PWEP performance of space-time trellis coding nonlinear Rayleigh fading channel. With the variation in the antenna selection at the receiver side, the performance degradation due to nonlinear fading channel reduces.

The comparison of MIMO with conventional Single-Input Single-Output (SISO) technology was discussed by S. G. Kim et. al [7]. The authors discussed that the MIMO system enhances the link throughput and also improves the spectral efficiency. The authors analyzed the BER performance of MIMO systems for M-PSK using ZF receiver over various fading channels in the presence of practical channel estimation errors .C. Wang [8] explains the approach to increase the capacity of MIMO systems by employing spatial multiplexing. Maximum likelihood (ML) receiver achieves optimal performance whereas the linear

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receivers like Zero-Forcing (ZF) receiver provide sub-optimal performance. But Zero- Forcing receiver also offers significant reduction in computational complexity with performance degradation in tolerable limits. A simple transmit diversity scheme comprises of two transmit antennas and one receive antenna was presented by X. Zhang et. al [9]. It provides the same spatial diversity order as that can be achieved by maximal-ratio receiver combining (MRRC) which makes use of one transmit antenna and two receive antennas.

Fast Time-Varying Channel Estimation

The channel estimation may be suitable only when the channel characteristic does not change within symbol period. However, the channel for the terminal that move fast vary within an symbol period which is longer symbol period has a more severe effect on the channel estimation performance. At the receiver , the orthogonality among the subcarriers resulting in ICI maybe destroyed by the time varying channel. This channel estimation deals with the effect of the ICI in time varying channels. A transmitted OFDM signal can be written in the time domain

$$X[n] = \sum_{k=0}^{N-1} X[k] e^{j2\pi kn/N} \text{ , N = 0,1......... , N-1}$$

The corresponding signal received though a wireless channel with L path can be expressed as:

$$Y[n] == \sum_{i=0}^{L-1} h_i[n]\, x[n-ti] + w[n]$$

Where $h_i[n]$ and t_i denote the impulse response and delay time for the i^{th} path of the time varying channel.

Diversity Techniques

a) Space Time Block Code (STBC)

A sufficient guard interval each subcarrier has provided in a flat fading MIMO-OFDM system. Therefore, a STBC can be applied for each subcarrier. The mapping of STBC code matrix on subcarrier is depicted in [4] for a simple operation of MIMO-OFDM. A block parallel to serial converter performs the inverse operation of the block serial to parallel converter at the transmitter and a STBC combiner is applied. This will be a problem since the MIMO-OFDM symbol duration channel will change during the transmission. Therefore, the performance of STBC will degrade in fast time-varying channel. This is particularly critical for STBC if more than two transmit antennas are applied [5].

b) Space Frequency Block Code (SFBC)

To avoid the problem of fast time-varying in time, the symbols of an orthogonal design can be transmitted on neighboring subcarrier of the same OFDM symbol rather than on the same sub-carrier of subsequent OFDM symbols [9]. This is true in channels with low frequency-selectivity or can be accomplish by using a large number of subcarrier in order to make the subcarrier spacing very narrow. Space frequency block codes avoid the problem of fast time-varying channel. However the performance will degrade heavily in frequency selective channels [5].

c) Space Time Frequency Block Code (STFBC)

From the previous section, STBC faced problems in fast time varying whereas SFBC suffer from frequency selectivity. So, STFBC were used to distribute the element of the orthogonal design both in time and frequency in order to relax the requirements for constant channel coefficients in both dimensions. It can apply for more than two transmit antenna [5]. There are many possibilities to distribute the symbolstransmitted from the same antenna in time and frequency. However, for larger matrices it is possible to use more subcarriers than OFDM symbol.

Simulation & Result

In general, there are three input signal like QAM , QPSK , 8 PSK is to be used. The input signal is given in Fig 2

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Table I Simulation Parameter

FFT Size (N_FFT)	256
No. of Active Subcarriers (N_{used})	200
No. of guard subcarrier	28 low, 27 high
Channel Bandwidth	3.5 MHz
Sampling Rate (F_S)	2.28 MHz (n= 57/50)
Distance between adjacent Subcarrier(Δf)	8.9 KHz
Useful Symbol Duration (T_b)	0.112 ms
Guard Time (T_g)	28.07 µs
Total Symbol Duration (T_S)	140 µs
Cyclic Prefix Length (CP)	$^1/_4$
Modulation	16 QAM , QPSK , 8 PSK
SUT	1,3

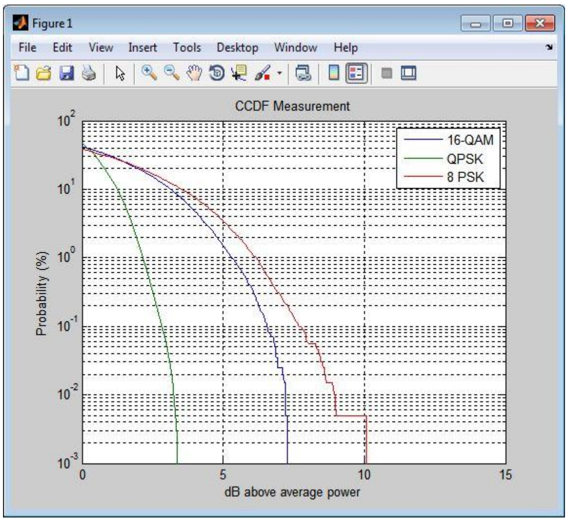

Fig 2 Input Signals

After applying STBC & SFBC technique in MIMO system and compared their performances, the fast time-varying channel design methods were simulated with different diversity techniques scheme. The simulation parameters are selected as in Table I.

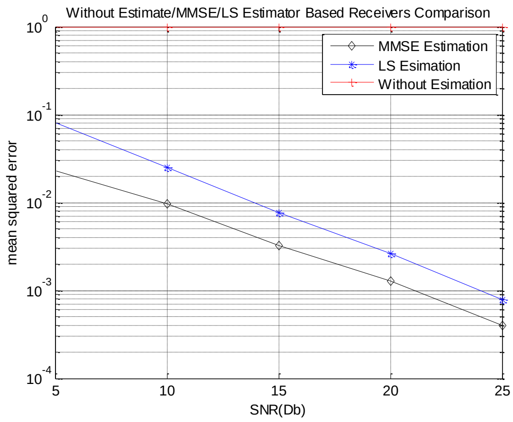

Fig 3 Comparison between without estimation, with LS estimation & with MMSE estimation

The proposed method is simulated and its performance is checked on the STBC MIMO system with and without estimation algorithms. Estimation algorithms like Least Square(LS) estimation and Minimum Mean Square estimation(MMSE) are used. In this STBC MIMO system,G2 code is used in which two transmitters and two receivers are present. The figure below gives the response of any of the two receiver showing the variation of Symbol Error Rate(SER) with increasing Signal to Noise Ratio(SNR).

Conclusion

In the simulations of the STBC MIMO systems, we observed that the LS channel estimator (using only a few dominant taps of the channel) performed better than the system without channel estimator for all SNRs since the energy in the excluded taps became dominant compared to the channel noise.

The BER performance of the LS channel estimator degraded more than the performance of the comb-type channel estimator as the Doppler shift of the channel increased. This was due to the fact that the block-type channel estimator used previous blocks of data in the channel estimation process. In particular, at low Doppler frequencies (i.e., almost time invariant channels) the block-type performed better than the comb-type channel

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estimator while the opposite was true at high Doppler frequencies. The STBC method performed satisfactorily at low SNRs. However, at high SNRs the estimation methods based STBC system on full channel model performed significantly better.

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