
Multi-user space time coding technique for wireless communication using MIMO for channel Estimation

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ABSTRACT

In wireless transmission the randomness of the communication channel leads to random fluctuation in the received signal known as fading. The fading is a fundamental problem in wireless communications because of this fading effect we cannot get exact signal at the receiver side. So to improve the signal performance at the receiver side diversity technique is the best method. Diversity gain results multiple paths between base station and user terminal and coding gain results from how symbols are correlated across transmit antennas. Antenna selection reduces the system cost and complexity by reducing the number of radio frequency (RF) chains while still retaining full diversity. Space time coding arises from a technique known as diversity. Wireless communication using multiple-input multiple-output (MIMO) systems enables increased spectral efficiency for a given total transmit power. Increased capacity is achieved by introducing additional spatial channels that are exploited by using space-time coding. This paper presents the progress made towards determining the capacity and diversity benefits of multiple antennas under different assumptions about the underlying channel. Simulations suggest that the resulting codes allow for effective high-rate data transmissions, Rayleigh channel model evaluate its performance in term of BER. Finally, the simulation results will be used to analyze and compare their performance. The research will be conducted in MATLAB environment.

Key words: Diversity, space-time code, fading channels, wireless communications.

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INTRODUCTION

Wireless communication systems provide users with wireless multimedia services such as high speed Internet access, wireless television and mobile computing. The Largest obstacle facing designers of wireless communication systems are the random nature of the wireless propagation Channel. The wireless channel is non stationary and noisy due to fading and interference. The fading effects are Large scale fading and Small scale fading. The loss of transmitting signal power due to distance between transmitting node and receiving node, also called path loss and measured in decibel (dB) ratio between transmitting and receiving power[1]. The path loss is proportional to the distance; it means attenuation increases as the signal propagates from the transmitter to receiver. This degradation occurs slowly in time and phase over the distance classified as large scale propagation effects. When the signal propagates through the wireless channel it will experience random reflectors, scatterers and attenuators, results a multiple copies of the arriving at the receiver after each has traveled through different

paths. When multiple copies arrive at the destination, they will be added up and creating constructive and destructive interference with each other that is due to that each signal copy having a different amplitude, phase and delay[9]. This result in a received signal has shape change rapidly over time, so this effect is referred as small scale propagation effects.

MULTI ANTENNAS COMMUNICATION SYSTEM MODEL

MIMO wireless technology exploits multipath propagation to improve the quality of service measures such as the bit error rate (BER) or the data rate (bits/sec). In other words, MIMO effectively takes advantage of random fading and multipath delay spread to increase the data transfer rate. The ST code design, a major challenge in MIMO systems, involves finding an optimal way of encoding and transmitting multiple copies of a data stream across multiple antennas to improve the rate and reliability of data transfer [8].

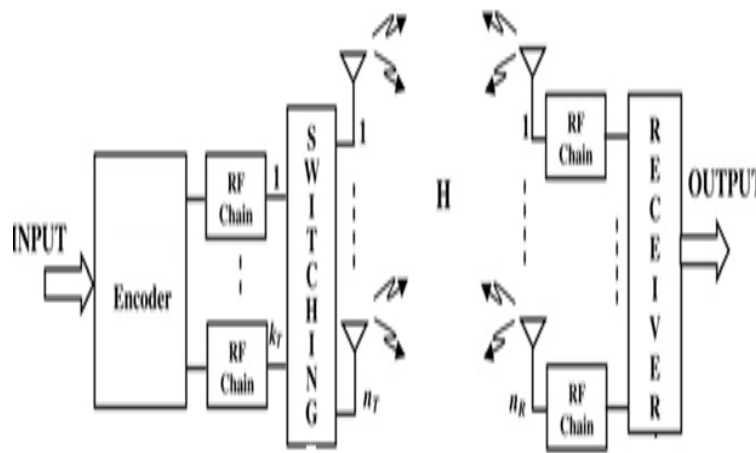


Fig 1: MIMO System with TAS (Transmit antenna selection)

The figure shows the block diagram of MIMO system that couples STTC coding with TAS. In figure k_T of n_T transmit antennas are chosen. The receive antennas n_R are used without selection [2]. Let H be $n_T \times n_R$ channel matrix. The matrix is represented by h_{ij} ($i=1, \dots, n_T$ and $j=1, \dots, n_R$) are fading coefficients. The channel power gain (C_i) between transmit antenna i and all the receive antennas are given by

$$C_i = \sum_{j=1}^{n_R} |h_{ij}|^2$$

The Channel power gains are identical and independent distributed.

SPACE TIME CODING

Space-time coding introduces redundancy in space, though the addition of multiple antennas, and redundancy in time, through channel coding. Two prevailing space-time Coding techniques are Space Time Block Codes (STBC) and Space Time Trellis Codes (STTC). STBC provide diversity gain, with very low decoding complexity, whereas STTC provide both diversity and coding gain at the cost of higher decoding complexity. STBC must be concatenated with an outer code to provide coding gain. Most of modulation schemes have a poor performance over Rayleigh wireless channel, the error probability decays very slowly over increasing the value of signal to noise ratio (SNR)[3]. The main cause of that poor strength of single signal path which have a significant probability to face a fade. To overcome that problem, a system rely on receiving the data from multiple channels must be created. The probability to face fading at the same time of the transmission is reduced because of the diversity. There are many forms of diversity, such as space, time, polarization and frequency diversity. Diversity schemes are implemented in different ways, but all of them aim to the same objective which is providing multiples uncorrelated copies of transmission to the receiver. The receiver will select the better copy or will coherently combine the independent fading paths so that the effects of fading are reduced [4].

Space time block coding

The theory of orthogonal designs, we can generate codes to any arbitrary number of transmitting antennas [5]. These codes are known as space time block codes (STBCs), and it can achieve the full diversity with a very simple ML detector.

SIMULATION RESULTS

MATLAB, V 10.0 was used as a simulator tool in order to perform the simulation experiments.

Simulation Results for different numbers of transmitting and receiving antennas

This paper presents performance results of different numbers of transmitting and receiving antenna over the impact of time-varying channels base of fading [6]. By taking different numbers of transmitting and receiving antennas we find that BER is being reduced and the received signal becomes more efficient. In the simulation, QPSK modulation technique is being used and there is perfect channel state information at receiver [7]. The perfect information at the receiver side is being achieved by proper channel estimation which we have done in our present work. During work our motive is to improve efficiency by proper Antennas design and it is successfully achieved. We reduced the BER and also improve the efficiency of the receiving signal. From the Results it is clear shown that as we increases the no. of transmitting and receiving antennas BER becomes reduced and the received signal becomes more efficient. The Graphs are plotted between BER Vs SNR for STBC when there are different numbers of transmitting and receiving antennas are shown in Figure IV. a. Also, the performance of an un-coded QPSK is plotted in the figures for comparison. The figure shows that there is a big improvement between coded and un-coded [6].

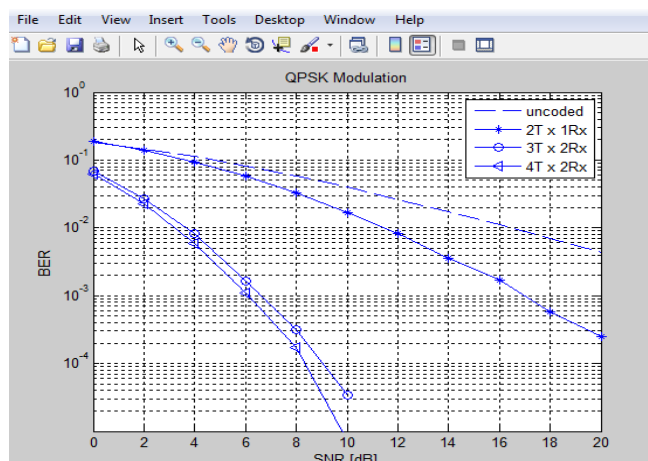


Fig 2: The BER performance curve of STBC for uncoded, n_{TX} = Two, Three and Four and n_{RX} = one, Two and Two.

Simulation Results for Same numbers of transmitting and receiving antennas

The bit error rate (BER) for STBC when there is same numbers of transmitting and receiving antennas are shown in Figure IV.b. Also, the performance of an un-coded QPSK is plotted in the figures for comparison. The figures show that there is improvement between coded and un-coded, and also when number of transmitting antennas and receiving antennas increases.

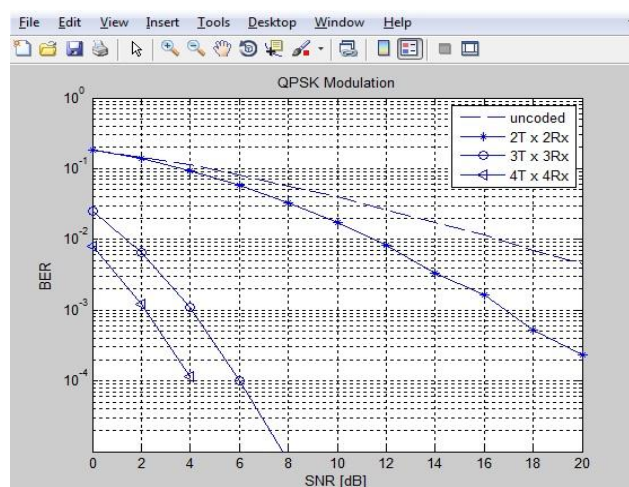


Fig 3: The BER performance curve of STBC for uncoded, and same numbers of n_{TX} and n_{RX} .

The graphs in Figure IV.a and IV.b illustrate simulation results in terms of bit error rate versus signal-to-noise ratio (SNR) for Two, Three and Four transmitting antennas.

We investigated and demonstrated that significant gains can be achieved by increasing the number of transmit antennas as shown in Figure IV.a. We provided space-time codes for transmission using multiple transmit antennas. The encoding and decoding of these codes have low complexity. It's essential to observe that the two, three, and four transmit antennas schemes

shows that error reduced at any value of SNR. We also observe that the bit error rate reduced by using same numbers of transmitting and receiving antennas as shown in figure IV.b.. By comparing these two figures that is Figure IV.a. and Figure IV.b. we observe that we get better performance when we used same number of transmitting and receiving antennas.

CONCLUSION AND FUTURE SCOPE

During the present investigations the following observations have been made:

- 1) The space time coding under realistic channel condition can reduce the bit error rate (BER) and improve the efficiency of a received signal. The effect of fading can be reduced by using spatial and temporal correlation in channel.
- 2) With the use of fundamental space-time coding and modulation methods; the gains provided by multiple antennas has improved the robustness of the link and spectral efficiency.
- 3) The progress made towards determining the capacity and diversity benefits of multiple antennas under different assumptions about the underlying channel gives us efficient signal.

Future Scope of the work

The present work can be extended by using advanced channel estimation schemes that exploit the structure of the Alamouti code to further reduce the computational complexity. This work can be further extended as simultaneous transmit and receive diversity in a 4G frame work with space frequency coded transmitters in a frequency selective channel modeling. It is also possible to design space-time trellis codes that preserve uniform error probability property even under spatial correlation.

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