International Journal of
Emerging Research in Management &Technology
ISSN: 2278-9359 (Volume-4, Issue-5)

Research Article

May 2015

A Novel Approach of Multiple-Input Multiple-Output (MIMO) Transmission Scheme

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Abstract—

A new method of multiple-input multiple-output transmission scheme, called space-time block coded spatial modulation. It combines spatial modulation (SM) and space-time block coding (STBC) to take advantage of the benefits of both while avoiding their drawbacks. In the STBCSM scheme, the transmitted information symbols are expanded not only to the space and time domains but also to the spatial (antenna) domain which corresponds to the on/off status of the transmit antennas available at the space domain, and therefore both core STBC and antenna indices carry information. A general technique is presented for the design of the STBC-SM scheme for any number of transmits antennas. Besides the high spectral efficiency advantage provided by the antenna domain, the proposed scheme is also optimized by deriving its diversity and coding gains to exploit the diversity advantage of STBC. The performance advantages of the STBC-SM over simple SM and over V-BLAST are shown by simulation results for various spectral efficiencies and are supported by the derivation of a closed form expression for the union bound on the bit error probability.

Keywords—Spatial Modulation, space time block coding, Decoding, MIMO system, Bit rate.

I. INTRODUCTION

Multiple antenna systems that operate at high rates require simple yet effective space–time transmission schemes to handle the large traffic volume in real time. At rates of tens of bits per second per hertz, Vertical Bell Labs Layered Space–Time (V-BLAST), where every antenna transmits its own independent sub stream of data, has been shown to have good performance and simple encoding and decoding. Yet V-BLAST suffers from its inability to work with fewer receive antennas than transmit antennas—this deficiency is especially important for modern cellular systems, where a base station typically has more antennas than the mobile handsets. Furthermore, because V-BLAST transmits independent data streams on its antennas there is no built-in spatial coding to guard against deep fades from any given transmit antenna. On the other hand, there are many previously proposed space–time codes that have good fading resistance and simple decoding, but these codes generally have poor performance at high data rates or with many antennas.

This project a high-rate coding scheme that can handle any configuration of transmit and receive antennas and that subsumes both V-BLAST and many proposed space–time block codes as special cases. The scheme transmits sub streams of data in linear combinations over space and time. The codes are designed to optimize the mutual information between the transmitted and received signals. Because of their linear structure, the codes retain the decoding simplicity of V-BLAST, and because of their information-theoretic optimality, they possess many coding advantages. These are the examples of the codes and show that their performance is generally superior to earlier proposed methods over a wide range of rates and signal-to-noise ratios (SNRs).

1.1 Problem Definition

A novel multiple-input multiple-output (MIMO) transmission scheme, called space-time block coded spatial modulation (STBC-SM), is proposed. It combines spatial modulation (SM) and space-time block coding (STBC) to take advantage of the benefits of both while avoiding their drawbacks. In the STBCSM scheme, the transmitted information symbols are expanded not only to the space and time domains but also to the spatial (antenna) domain. Which corresponds to the on/off status of the transmit antennas available at the space domain, and therefore both core STBC and antenna indices carry information. A general technique is presented for the design of the STBC-SM scheme for any number of transmits antennas.

Beside high spectral efficiency advantage provided by the antenna domain, the proposed scheme is also optimized by deriving its diversity and coding gains to exploit the diversity advantage of STBC. A low-complexity maximum likelihood (ML) decoder is given for the new scheme which profits from the orthogonality of the core STBC. The performance advantages of the STBC-SM over simple SM and over V-BLAST are shown by simulation results for various spectral efficiencies and are supported by the derivation of a closed form expression for the union bound on the bit error probability.

II. RELATED WORKS

In this, a generalized space-time coded continuous phase modulated (STC-SM) framework is developed. It allows for a wide variety of space-time trellis codes, including high-rate codes. An integrated design is obtained by defining all code structures on the same integer ring. This integrated design enables performance measures to be readily evaluated. This work is an extension of the ideas in where integrated ring convolution code designs are implemented for various single thread STB systems.

Yang and Taylor investigate[1] ring convolution code design for a subset of STB called continuous phase frequency shift keying (STBC), and Remold and Liu[6] [extend this concept to more general CPM. In [3, 4], Griffin and Taylor use a ring convolution code to differentially encode STBC, and investigate ring convolution code design for differentially demodulated STBC. The examples and performance results presented in this thesis are primarily focused on STBC modulated space-time codes.

A Rayleigh fading channel [5] with additive white Gaussian noise (AWGN) is assumed. The proposed STC-SM schemes are narrowband. Therefore, Assume the Rayleigh fading to be non-frequency selective (flat-fading). At the receiver, Assume there is ideal knowledge of channel information and transmitter parameters, such as, symbol timing and carrier frequency. The new STC-SM design [2] will be implementable in real world wireless communication systems at affordable costs and has considerable potential for commercial development in the area.

A. Design of Stbc-Sm System

A general technique has been presented for the construction of the STBC-SM scheme for any number of transmit antennas in which the STBC-SM system was optimized by deriving its diversity and coding gains to reach optimum performance.

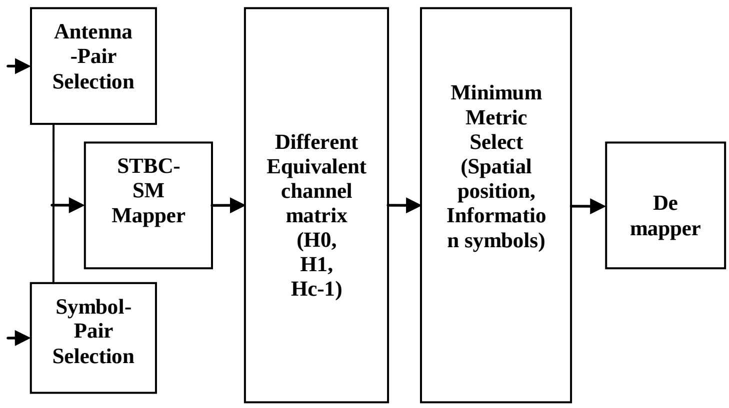


Fig 1 Block diagram of STBC-SM system

Fig 1, the antenna pair selection and symbol pair selection is done based on transmission from main station to base station and uplink or downlink respectively. STBC-SM mapper acts like modulator. In channel matrix it forms matrix and selects minimum matrix symbols which was transmitted. Finally in demapper acts like demodulator that is carrier is removed from receiver in order to get original signal.

Consider a MIMO system with M transmits and N receives antennas operating over a frequency-flat channel that remains constant for at least T signaling intervals over a channel. The information bit stream is encoded into a ST code word of dimension T £ M. The ST code word is defined by, S = [s1*;* s3*; : : : ;* sT]T , where st is the transmitted vector symbol over the tth time slot.

The simulation results for the STBCSM system with different numbers of transmit antennas and make comparisons with SM, V-BLAST, rate-3/4 OSTBC for four transmit antennas Altamonte's STBC, the Golden Code and double space-time transmit diversity (DSTTD) scheme. The bit error rate (BER) performance of these systems was evaluated by Monte Carlo simulations for various spectral efficiencies as a function of the average SNR per receive antenna (ρ) and in all cases we assumed four receive antennas. All performance comparisons are made for a BER value of 10−5. The SM system uses the optimal decoder derived. The V-BLAST system uses MMSE detection with ordered successive interference cancellation (SIC) decoding where the layer with the highest post detection SNR is detected first, then nulled and the process is repeated for all layers, iteratively.

Employ ML decoders for both the Golden code and the DSTTD scheme. First present the BER performance curves of the STBCSM scheme with three and four transmit antennas for BPSK and QPSK constellations. As a reference, the BEP upper bound curves of the STBC-SM scheme are also evaluated and depicted. It follows that the derived upper bound becomes very tight with increasing SNR values for all cases and can be used as a helpful tool to estimate the error performance behavior of the STBC-SM scheme with different setups. Also note that the BER curves are shifted to the right while their slope remains unchanged and equal to $2nR$, with increasing spectral efficiency.

B. Explanation Of Key Function

These are the explanation of key functions used in this project

i. *Bit Error Rate:* The BER may be analyzed using stochastic computer simulations. If a simple transmission channel model and data source model is assumed, the BER may also be calculated analytically. An example of such a data source model is the Bernoulli source. A worst case scenario is a completely random channel, where noise totally dominates over the useful signal. This results in a transmission BER of 50%.

ii. *Signal-To-Noise Ratio:* Signal-to-noise ratio (often abbreviated SNR or S/N) is a measure used in science and engineering that compares the level of a desired signal to the level of background noise. It is defined as the ratio of signal power to the noise power. A ratio higher than 1:1 indicates more signal than noise. While SNR is commonly quoted for electrical signals, it can be applied to any form of signal.

C. Space Time Block Code (Stbc)

A novel multiple-input multiple-output (MIMO) transmission scheme, called space-time block coded spatial modulation (STBC-SM), is proposed. It combines spatial modulation (SM) and space-time block coding (STBC) to take advantage of the benefits of both while avoiding their drawbacks. In the STBCSM scheme, the transmitted information symbols are expanded not only to the space and time domains but also to the spatial (antenna) domain which corresponds to the on/off status of the transmit antennas available at the space domain, and therefore both core STBC and antenna indices carry information.

The main two requirements for next generation communication systems are high data rate and high reliable communication. Spectral efficiency is available because systems are band limited and user's demands are growing continuously. Application of multiple input multiple output (MIMO) technique is the best technique to improve link capacity, and potentially increase spectral efficiency.

Space-time block coded spatial modulation (STBC-SM) is introduced in which combines spatial modulation (SM) and space-time block coding (STBC) to take advantage of the benefits of both while avoiding their drawbacks. In the STBCS-SM scheme, the transmit ted information symbols are expanded not only to the space and time domains but also to the spatial (antenna) domain which corresponds to the on/off status of the transmit antennas available at the space domain, and therefore both core STBC and antenna indices carry information. A low-complexity maximum likelihood (ML) decoder is used for the STBC-SM scheme, which profits from the orthogonality of the core STBC.

D. Validation of Result

Space–time block coding is a technique used in wireless communications to transmit multiple copies of a data stream across a number of antennas and to exploit the various received versions of the data to improve the reliability of data-transfer. This redundancy results in a higher chance of being able to use one or more of the received copies to correctly decode the received signal. In fact, space–time coding combines all the copies of the received signal in an optimal way to extract as much information from each of them as possible.

Antenna selection is a low-cost low-complexity alternative to capture many of the advantages of MIMO systems. In this work, we firstly construct a beam space-time block coding (BSTBC) scheme at the transmitter. In particular, we propose new algorithm for receive antenna selection (RAS) aiming to minimize the error rate when linear detectors are used at the receiver. Simulation results for quasi-static Rayleigh flat fading channel demonstrate the significant performance of the proposed selection algorithm and the combining system.

The fact that the transmitted signal must traverse a potentially difficult environment with scattering, reflection, refraction and so on and may then be further corrupted by thermal noise in the receiver means that some of the received copies of the data will be 'better' than others. This redundancy results in a higher chance of being able to use one or more of the received copies to correctly decode the received signal[9].

This work explores that the system combining beam forming with space-time block coding (STBC) in MIMO systems can improve the performance efficiently[11]. However, the multiple RF chains associated with multiple antennas are costly in terms of size, power, and hardware. Antenna selection is a low-cost low-complexity alternative to capture many of the advantages of MIMO systems.

Firstly construct a beam space-time block coding (BSTBC) scheme[10] at the transmitter. In particular, we propose new algorithm for receive antenna selection (RAS) aiming to minimize the error rate when linear detectors are used at the receiver. Simulation results for quasi-static Rayleigh flat fading channel demonstrate the significant performance of the proposed selection algorithm and the combining system.

E. Output Graphs

A more general way of measuring the number of bit errors is the Levenshtein distance. The Levenshtein distance measurement is more appropriate for measuring raw channel performance before frame synchronization, and when using error correction codes designed to correct bit-insertions and bit-deletions, such as Marker Codes and Watermark Codes.

Module 1:

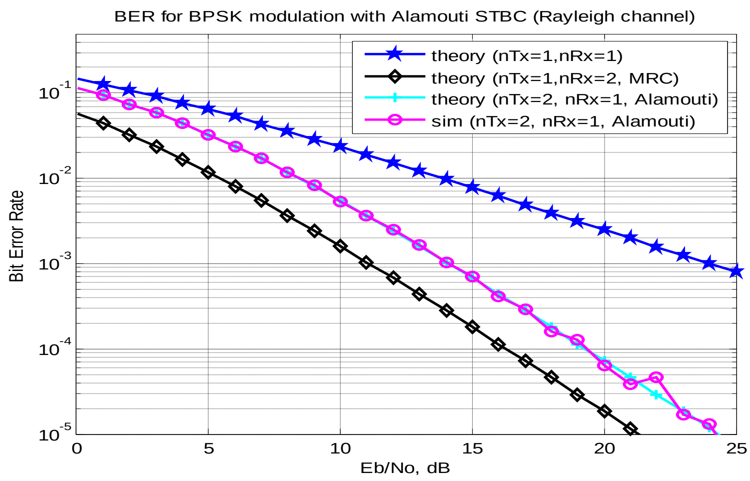


Fig.2. BER for BPSK Using Alamouti STBC

The above graph explains about Bit Error Performance for the BPSK type modulation. The blue colored line indicates the theoretical calculation for 1 Tx and 1 Rx, black indicates 1Tx and 2Rx's using MRC, light blue 2Tx and 1Rx using Alamouti, and the pink colored line indicates the simulation results for 2Tx and 1Rx using Alamouti. Its shows BER are better using Alamouti in STBC.

Module 2:

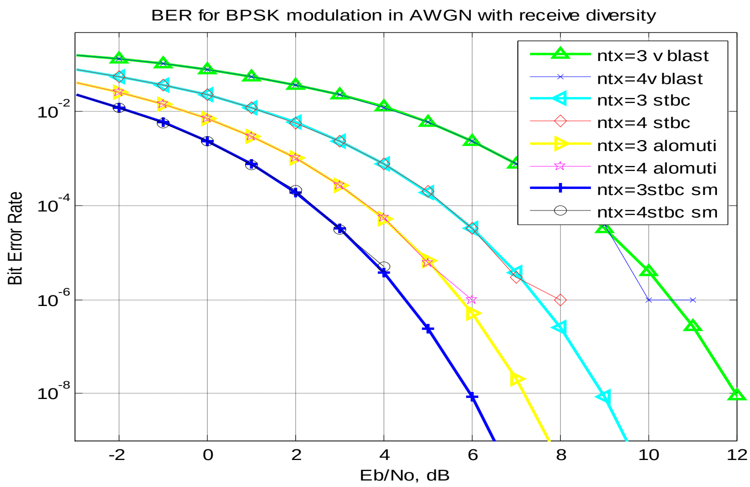


Fig.3 BER Comparison of Various systems

Module 3:

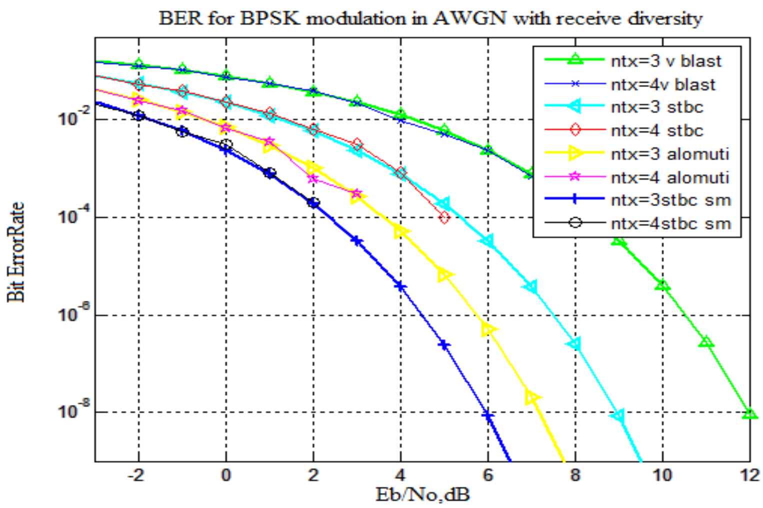
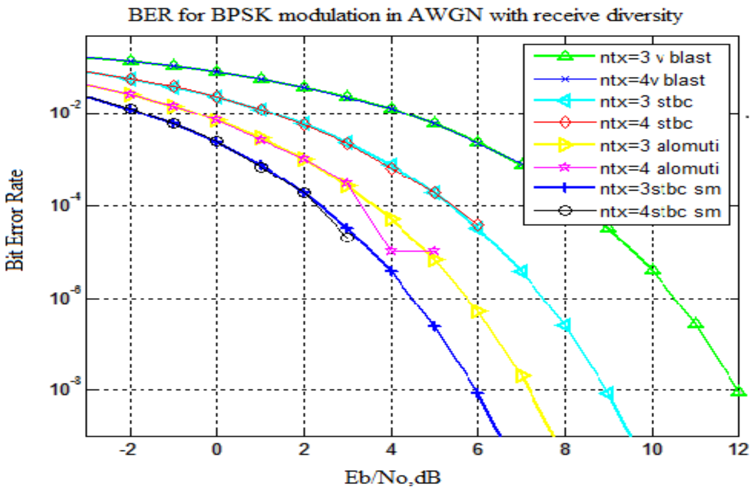


Fig.4 BER Comparison of Various systems

Module 4:



In Fig.5, BER Comparisons of Various systems, where N=5

In Fig 3, 4 and 5 shows all types of system performance like V-BLAST, STBC, ALAMOUTI, STBC-SM for N=3,4 and 5 respectively. Light green curve indicates for V-BLAST using 3Tx's, purple for 4tx's. Light blue and red indicates for 3,4Tx using STBC and yellow and pink shows 3,4Tx's using Alamouti. Finally blue for 3Tx and black for 4Tx using STBC-SM. It clearly explains that compared to all systems STBC-SM has better BER performance.

IV. CONCLUSION

Introduced a novel high-rate, low complexity MIMO transmission scheme,called STBC-SM, as an alternative to existing techniques such as SM and VBLAST. A general technique has been presented for the construction of the STBC-SM scheme for any number of transmit antennas in which the STBC-SM system was optimized by deriving its diversity and coding gains to reach optimum performance. It has been shown via computer simulations and also supported by a theoretical upper bound analysis that the STBC-SM offers significant improvements in BER performance compared to SM and V-BLAST systems with an acceptable linear increase in decoding complexity.
This project conclude that the STBC-SM scheme can be useful for high-rate, low complexity, emerging wireless communication systems such as LTE and WiMAX. The future work will be focused on the integration of trellis coding into the proposed STBC-SM scheme.

ACKNOWLEDGMENT

The heading of the Acknowledgment section and the References section must not be numbered.
Causal Productions wishes to acknowledge Michael Shell and other contributors for developing and maintaining the IEEE LaTeX style files which have been used in the preparation of this template. To see the list of contributors, please refer to the top of file IEEETran.cls in the IEEE LaTeX distribution.

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