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Comparative Analysis of Different Techniques for Data Transmission and Reception using STBC

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Abstract: *Use of multiple antennas at the transmitter and/or at the receiver provides a substantial improvement in terms of both data rate and reliability in wireless infrastructures, especially in a rayleigh fading environment. The space-time block codes (STBC) in multiple antenna systems have received much attention and research for their outstanding ability to improve channel fading. In most wireless communications, setting multiple antennas at the base station is more cost-effective than at mobile handsets. The channel state information (CSI) over independent links leads to more consistent communication. In this paper, we have surveyed different STBC techniques and propose a technique to overcome AWGN fading. For AWGN fading channels, space–time block coding (STBC) is a recent breakthrough solution to this kind of problem.*

Keywords*: - STBC, MIMO, OFDM system, Multiple Input Multiple Output System, AWGN, Fading, PSK, QAM, BER.*

1. INTRODUCTION

Space-time code (STC) is a method usually employed into wireless communication systems to improve the reliability of data transmission using multiple antennas. STCs rely on transmitting multiple, redundant copies of a data stream to the receiver in the hope that at least some of them will survive the physical path between transmission and reception in a good state to allow reliable decoding[1]. Features of STC are:

1. STC provides the best possible tradeoff between constellation size, data rate, diversity advantages & trellis complexity.
2. It improves link reliability.
3. Increases system capacity through resource allocation.

In recent years, space-time coding techniques have received much interest. The concept of space time coding has arisen from diversity techniques using smart antennas. By using data coding and signal processing at both sides of transmitter and receiver, space-time coding now is more effective than traditional diversity techniques [2, 3]. Two main functions of STC are diversity & multiplexing. For maximum performance there should be trade-off between diversity and multiplexing. Space can be divided in three types are:

1. Space Time Trellis Codes (STTCs)
2. Space Time Turbo Codes (STTuCs)
3. Space Time Block Codes (STBCs)

1.1 Space Time Trellis Codes

It distributes a Trellis code over multiple antennas and multiple time-slots. STTCs are always used to provide both coding gain and diversity gain. Space-time trellis code, proposed by Tarokh , is a scheme where symbols are encoded according to the antennas through which they are simultaneously transmitted and decoded using maximum likelihood detection. Trellis coding is a very effective scheme that provides a considerable performance gain, as it combines the benefits of forward error correction coding and diversity transmission. However, the scheme requires a good trade-off between constellation size, data rate, diversity advantage, and Trellis complexity.

1.2 Space Time Turbo Codes

The second type of STCs is space-time turbo codes a combination of space-time coding and turbo coding. They are originally introduced as binary error-correcting codes built from the parallel concatenation of two recursive systematic convolution codes exploiting a sub-optimal but very powerful iterative decoding algorithm, which is called turbo decoding algorithm. The turbo principle has these days been successfully applied in many detection and decoding problems such as serial concatenation, equalization, coded modulation, multi-user detection, joint interference suppression and decoding.

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1.3 Space Time Block Codes

The third type of STCs is space–time block codes [4]. They act on a block of data. STBCs do provide diversity gain but they do not provide coding gain. This makes STBC less complex in implementation than STTCs and STTuCs.

2. RELATED WORKS

2.1 SS OSTBC system [4]

We consider an uplink multiuser SS network depicted in Fig. 1, where all the nodes are equipped with multiple antennas and a spatial diversity structure is applied at the secondary transmitter. To simplify the notations, the author assume that all the nodes have the same number of antennas N and ignore the interference from the primary transmitter to the secondary receivers. Let Hk and Gk denote the channel gain matrices from the kth secondary transmitter to the secondary receiver and the primary receiver, respectively. The author assume that the secondary receiver can obtain the full CSI of the channel matrix Hk. All the entries of Hk and Gk are assumed independent and identically distributed (i.i.d) complex Gaussian random variables with zero mean and unit variance. To ensure that the interference constraint is satisfied at the primary receiver, we adopt the interference temperature Q. Notice that such a constraint requires the secondary user's access to the CSI Gk to implement the transmit power control protocol. To obtain the CSI of the interference link, some detailed channel estimation methods have been given in [5]-[7].

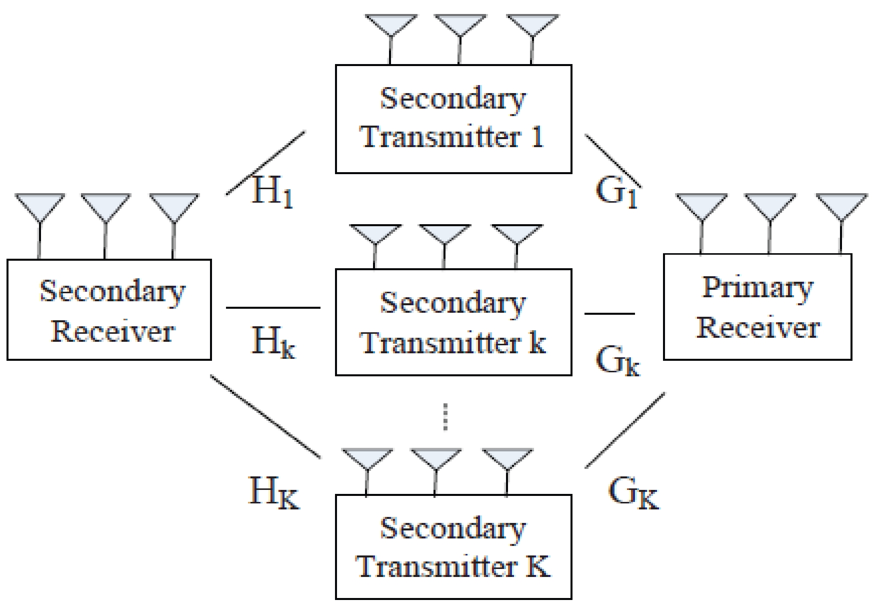

Figure 1: Channel model of a multiuser SS OSTBC system.[4]

2.2 RRNS-STBC coded MIMO system [8]

The block diagram of RRNS-STBC coded MIMO system is given in Fig. 2. The RRNS-STBC scheme is a concatenated channel code [9], with M-*ary* modulation and STBC together acting as the inner code and RRNS being the outer code. The system is assumed to have *MT* transmit antennas and *MR* receives antennas. Binary inputs are first converted to integer residues following the RRNS arithmetic. The generated residue digits are directly mapped to *M*−ary complex constellation points forming the so-called DM scheme, where each residue corresponds to one complex symbol in the constellation. In the STBC mapping block in Fig. 2, the mapped complex symbols are grouped into $MT \times T$ code blocks, where *T* is the length of each block, and then transmitted over a wireless channel. The receiver decodes the received symbols using ML decoding and consequently performs STBC demapping and inverse RNS transform using the CRT to obtain the binary output. The next section discusses RNS and RRNS arithmetic and the coding scheme.

3. PROPOSED METHODOLOGY

A proposed methodology to implement the design of a STBC-OFDM wireless communication system is given:

1. Initially, number of bits, number of subcarriers, levels of FFT, number of constellations, number of cyclic prefixes and input SNR must be declared.

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2. Binary data i.e. data to be transmitted depending on number of bits must be generated.
3. Construct an object to modulate binary data using PSK and QAM depending on number of constellation and type of input data.
4. Modulation of data on modulator and conversion of data from serial to parallel.

STBC encoding

5. Grouping of data bits at size of 8 and then division of grouped bits into size of
6. Formation of 2 data symbol matrix i.e. x1 and x2 and Calculation of complex conjugate of both matrix bits so as to form imaginary part of data bits which will be orthogonal from their data bits.

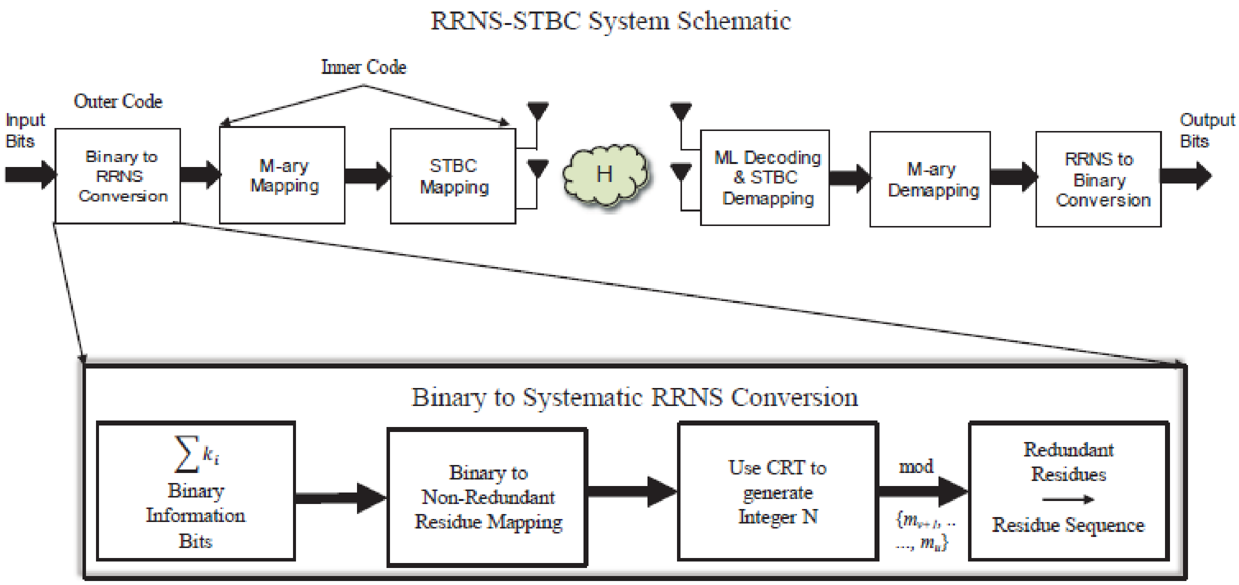

Figure 2: The block diagram of RRNS-STBC coded MIMO systems [8]

7. Designing of OFDM transmitter so as to transmit the data depending on level of FFT, number of cyclic prefixes and number of bits.
8. Transmission of all 4 digital data symbol matrices using OFDM transmitter and Designing of transmission channel depending on number of bits and number of subcarriers and Designing of Additive White Gaussian Noise depending on number of subcarriers, levels of FFT, number of cyclic prefixes. Then, Designing of receiver depending upon number of subcarriers, levels of FFT, number of cyclic prefixes.
9. Reception of data with removal of all additional guard and pilot bits.
10. Construction of an object to demodulate binary data using PSK and QAM depending on number of constellation and type of input data. Conversion of data from serial to parallel.
11. Calculation of number of errors by comparing transmitted and received data and Calculation of BER by using number of errors.
12. Plotting of curve indicating value of BER at each input SNR value, plotting of Transmitted signal mapping Constellation and Plotting of Number of errors at each input SNR value.

4. CONCLUSION AND FUTURE WORK

From the above literature survey it can be concluded that there is a lot of problem regarding improvement of spectrum efficiency, capacity, and coverage and link reliability of wireless communication networks. This problem was greatly tackled by MIMO-OFDM wireless communication system. However, problem concerning coding across space and time to obtain the maximum output (minimum BER) was still present in the system. The only solution of this major

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problem is STBC, which also have a feature of linear decoding/detection algorithms. So a MIMO-OFDM system with STBC encoded input data (binary data to be transmitted) at transmitter can give maximum capacity and coverage as well can tackle the entire problem in an efficient manner.

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