Channel Estimation of STBC System: A Review

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Abstract-In this review paper we have done our analysis on various researches on MIMO STBC system in order to achieve the better system performance. This is well known that the performance of the wireless communication systems can be improved by using multiple transmit and receive antennas (MIMO), which is generally referred to as the MIMO technique, and has been incorporated. The space-time coding (STBC) is a promising way to realize the gain in the wireless communications system using MIMO. To increase the code rate and the throughput of the orthogonal space time block code for more than two transmit antennas is analyzed. Numerous researchers have investigated many benefits as well as a substantial amount of performance gain of receive diversity can be reproduced by using multiple antennas at transmitter to achieve transmit diversity. The development of transmit diversity techniques has started for the future enhancement of this rapid fashion research field. It can be expected multiple-input multiple-output technology to be a keystone of various wireless communication systems due to the possible increase in data rate and performance of wireless links offered by transmit diversity and MIMO technology.

Keywords- Wireless Communication, Multiple Input Multiple Output (MIMO) and Space Time Block Coding (STBC).

I. INTRODUCTION

Space-time block codes (STBC) are a generalized version of Alamouti scheme [2]. These schemes have the same key features. Therefore, these codes are orthogonal and can achieve full transmit diversity specified by the number of transmit antennas. In another word, space-time block codes are a complex version of Alamouti's space-time code in [3], where the encoding and decoding schemes are the same as there in the Alamouti space-time code in both the transmitter and receiver sides. The data are built as a matrix which has its rows equal to the number of the transmit antennas and its columns equal to the number of the time slots required to transmit the data. At the receiver section, when signals are received, than they firstly combined and then sent to the maximum likelihood detector where the decision rules are applied. Space-time block codes were designed to achieve the maximum diversity order for the given number of transmit and receive antennas subject to the constraint of having a simple linear decoding algorithm. This had made space-time block codes (STBC) an extremely poplar scheme and most widely used. Space-time block codes (Fig 1 shows) [1] and indeed many other space-time techniques including STTCs are designed for coherent detection where channel estimation is necessary. There is a substantial literature addressing the channel estimation issue for multiple-input multiple-output (MIMO) systems, ranging from standard training based techniques that rely on pilot symbols [4] in the data stream to blind which does not require pilot sequences and semi-blind estimation where observations corresponding to data and pilot are used jointly. Other authors have considered non-coherent detection schemes based on differential encoding which do not require channel state information (CSI) [5]. Although these methods avoid the need for channel estimation, they often suffer from problems such as error propagation. Training-based methods seem to give very good results on the performance of channel estimation at the receiver. Pure training-based schemes can be considered as an advantage when an accurate and reliable MIMO channel needs to be obtained. However, this could also be a disadvantage when bandwidth efficiency is required. This is because pure training-based schemes reduce the bandwidth efficiency considerably due to the use of a long training sequence which is necessarily needed in order to obtain a reliable MIMO channel estimate.

Due to the of the computation complexity of blind and semi-blind methods, many wireless communication systems still use pilot sequences to estimate the channel parameters at the receiver side. To propose a new joint detection scheme for transmit diversity with no CSI [29]. To propose a new channel estimation algorithm that uses pilot sequences and minimum square error (MSN) to estimate the channel parameters. These two methods have the advantages of low computation.

II. SYSTEM MODEL

The concept of exploiting the multipath channel rather than attempting to mitigate its effects was emerged in [1], it was demonstrated theoretically that it is possible to exploit the multipath channel and thereby increase the information capacity of a wireless link through receive and transmit diversity using multiple receivers and multiple transmitters MIMO system.

This promise of MIMO channels is remarkable. By adding more antennas at the transmitter and/or receiver, a wireless link in the multipath fading environment may have a higher information rate than a Single-Input –Single-Output (SISO) wireless link. Recently, there are efforts on realizing both capacity and robustness gains simultaneously. In [3], the researchers established that there is a tradeoff between these two types of gains based on how fast error probability can deteriorate and how rapidly data rate can be increased with a given signal to noise ratio (SNR).

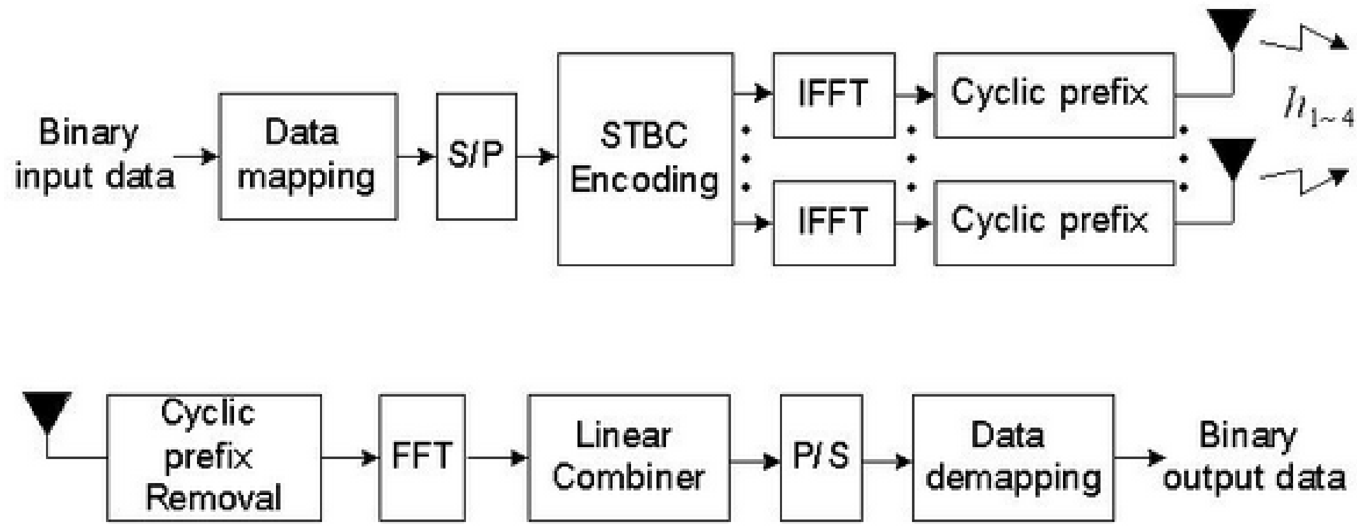

Fig.1 Shows the Block Diagram of STBC

In fact the advantages of MIMO are exceeds its fundamental issue of adding diversity benefits. The mathematical nature of MIMO, whereas the data is transmitted over a matrix rather than a vector channel, creates several new opportunities.

Let ***H*** be the channel matrix of *N* x *M* dimensions, where *M* is a number of transmit antennas and *N* is a number of receive antennas as shown in Fig.1 . In the ideal case, each path is assumed to be statistically independent from the others. Independent data can be sent from each antenna, increasing the capacity of the system.

$$r = Hx + n$$

Consider a transmitted vector

$$x = [x , x , x ......xM]^T ,$$

The vector is then transmitted through a MIMO channel characterized by the channel matrix ***H*** whose element $h_{i,j} \sim CN(0,1)$ is the random Gaussian complex channel coefficient between the *jth* transmit and *ith* receive antennas with zero mean and unity variance.

The received vector

$r = [r_1, r_2, r_3 \; \dots\dots, r_N]^T$ can then be give as following.

The STBC technique considers that the system has a transmission sequence.

$$x = [x_1, x_2, x_3 \; \dots\dots, x_M].$$

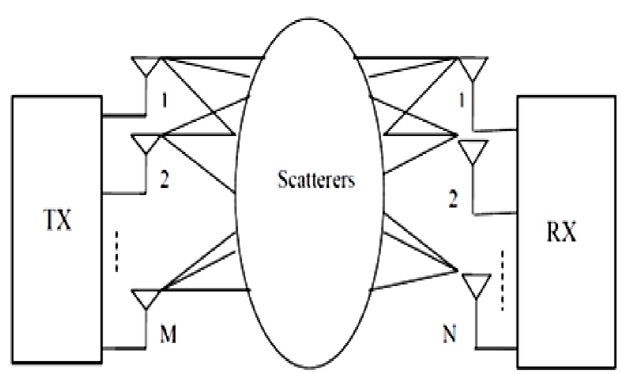

Fig. 2.0 MIMO Channel Model.

In normal transmission, x_1 is sent in the first time slot, x_2 in the second time slot, x_3 and so on. Though, Alamouti suggested that the symbols will be divided into two groups. In the first time slot, x_1 and x_2 are sent from the first and second antennas, respectively. In second time slot - $x_2{}^*$ and $x_1{}^*$ are sent from the first and second antennas, respectively as seen in Fig. 2.1. In the third time slot *x3* and *x4* are sent from the first and second antennas and so on. Notice that although we are grouping two symbols, we still require two time slots to send two symbols. Therefore, no change in the data rate. This forms a simple explanation of the transmission scheme with Alamouti Space Time Block coding [54].

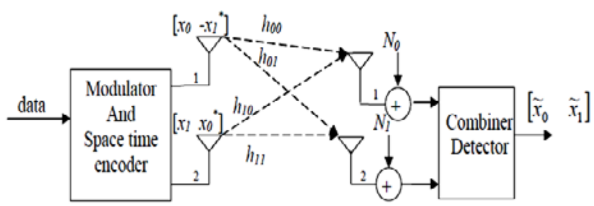

Fig. 2.1 Simple Space Time Code Setup for 2-Tx and 2-Rx Antennas.

The transmitted 2 × 2 STBC codeword is ***x***, and the symbols *xi* can be any quadrature modulated symbols.

I. ENCODING AND DECODING METHODS OF SPACE-TIME BLOCK CODES

The structure of a system employing space-time block codes is shown in Figure 2.2.1. Here, at a given time instant t , the transmitter maps a block of kb bits into a block of k information symbols $s_t^1\ s_t^2 \ldots \ldots s_t^k$ Each symbol belongs to the 2^b element signal constellation used at transmitter. Symbols are then encoded in space (across different antennas) and time (across a range of symbol periods). The type in which symbols are

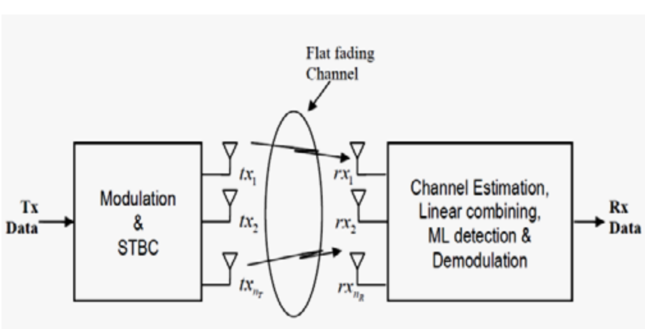

Fig. 3 Schematic of a system using STBC

encoded is determined by a specific code matrix, usually denoted by nT G_{n_T} or H_{n_T}. The matrix has n_T columns and p rows. Every block of k information symbols is encoded using this $p \times n_T$ matrix. After encoding, all space-time block coded symbols corresponding to a particular row of the encoder matrix are transmitted in one symbol period. Since p symbol intervals are utilized in transmitting k information symbols, the code rate R for a particular T p□□n encoder matrix is given by R □□k / p . It should be noted that at any given time instant t , n_T space-time block coded symbols $c_t^1\ c_t^2\ \ldots . c_t^{nr}$ are transmitted.

To achieve linear processing at the receiver, Alamouti in [7] proposed a novel transmit diversity scheme where the transmitted symbols are mapped to a 2 × 2 space time orthogonal transmission matrix. The orthogonal design achieves maximum likelihood decoding with linear processing per transmitted symbol. Extending Alamouti's work, the researchers in [8] have designed STBC for more than two transmit antennas. They showed that the orthogonal design couldn't provide a full transmission rate for more than two transmit antennas with complex modulation.

II. LITERATURE REVIEW

Ben Slimane, E., Jarboui, S., and Ben Mabrouk proposed channel estimation method that adopts a pilot symbol assisted modulation (PSAM) which had been established to be effective for fading channels. In this methodology, pilot symbols are periodically inserted into the data stream that is sent through the orthogonal STBC encoder. At the receiver, authors propose a straightforward MIMO channel estimation method before being used by STBC decoder. Output indicates that the proposed work provides accurate channel estimates [6].

Minggang Luo, Liping Li and Bin Tang investigated a modulation classifier is presented based on Maximum Likelihood (ML) without utilizing the Channel State Information (CSI) and coding matrix. The modulation recognition based on the ML classifier is discussed for independent (resp. non-independent) constellations by using Independent (resp. Multi-dimensional Independent) Component Analysis. Results show that our algorithm can work with high recognition probabilities in MIMO-STBC communication systems when CSI and coding matrix are unavailable [7].

Minggang Luo and Liping Li presented blind separating the intercepted signals is a research topic of high importance for both military and civilian communication systems. A rotation transforms to maximize the independence between the real and imaginary parts without using a precoder at the transmitter side. Outcome present that the new algorithm can separate complex PSK-modulated signals blindly with high Symbol Error Rate performance when Channel State Information (CSI) and coding matrix are unavailable [8].

Jie Wang, Xiaoxu Chen and Tao Liu have done their research work which avoids matrix-inversion computation needed in ordinary reception. Outcomes are given to verify performance of the proposed methodology. Compared with other suppression methods, the proposed scheme has better SER performance and is less sensitive to the length of pilot symbols [9].

Quadeer, A.A. and Sohail, M.S. investigated the algorithm which utilizes both time and frequency correlation information. The Cyclic Prefix can be used to enhance the joint channel estimation and data detection process. Authors present two variations of the Expectation Maximization (EM) based Forward Backward (FB) Kalman filter algorithm utilizing the CP information and provide their performance comparison. Outcomes show that the proposed use of CP to aid the EM based FB Kalman algorithm results in improved performance [10].

Hsiao, C., Chi-Yun Chen and Tzi-Dar Chiueh, presented a dual mode 2times2 MIMO OFDM & OFDMA receiver this dual mode receiver functions well in both static and mobile channels. Two times MIMO STBC and V-BLAST are supported and a low cost ICI cancellation hardware is also proposed [11].

III. CONCLUSION

The MIMO STBC method has a notable performance and achieves large diversity gain over fading channel. We analyze that the performance of the STBC is very sensitive to the channel estimation error. In wireless communication systems, it is sometimes difficult to have an accurate estimate of the CSI, for instance, when either the channel fading rate or the number of transmit antennas increases. In an effort to increase system performance, it is accepted to use Multiple Input Multiple Output (MIMO). But increasing the number of transmit antennas increases the requirement of training period and reduces the available time to transmit data before the channel coefficients change [44].

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