Literature Review on Asynchronous Cooperative Systems

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Abstract- In this review work we have presented the analysis of Space-time coding that reduces the detrimental effect of channel fading in order to enhance system efficiency. The space-time receiver takes advantage of diverse propagation paths on transmits and receive antennas to improve the performance of wireless communication. It contains a literature survey of the recent developments in MIMO signaling. The main types of space-time codes are block and trellis codes. Space-time block codes (STBC) operate on a block of input symbols, producing a matrix output. Space-time block codes do not generally provide coding gain. Space-time block codes alone generally have little or no coding gain. To extract coding gain, space-time block codes have been previously concatenated with an outer trellis to generate simple and powerful codes, recognized as super-orthogonal codes. New algorithms would be developed to efficiently build trellises for various full-rate MIMO codes, for that reason they extend the concept of trellis-block MIMO coding beyond orthogonal and quasi-orthogonal codes.

Keywords:- Orthogonal Space-Time Block Code, Asynchronous Cooperative Communication.

I. INTRODUCTION

OSTBC have full diversity ($n_T \times n_R$), but have little or no coding gain. To provide both diversity and coding gain that can specify a space-time code that has an in-built channel coding mechanism then example space-time trellis codes, or one can choose a space-time block code concatenated with an outer channel code. Borran et al. [8] discuss design issues of concatenating channel codes with OSTBC. They show that design issues in maximizing diversity gain, and maximizing coding gain can be decoupled. Appropriate to that effortlessness, that structure has been accepted, e.g. in WCDMA standard. Design of concatenated trellis coded inflection (TCM) and OSTBC, and also show that that scheme outperforms space-time trellis codes with the same spectral efficiency, trellis complexity and signal constellation. That gives a new view of OSTBC over fading channel as an equivalent SISO channel. By means of that corresponding channel model, they give analytical evaluation of error probability, without considering the effect of block fading (which is typically assumed for linear decoding of STBC). To give error bounds for MTCM-STBC under Rican Fading. Though, interleaving does not appear in their analysis. Union bounds for channel codes and Alamouti signaling for temporally correlated and channel. But again, the block fading assumption is absent in his analysis. None of the above mentioned works discuss spatially correlated fading. Convolutional/turbo codes with two temporally and spatially correlated antennas in the structure of WCDMA, but do not present any investigation.

Introduction to Space-Time Coding

A typical communication system consists of a receiver, a transmitter and a channel. Space-time coding involves utilize of multiple transmit and receive antennas, as illustrated in Fig. 1. Bits entering the space-time encoder serially are distributed to equivalent sub-streams. Surrounded by each sub-stream, bits are mapped to signal waveforms, which are then emitted starting the antenna corresponding to that sub-stream. The system worn to map bits to signals is the called a space-time code. Signals transmitted simultaneously over each antenna interfere with each other as they propagate through the wireless channel. For now, the fading channel also distorts the signal waveforms. At the receiver, the distorted and superimposed waveforms detected by each receive antenna are used to estimate the original data bits.

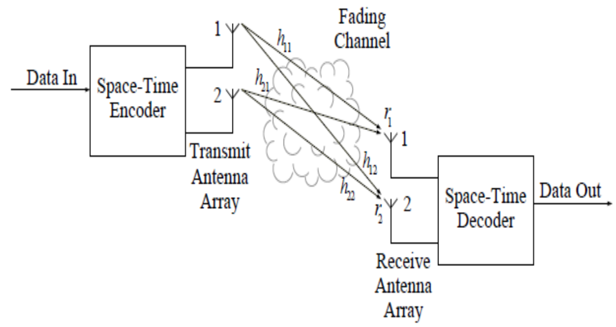

Fig. 1. Communication System Utilizing Space-Time Coding.

MIMO

A wireless communication system with multiple transmitting and receiving antenna elements is called a MIMO organization. The principle of that setup is that transmit signals can be thus designed, and obtain signals so processed, that bit-error rate (quality) or data rate (bit/sec) of the communication is enhanced. MIMO signaling operates by spreading the information across both space and time. Signal processing in time is the natural dimension of the digital communication data. Spatial processing is possible through the use of multiple spatially distributed antennas. MIMO spatial processing takes advantage of multipath propagation, which is a key feature of wireless channel. Multipath fading has been habitually a obscurity in wireless transmission. However, MIMO successfully takes advantage of random fading [1] and when available, multipath delay spread [6], for improving the quality of wireless communication. That improved performance requires no extra spectrum, but demands added hardware and complexity.

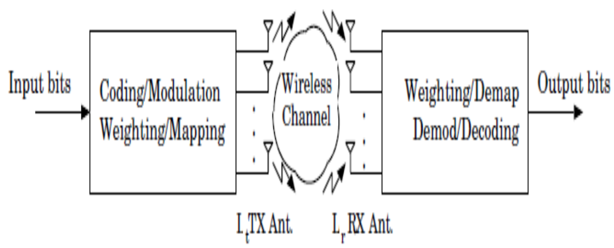

Fig.2. MIMO wireless system diagram.

II. SYSTEM MODULE

The overall capacity is the sum of capacities of each of these modes. Clearly, linear growth in the number of antennas is dependent on the properties of the eigen values. If they decay rapidly, then linear growth would not occur in practice. However, the eigen values have a known limiting distribution [9]; that is unlikely that most eigen values are very small and the linear growth is indeed achieved. The capacity (2.1) is a random variable and does not give a single-number representation of channel quality. Two straightforward summaries are commonly used: the mean (or ergodic) capacity [9] and capacity outage [7]. Capacity outage measures (usually based on simulation) are often denoted C0:1 or C0:01 , i.e., Now they can focus on the information theoretic capacity of a MIMO system. The MIMO signal model is

$$r = Hs + n$$

where r is the $Lr \times 1$ received signal vector, s is the $Lt \times 1$transmitted signal vector and n is an $Lr \times 1$vector of additive noise terms, assumed i.i.d. complex Gaussian with each element having a variance equal to σ^2. For expediency they normalize the noise potheyr so in this assume $\sigma^2 = 1$. Note that the system equation represents a single MIMO user communicating over a fading channel with additive white Gaussian noise (AWGN). The simply interference near is self-interference between the input streams to the MIMO system. Some have considered more general systems but study can be discussed in that simple context, so they use (2.2) as the basic system equation.

$$c = log_2\left[det(I_{L_t} + \frac{\rho}{N}HQH^*)\right] b/s/Hz,$$

For every input symbol sl, a space-time encoder generates L_t code symbols $c_{l1}, c_{l1}, \dots, c_{lLt}$. These Lt code symbols are transmitted simultaneously from the Lt transmit antennas. They define the code vector as $c_l = [c_{l1}, c_{l1}, \dots, c_{lLt}]^T$. Suppose that the code vector sequence

$$C = \{C_1, C_2, \dots, C_L\}$$

was transmitted. They consider the probability that the decoder decides erroneously in favor of the legitimate code vector sequence

$$\hat{C} = \{\widehat{C_1}, \widehat{C_2}, \dots, \widetilde{C_L}\}$$

Consider a frame or block of data of length L and define the Lt _ Lt error matrix A as

$$A(C, \hat{C}) = \sum_{l=1}^{L} (C_l - \hat{C}_l)\,(C_l - \hat{C}_l)^*$$

If ideal channel state information (CSI) $H(l), l = 1, \dots, L,$ is available at the receiver, then it is possible to show that the probability of transmitting C and deciding in favor of ~C is upper bounded for a Rayleigh fading channel by [20]

$$P(C \to \hat{C}) \le (\prod_{i=1}^{r} \beta_i)^{-L_r}.(E_S/4N_O)^{-rL_r}$$

Orthogonal Space-Time Codes

The Alamouti space-time code supports maximum-likelihood (ML) detection with linear processing at the receiver. The simple structure and linear detection of that code makes it very attractive; it has been adopted for both the W-CDMA and CDMA- 2000 standards. That scheme was later generalized in to an arbitrary number of antennas. Here, they will brief review the basics of STBCs. Figure 2.3 shows the baseband representation for Alamouti STBC with two antennas at the transmitter. The input symbols to the space-time block encoder are divided into groups of two symbols each. At a given symbol period, the two symbols in each group $\{c_1, c_2\}$are transmitted simultaneously from the two antennas. The signal transmitted from Antenna 1 is c_1 and the signal transmitted from Antenna 2 is c_2. In the next symbol period, the signal $-c_2^*$ is transmitted from Antenna 1 and the signal c_1^* is transmitted from Antenna 2. They assume a single-antenna receiver, and denote with h1 and h2 be the channels from the and second transmit antennas to the receive antenna, respectively. The channel gains are constant over two consecutive symbol periods. The received signals can be expressed as

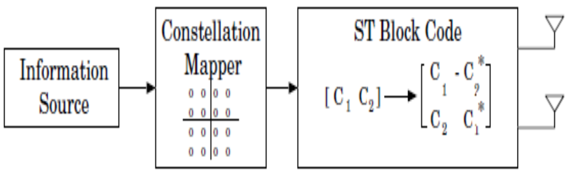

Fig.3. Transmitter diversity with space-time block coding.

$$r_1 = h_1 c_1 + h_1 c_2 + n_1$$

$$r_2 = h_1 c_2{}^* + h_2 c_1{}^* + n_1$$

where r1 and r2 are the received signals over two consecutive symbol periods and n1 and n2 represent the receiver noise and are modeled as complex Gaussian random variables with zero mean and potheyr spectral density No=2 per dimension. They define the received signal vector $= [r_1\ r_2^*]^T$, the code symbol vector $c = [c_1\ c_2]^T$, and the noise vector $n = [n_1\ n_2^*]^T$. Equations (2.7) and (2.7) can be rewritten in a matrix form as

$$r = Hc + n$$

$$H = \begin{pmatrix} h_1 & h_2 \\ h_2^* & -h_1^* \end{pmatrix}$$

The matrix H represents a concatenation of the channel vector (h1 h2)t and the Alamouti code. The vector n is a complex Gaussian random vector with zero mean and covariance NoI2. Let us define C as the set of all possible symbol pairs

$$c = \{c_1, c_2\}.$$

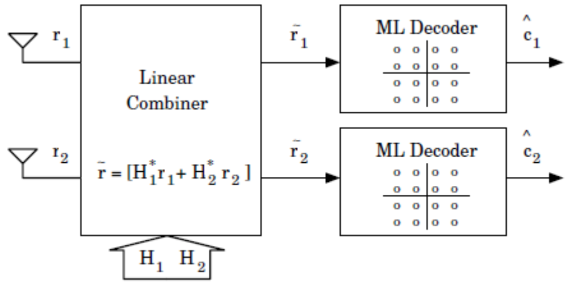

Fig.4. Receiver For Orthogonal Space-Time Block Coding.

diversity order provided by that scheme is 2Lr. Figure 2.4 shows a simplified block diagram for the receiver with two receive antennas. Note that the decision rule in (2.12) and (2.14) amounts to performing a hard decision on $\tilde{r}$ and $\tilde{r}_M = \sum_{m=1}^{L_r} H_m^* r_m$, respectively. Therefore, as shown in Figure 2.4, the received vector after linear combining, $\tilde{r}_M$, can be considered as a soft decision for c_1 and c_2, which can be utilized by any outer channel codes used in the system. Note also that for the above 2×2 STBC, the transmission rate is one symbol/transmission, and it achieves the maximum diversity order of 4 that is possible with a 2×2 system. The method of Alamouti can be generalized to more than two transmit antennas. The resulting orthogonal codes are still optimally decoded with a linear receiver. Unfortunately, only a few codes with a rate of one symbol/ transmission are available, and for the case of general complex-valued signals, there is no orthogonal rate-1 code beyond the Alamouti code. Though, it is possible to design orthogonal codes by relaxing the rate requirement below one symbol/ transmission. For example, for $L_t = 4$, a rate 1/2 STBC is given by

$$C = \begin{pmatrix} c_1 & -c_2 & -c_3 & -c_4 & c_1^* & -c_2^* & -c_3^* & -c_4^* \\ c_2 & c_1 & c_4 & -c_3 & c_2^* & c_1^* & c_4^* & -c_3^* \\ c_3 & -c_4 & c_1 & c_2 & c_3^* & -c_4^* & c_1^* & c_2^* \\ c_4 & c_3 & -c_2 & c_1 & c_4^* & c_3^* & -c_2^* & c_1^* \end{pmatrix}$$

Quasi Orthogonal Space-time codes

Earlier they saw that orthogonal codes allow a linear receiver, but in general they support a rate smaller than one symbol per transmission for $L_t > 2$. Quasi-orthogonal codes compromise on a fully orthogonal code in order to achieve the full rate of one symbol per transmission for $L_t > 2$ Recall that the Alamouti code is dinned by the following transmission matrix

$$A_{12} = \begin{pmatrix} c_1 & c_2 \\ -c_2^* & c_1^* \end{pmatrix}$$

where the subscript [12] is to represent the in determinates c_1 and c_2 in the transmission matrix. Now, let us consider the following space-time block code for four transmit antennas as

$$A = \begin{pmatrix} A_{12} & A_{34} \\ -A_{34}{}^{*} & A_{12}{}^{*} \end{pmatrix} \begin{pmatrix} c_1 & c_2 & c_3 & c_4 \\ -c_2^* & c_1^* & -c_4^* & c_3^* \\ -c_3^* & -c_4^* & c_1^* & c_2^* \\ c_4 & -c_3 & -c_2 & c_1 \end{pmatrix}$$

III. LITERATURE REVIEW

In the year of 2014 Yudong Ma; Hua Jiang; Sidan Du,[1] Investigated a novel two-way cyclotomic orthogonal space-time transmission scheme (TCOSTS) is designed for asynchronous cooperative systems. In TCOSTS, the two terminals transmit signals to each other simultaneously to double the transmission rate. By exploiting cyclotomic orthogonal space-time block code (COSTBC), this scheme achieves full rate, full diversity and low decoding complexity. Also, higher diversity order is available by employing more relay nodes. Benefiting from OFDM asynchronous system architecture, operations implemented at relay nodes are very simple, and the scheme is tolerant of delays relay nodes.

In the year of 2013 Qaja, Walid; Elazreg, Abdulghani; Chambers, Jonathon,[2] presented a amplify-and-forward (AF) type cooperative wireless relay networks employing single bit closed-loop extended orthogonal space-time block coding (CL EO-STBC) over two selected cooperating relay nodes. Selection is performed from a set of NR available relay nodes each equipped with two antennas and outer convolutive coding is used to improve performance. A near-optimum detection scheme is used at the destination node for overcoming the effects of imperfect synchronization among selected relay nodes. End-to-end simulation outcomes show that the employed detection scheme can effectively eliminate the interference components induced by asynchronism with low detection complexity. Furthermore, the one-bit feedback scheme and relay selection technique can enhance the overall system performance and outperform previous feedback methods.

In the year of 2013 Manna, M.A.; Qaja, W.M.; Chambers, J.A.,[3] Investigated on a modified quasi orthogonal space-time block coding (M QO-STBC) scheme with full diversity and code gain distance (CGD) for use in asynchronous relay networks. They implement an orthogonal frequency division multiplexing (OFDM) scheme with cyclic prefix (CP) at the source to mitigate the effects of random delays the relay nodes and the destination caused by a synchronism. The modified code is structured by using a proper signal rotation and set partitioning of two quasi-orthogonal codebooks. Furthermore, the best two relays are selected from a set of M available relays based on the end-to-end instantaneous path gains. Simulation outcomes show that the OFDM-based scheme can significantly enhance the performance of the system under imperfect synchronization. Outcomes also show that the relay selection improved the reliability of the link as compared to a conventional system.

In the year of 2012 Shan Ding; Rui Li,[4] The study of a novel coding system which can reduce the error rate and improve the image transmission performance in the asynchronous cooperative MIMO systems. They propose a combined coder of LDPC-STBC with guard intervals for Set Partitioning in Hierarchical Trees (SPIHT) coded image transmission. The linear dispersion structure is employed to accommodate the cooperative wireless communication network in the dynamic topology of structure, as they achieving higher throughput than conventional space time codes based on orthogonal designs. The LDPC encoder without girth-4 and the STBC encoder with guard intervals are introduced respectively. The outcomes show that the combined scheme can be the good error correcting codes and achieve better BER performance in the asynchronous cooperative communication. The combined scheme can improve the quality of the reconstructed image in the PSNR values and SPIHT coded image transmission in the asynchronous cooperative MIMO systems.

In the year of 2011 Mannai, U.N.; Abdurahman, F.M.; Elazreg, A.M.; Chambers, J.A.,[5] Investigated on distributed space time block codes (D-STBCs) are applied within an asynchronous two-way cooperative wireless relay network using two relay nodes. A parallel interference cancelation (PIC) detection scheme with low structural and computational complexity is applied at the terminal nodes in order to overcome the effect of imperfect synchronization among the cooperative relay nodes. Simulation outcomes based on end-to-end bit error rate (BER) illustrate that the PIC detection algorithm can mitigate the inter symbol interference (ISI) introduced by a synchronism, and that only a small number of iterations is necessary within the PIC detection to improve the system performance.

In the year of 2011 Alotaibi, F.T.; Abdurahman, F.; Mannai, U.; Chambers, J.A.,[6] The study of a new robust closed-loop extended orthogonal space-time block coding (EO-STBC) scheme for two-way four relay networks over frequency selective fading channels with imperfect synchronization. It is a three time slot scheme where the first one is specified for the two terminals while the other two are specified for amplify-and-forward (AF) relays. An orthogonal frequency division multiplexing (OFDM) data structure is employed at the two terminals using cyclic prefix (CP) insertion to combat the effect of multipath and time asynchronicity. Full spatial diversity with array gain and code rate of 2/3 is achieved through applying a simple feedback approach over only two relays. Simulation outcomes are used to show the performance improvements resulting from the proposed system. Furthermore, authors scheme uses a simple symbol-wise maximum likelihood (ML) decoder to extract the information data.

In the year of 2011 Elazreg, A.M.; Chambers, J.A.,[7] Investigated on a novel closed-loop distributed extended orthogonal space time block code (D-EO-STBC) with one-bit feedback based on selection of phase rotation is proposed for two relay nodes each relay equipped with two antennas. In this scheme, only one-bit of feedback is used to determine the transmission phase terms applied to the symbols from the antennas of each relay nodes. This is considerably the feedback overhead than previous feedback schemes. This feedback information is based upon channel state information (CSI) available at the destination node. In addition, the transmission rate over each hop in the network is unity and full cooperative diversity is obtained by the approach. Furthermore, this proposed scheme is applied to asynchronous relay networks using orthogonal frequency division multiplexing (OFDM) with cyclic prefix (CP) at the source node to combat the timing error at relay nodes, which operate in a simple distributed STBC mode. End-to-end bit error rate (BER) simulation outcomes show that the proposed scheme can enhance the performance of the system with feedback limited to only one-bit and outperform previous feedback methods.

In the year of 2009 Alotaibi, F.T.; Chambers, J.A.,[8] The study of a novel extended orthogonal space-time block code (EO-STBC) scheme for a cooperative relay system with four relay nodes and without perfect synchronization. Full-rate and full-diversity can be achieved through using feedback channels. The relay nodes forward information symbols in a simple amplify-and-forward (AF) manner. The information symbols can be extracted with simple symbol-wise maximum-likelihood decoding.

IV. PROBLEM DESCRIPTION

The first challenge In general, diversity means using different dimensions of the channel, e.g. space, and time, frequency, and so on, to get better the equivalent channel seen by the receiver. In the study they will specifically deal with one of the realizations of space diversity techniques termed as space-time codes. It is in general any modulation scheme which is designed for a multiple transmitter wireless system that tries to achieve antenna (space) range. The problem of designs of space-time codes they are in the form of trellis coded modulation, and beginning exponential decoding complexity as the number of transmit antennas increased. After a while, simple transmitter diversity scheme which provide both full diversity of a two-transmit antenna channel as they as simple Maximum-Likelihood (ML) decoding. The superior properties of that code inspired to inspect the existence of similar designs for more numbers of transmit antennas. In the container of complex codes, i.e. modulation schemes using complex constellation members, the proposed structured modulation method, called Orthogonal Space-time Block Code that could send on average one symbol in every two time slots, in addition to achieved full diversity as simple ML decoding but still there is a unique chance to improve the system performance.

V. CONCLUSIONS & FUTURE WORK

The Space Time Coding would be designed in distributed networks along with the Randomization system where each node of the network transmit an autonomous, arbitrary linear combination of the columns of a space time code matrix, irrespective of the number of cooperative node. That approach enables a novel design of the line to decentralize the relay transmission and yet obtain the same diversity as that of multi antenna organization. A distributed planning is advantageous in that there is no single point of failure, with the potential for continuous operation in the presence of individual terminal or node failures. Exploring a new family of codes called as Space–Time codes for transmission in wireless Rayleigh fading channel using multiple antennas at either the transmitter or receiver side. Many subfamilies of space–time codes they are also set up. We study in this review that the performance of these codes and a comparison between them is completed. Space–time codes can be readily designed in DSP due to their simplicity in architecture and design. In addition to the performance of these codes they have also studied the diversity feature of each code.

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