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An Extensive Literature Review on Orthogonal Space-Time Transmission Scheme for Cooperative Systems

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Abstract: Recently, cooperative relay networks have emerged as an attractive communications technique that can generate a new form of spatial diversity which is known as cooperative diversity, that can enhance system reliability without sacrificing the scarce bandwidth resource or consuming more transmit power. To achieve cooperative diversity single-antenna terminals in a wireless relay network typically share their antennas to form a virtual antenna array on the basis of their distributed locations. As such, the same diversity gains as in multi-input multi-output systems can be achieved without requiring multiple-antenna terminals. However, there remain technical challenges to maximize the benefit of cooperative communications, e.g. data rate, asynchronous transmission, interference and outage

Keywords: asynchronous cooperative communication, two-way transmission, Cyclotomic orthogonal space-time block code (COSTBC).

I. INTRODUCTION

The increasing demand for high data rates in wireless communications due to emerging new technologies makes wireless communications an exciting and challenging field. The spectrum or bandwidth available to the service provider is often limited and the allotment of new spectrum by the federal government is often slow in coming. Also, the power requirements are that devices should use as little power as possible to conserve battery life and keep the products small. Thus, the designers for wireless systems face a two-part challenge, increase data rates and improve performance while incurring little or no increase in bandwidth or power. The wireless channel is by its nature random and unpredictable, and in general channel error rates are poorer over a wireless channel than over a wired channel. A major problem in the wireless channel is that out-of-phase reception of multipath causes deep attenuation in the received signal, known as fading. The distortion induced by the time-varying fading is caused by the superposition of delayed, reflected, scattered and diffracted signal components. Another problem of the wireless channel is variation over time, due to the movements of the mobile unit and objects in the environment. This results into severe attenuation of the signal, referred to as deep fade. This instantaneous decrease of the signal-to-noise ratio (SNR) results in error bursts which degrades the performance significantly.

The propagation of a signal over a wireless channel is affected by various phenomena, among which are reflections, diffraction and scattering from buildings, moving objects such as cars and trees [2], as shown in Figure 1 Such phenomena may result from different

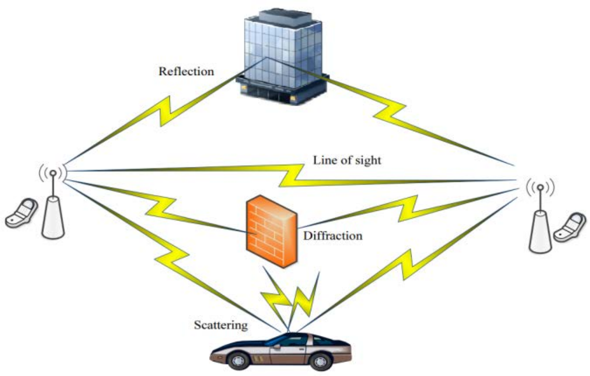

Figure 1. A typical wireless transmission environment showing diffraction, reflection and scattering phenomena.

sources, such as multi-path transmission, fading and shadowing [2]. When the transmitted wireless signal reaches the receiving end by more than one path, a propagation phenomenon known as multi-path takes place. Multi-path can be defined as the combination of the original signal plus the duplicate wave fronts that result from reflection of the waves off obstacles between the transmitter and the receiver.

Space time coding

To improve spectral efficiency and robustness of wireless systems, different transmission techniques can be applied, which depend on the knowledge of the channel state information (CSI) at the transmitter side. If the CSI is available at the transmitter, beam forming can be used to transmit information over the wireless channel. If the CSI is not available at the transmitter STC can be used for transmission.

Cooperative systems

Cooperative relay networks have developed as a useful technique that can achieve the same advantage as MIMO wireless systems whilst resolving the difficulties of co-located multiple antennas at individual no des and avoiding the effect of path-loss and shadowing.

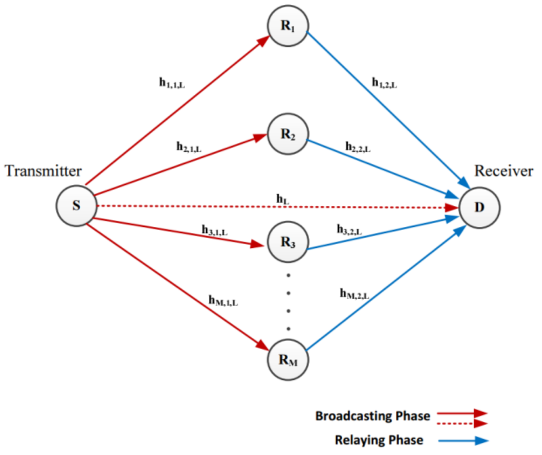

Figure 2. Basic structure of a cooperative relay network with two phases for one-way cooperative transmission, (M relay nodes and L channel length).

A two-way cooperative relay network with two terminals, T1 and T2, which exchange their information between each other through the relay nodes. The transmission requires two phases to complete the whole transmission. In the broadcast phase the data symbols are grouped into symbols and then the data symbols are transmitted from both terminals in different time slots to all cooperative relay nodes. Then in the relaying phase, the cooperative relay nodes pre-code the received data packet from both terminals and then transmit the data back to both terminals. The relays nodes may either act as a repeater where they amplify the received signals or they may decode the received signals from the source node,

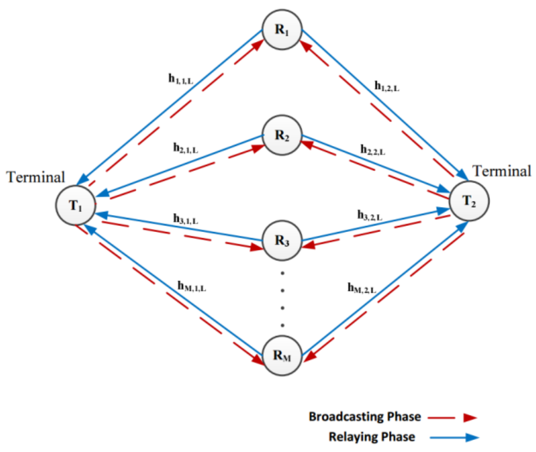

Figure 3. Basic structure of a cooperative relay network with two phases for two-way cooperative transmission process, (M relay nodes and L channel length).

before forward them to the receiver node. The maximum cooperative diversity gain can be achieved by using either a one-way scheme or a two-way scheme, is equal to the number of transmitting relay nodes. In brief, cooperative relay systems potentially offer several advantages and disadvantages for wireless communications as follows:

Major advantages

Performance gains: can be achieved due to capacity, diversity and path-loss gains. These gains can decrease power consumption due to transmitting over shorter links, provide higher capacity, higher transmission rate and improve the outage probability in a wireless network.

Coverage extension: on several occasions, due to distance it may be impossible to establish a direct link between the transmitter and the receiver. This means that such transmitters would be unable to communicate with the receiver because of insufficient power. However, a cooperative relay system can effectively extend the network coverage through the relaying capability, and thereby the transmitted signal can service more range.

II. LITERATURE SURVEY

Yudong Ma, H. Jiang and S. Du,[1] In this paper, 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 between relay nodes.

Y. Jing and H. Jafarkhani [2] Distributed space-time coding was proposed to achieve cooperative diversity in wireless relay networks without channel information at the relays. Using this scheme, antennas of the distributive relays work as transmit antennas of the sender and generate a space-time code at the receiver. It achieves the maximal diversity when the transmit power is infinitely large. This paper is on the design of practical distributed space-time codes (DSTCs). Authors use orthogonal and quasi-orthogonal designs which are originally used in the design of space-time codes for multiple-antenna systems. It is well known that orthogonal space-time codes have full diversity and linear decoding complexity. They are particularly suitable for transmissions in the network setting using distributed space-time coding since their ldquoscale-freerdquo property leads to good performance. Simulations show that they achieve lower error rates than the random code. Authors also compare distributed space-time coding to selection decode-and-forward using the same orthogonal designs. Simulations show that distributed space-time coding achieves higher diversity than selection decode-and-forward (DF) when there is more than one relay. Authors also generalize the distributed space-time coding scheme to wireless relay networks with channel information at the relays. Although the analysis and simulations show that there is no improvement in the diversity, in some networks, having channel information at the relays saves both the transmission power and the transmission time.

Q. Huo, L. Song, Y. Li, Y. Feng and B. Jiao [3] in this paper, consider general two-way relay networks (TWRNs) with two source and N relay nodes when neither the source nodes nor the relay nodes have access to channel-state information (CSI). A distributed differential space time coding with analog network coding (DDSTC-ANC) scheme had been proposed. A simple blind estimation and a differential signal detector are developed to recover the desired signal at each source. The pairwise error probability (PEP) and block error rate (BLER) of the DDSTC-ANC scheme are analyzed. Exact and simplified PEP expressions are derived, which can be used for power allocation between the source and relay nodes. The analytical results are verified through simulations.

SR. NO.	TITLE	AUTHORS	YEAR	METHODOLOGY
1	Two-way cyclotomic orthogonal space-time transmission scheme for asynchronous cooperative systems	Yudong Ma, H. Jiang and S. Du	2014	a novel two-way Cyclotomic orthogonal space-time transmission scheme (TCOSTS) is used for asynchronous cooperative systems
2	Using Orthogonal and Quasi-Orthogonal Designs in Wireless Relay Networks	Y. Jing and H. Jafarkhani	Nov. 2007	Distributed space-time coding was proposed to achieve cooperative diversity in wireless relay networks without channel information at the relays.
3	A distributed differential space-time coding scheme with analog network coding in two-way relay networks	Q. Huo, L. Song, Y. Li, Y. Feng and B. Jiao	2012	A distributed differential space time coding with analog network coding (DDSTC-ANC) scheme is proposed.
4	Joint Relay Selection and Power Allocation for Two-Way Relay Networks	S. Talwar, Y. Jing and S. Shahbazpanahi	Feb. 2011	Present an optimal joint relay selection (RS) and power allocation scheme for two-way relay networks which aim to establish a communication link between two transceivers with the help of one relay.
5	Bandwidth and Power Allocation for Cooperative Strategies in Gaussian Relay Networks	I. Maric and R. D. Yates	April 2010	Sensor network applications, power-constrained networks with large bandwidth resources and a large number of nodes are considered.

S. Talwar, Y. Jing and S. Shahbazpanahi [4] in this letter, authors present an optimal joint relay selection (RS) and power allocation scheme for two-way relay networks which aim to establish a communication link between two transceivers with the help of one relay. Their approach is based on the maximization of the smaller of the received signal-to-noise-ratios (SNRs) of the two transceivers under a total transmit power budget. They show that this problem has a closed-form solution and requires only a single integer parameter (i.e., the index of the optimally selected relay) to be broadcasted to all relays. authors also show that for large values of the total transmit power, the selection criterion can be approximated as the harmonic mean of the amplitudes of the relays' local channel coefficients to evaluate the performance of scheme numerically.

I. Maric and R. D. Yates [5] Achievable rates with amplify-and-forward (AF) and decode-and-forward (DF) cooperative strategies are examined for relay networks. Motivated by sensor network applications, power-constrained networks with large bandwidth resources and a large number of nodes are considered. It is shown that AF strategies do not necessarily benefit from the available bandwidth. Rather, transmitting in the optimum AF bandwidth allows the network to operate in the linear regime where the achieved rate increases linearly with the available network power. The optimum power allocation among the AF relays, shown to be a form of maximal ratio combining, indicates the favorable relay positions. Orthogonal node transmissions are also examined. While the same optimum bandwidth result still holds, the relay power allocation in this case can be viewed as a form of water-filling. In contrast, the DF strategy will optimally operate in the wideband regime and is shown to require a different choice of relays. Thus, in a large scale network, the choice of a coding strategy goes beyond determining a coding scheme at a node; it also determines the operating bandwidth, as well as the set of relays and best distribution of the relay power.

III. PROBLEM IDENTIFICATION

Based on COSTBC for MIMO systems, we have designed a novel transmission scheme (TCOSTS) for asynchronous cooperative systems. In TCOSTS, transmission rate is doubled, and diversity order can be expanded according to the number of relay nodes employed. Due to the asynchronous OFDM architecture, delays shorter than lcp will not damage TCOSTS's reliability, and relay nodes only study very simple operations on received signals. Simulation results demonstrate that BER performance of TCOSTS is close to the optimum level represented by DRQOSTBC for synchronous systems, and far better than clustered DAlamouti for asynchronous an system which only achieves diversity order.

IV. CONCLUSION

In this context, the distinct characteristics of wireless networks compared to their wired counterpart lead to more sophisticated design of protocols and algorithms. Some of the most important inherent properties of the Physical Layer (PHY) that make the design more complicated include, the attenuation of radio signals over long range communications called path loss, and the fading effect caused by multipath propagation. In order to mitigate these effects, the user has to increase its transmission power or use more sophisticated reception algorithms. Another important limitation of wireless performance caused mainly as a result of communication over a limited bandwidth is the interference from other users, communicating over the same frequency spectrum.

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