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BRUS Technology for Interference Management in Cooperative Communication

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Abstract

The cooperative communication is a developing technique for upcoming wireless networks. It can be used in improving communication dependability, and enhancing power and spectrum efficiency. However, its performance gain deteriorates in the presence of co-channel interference which makes it necessary to propose interference management methods. An effective cooperative communication scheme with interference management for multi-user cooperative wireless networks is based the on best relay and user selection (BRUS) technique. BRUS maximizes the received signal to noise ratio (SNR) while minimizing the interference by an optimum time slot allocation for the users. This cooperation scheme enhances the system performance and improves the interference management. By using power efficient algorithm (PVE) which is a pilot signaling scheme, we can reduce the power consumption of the entire system and thus increase the power efficiency of the system as compared to BRUS. In this paper, simulations are used for analysis and results are obtained which show that that the PVE has a better performance than BRUS technique in terms of bit error rate (BER) and power consumption.
Keywords: Cooperative communication, BRUS, PVE, SNR

I. INTRODUCTION

Cooperative relaying has been shown to have great potential in assisting communication duos in wireless networks by mitigating the effects of multi-path fading .The advantages of cooperative relaying depend on the broadcast nature of wireless networks, where it is expected that several nodes can overhear an ongoing communication between a source-destination pair. So, even if a packet cannot be delivered to a destination due to impaired channel conditions, a copy of that packet can be retransmitted by a nearby node which has successfully overheard the direct transmission. Such form of cooperative diversity helps to overcome hardly predictable signal drops on the direct transmission channel and can avoid the need for higher layer retransmissions. Cooperative communication in wireless networks is becoming an emerging trend recently since it could mitigate the particularly severe channel impairments arising from multipath propagation. Transmit diversity generally involves more than one antenna at the transmitter side. But many wireless devices face a limitation of size or hardware complexity related to one antenna. Cooperative communication enables single antenna mobiles in a multi-user environment to share their antennas and generate a virtual multiple-antenna transmitter that allows them to attain transmit diversity.

The advantages of multiple-input multiple-output (MIMO) systems have been widely recognized so as to incorporate certain transmit diversity methods (i.e., Alamouti signaling) into wireless standards. Although transmit diversity is clearly beneficial on a cellular base station, it may not be practical for other conditions like size, cost, or hardware limitations. Examples are that most handsets (size) or the nodes in a wireless sensor network (size, power).The mobile wireless channel undergoes fading, meaning that the signal attenuation can vary considerably during a given transmission. Transmitting independent copies of the signal generates diversity and can effectively combat the deleterious effects of fading. Thus cooperative communication typically refers to a system where users share and coordinate their resources to enhance the information transmission quality. A problem existing in cooperative communication is the interference management in the presence of fading. This paper addresses this issue, and thus an interference management technique known as the BRUS (best relay and user selection) is introduced. Also by using power efficient algorithm (PVE) for interference management, which is a pilot signaling scheme, we can reduce the power consumption of the entire system as compared to BRUS technique. The paper is organized as follows: section 2 provides an overview of related work, section 3 outlines the proposed methodology, section 4 provides details of the results obtained, and section 5 provides the overall conclusion.

II. RELATED WORKS

Cooperative communication has been adopted in long term evolution advanced (LTE-A) systems [3]. LTE-A is the 4G mobile communication system which is standardized by the 3^{rd} generation partnership project (3GPP) as an improved version of the LTE standard [3]. The use of cooperative communication is one of the main variation introduced by LTE-A to improve the communication reliability, and to improve the spectrum efficiency**.** In literature, different related research work have been proposed to avoid the interference problems in cooperative wireless communications networks. In [6], a zero-forcing (ZF) based relay cooperation strategy is presented, where the destination considers the undesirable signal as interference and tries to cancel it by ZF equalization. The drawback of this technique is the use of extra resource and energy at the receiver when two antennas have to be used. In [6] another technique that is, joint transmission with message passing (JTMP) is introduced, where each user decodes its own message, and then exchanges messages with each other to detect only the needed message without interference. This technique needs three time slots to be completed which reduces the average ergodic system capacity.

Relay location based interference management is another method presented in [7], in which nodes location information is used to prevent the interference problems. These schemes have high computation and feedback necessities which upsurge the system complexity. In [8], an iterative method is used to create the transmit-receive antennas weights. The transmit-receive weights are optimized iteratively such that the SINR for each user converges to a fixed value. The complexity of this technique is high since the antennas weights need to be designed iteratively and periodically. Aymen Omri in [16] presented two cooperative communications schemes with interference management for OFDMA wireless cooperative relaying networks. The first scheme maximizes the received SNR at the same time keeping the interference levels below a certain threshold, and the second scheme maximizes the received SNR with the method of interference avoidance by using a resource allocation algorithm. Mazen O. Hasna et al. [20] proposed interference (IRI) management technique for multi-user wireless networks. The first method (Interference management at relay station (IMR)) uses the decode-and-forward (DF) relaying protocol and treats the IRI at relay station. The second method (Interference management at mobile station (IMM)) uses the amplify-and-forward (AF) relaying protocol and considers the IRI at mobile station .However in [18**],** Best Available Relay Selection (BARS) technique is presented and its target is to maximize the SNR while keeping the interference levels below a particular threshold.

III. PROPOSED SYSTEM

A. System Model:

Let us consider a multi-user cooperative wireless networks consisting of a source denoted by S that is transmitting its signal to the user Uj with the help of relays denoted by Ri, as shown in Fig.1. There are Nr number of fixed single-antenna relays and Nu number of users in the cell. The users can share the transmission bandwidth using the TDMA or time division multiple access technique. We can assume that the average SNR of the second hop i.e. from relay to destination is the same for all the relays, and the first hop i.e. from source to relay is highly reliable and may be part of the backbone network, so all the relays can perfectly decode the received signal. We also assume also that before initializing the transmission, the base station knows all the channel state information (CSIs) for each and every user and every relay. The information transmission procedure for each user within the wireless cooperative relay network is divided into two time slots denoted by Tn and Tn+1.

During the time slot Tn, the source S snds its message to the destination Un* as well as all the relays and in the following time slot Tn+1, the selected relay Rn* can transmit the received message to user Un*, and the source S at the same time transmits to user Un+1*. At the receiver side the user Un*, combines the direct and the relay link signals using the maximum ratio combining (MRC). But the interference imposed on user Un+1* from the selected relay Rn* can destroy the transmission performance. To prevent this interference problem and reap the benefits of cooperative communication, the BRUS technique was proposed.

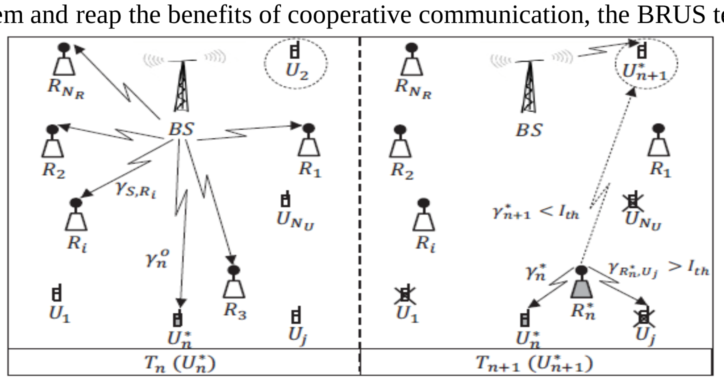

Fig. 1: System model

B. Best Relay and User Selection (BRUS) Scheme:

Every user has two possible transmission modes depending upon on the CSI of the direct link (DL). First, if the instantaneous DL SNR γon of user U*n is bigger than that of the DL threshold SNR γth, then only the DL transmission will take place. Otherwise, there is the possibility of using a cooperative communication based on the scheme for interference management. In this case, the best relay for the destination or user U*n (i.e. R*n) will be selected. The relay maximizing the instantaneous SNR of the second hop (γ*n) is R*n . After the relay selection procedure, a user satisfying the interference constraint will be selected randomly. After the user selection step, if U*n+1 exists, then the time slot Tn+1 will be assigned to this selected user, and the cooperative communication will be assigned for U*n. Otherwise, Tn+1 will be allocated to a randomly selected user and the direct link communication will take place for U*n.

C. *Transmission Power Efficient (TPE) Algorithm:*

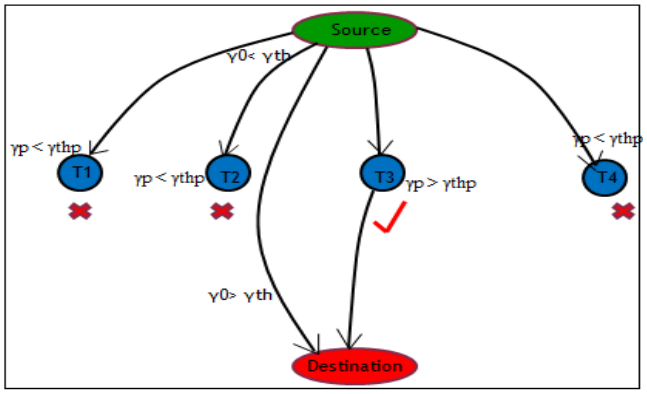

Fig. 2: Representation of TPE algorithm

Using the BRUS algorithm involves selection of the best relay for which the transmitting signal has to be sent to every relay which is accessible. Out of these relays only one of the relays is selected for transmission to the user. This involves a lot of power wastage as the signal is first sent to all relays and then only we select the best relay. But in the TPE algorithm firstly we shall send to the relays, a pilot signal which is not as lengthy as the actual signal. A threshold value for the SNR is fixed ie γthp . As shown in figure 2 , the condition is that if SNR of pilot signal (γp)is less than threshold SNR of pilot signal (γthp) i.e. γp < γthp ,that particular relay will be rejected .If SNR of pilot signal (γp)is greater than threshold SNR of pilot signal (γthp) i.e. γp > γthp, ,that particular relay will be selected .Once the best relay is selected (in this case T3) ,there will be a feedback given to the transmitting antenna only after which the actual signal will be sent to the selected relay. This relay will send the signal to the user at the destination. The advantage of the TPE algorithm is that a lot of power can be saved as compared to BRUS. In BRUS power is wasted as the signal is transmitted to many relays and only one relay is of interest and the rest of the power goes waste. But TPE avoids this wastage as a smaller pilot signal is used as a test signal to select the best relay and then only the actual signal is sent through the selected relay to the user.

IV. EXPERIMENTAL RESULTS

The main aim of this paper is to conduct a comparative study between two schemes for interference management in cooperative communication ie the BRUS and TPE methodologies and to prove that the performance of TPE is slightly better than that of BRUS. Figure1 is the case of an ideal single relay between the transmitter and the receiver. It is seen that BER of the theoretical case of BRUS ie BRUS-T is a little lower than that of the practical case of BRUS ie BRUS-P . Figure 2 is the case of multiple relays (number of relays fixed as 10) and it shows that the BER of BRUS practical and theoretical cases is lower than that of cooperative communication without interference i.e. co-comm. In figure 3, power consumption of the transmitting signal is shown in BRUS with TPE schemes and it is observed that power consumption is lower in TPE as compared to BRUS theoretical and practical cases thus showing an improved performance in TPE. A final graph figure 4 show a comparison of the bit error rate in case of cooperative communication, BRUS and TPE (pilot) schemes and it is clearly seen that BER of TPE is least .TPE is followed by BRUS and cooperative communication without interference management has the most BER.

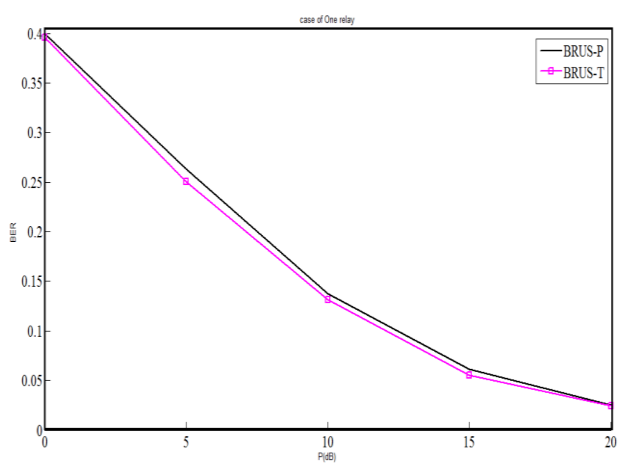

Fig. 3: Case of one relay

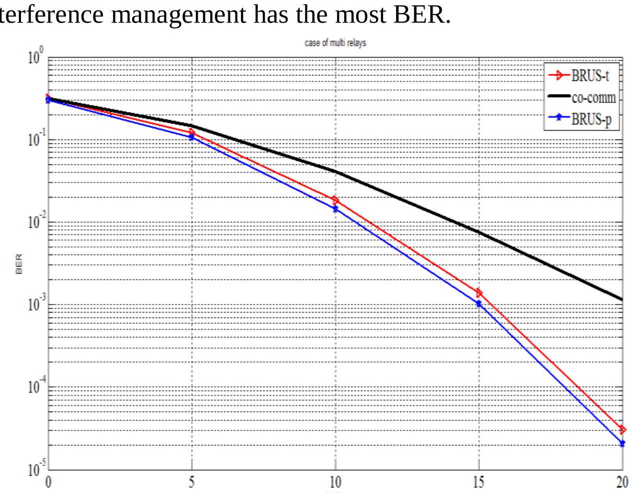

Fig. 4: Case of multiple relays

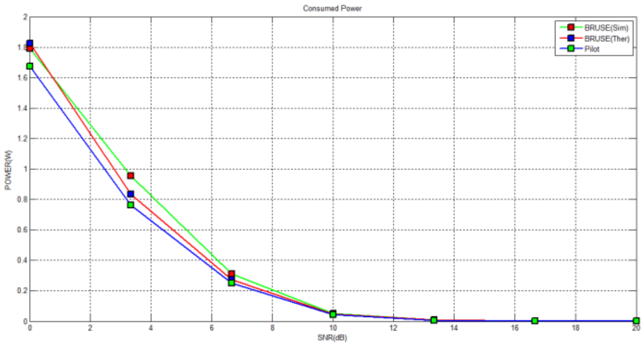

Fig. 5: Comparison of BRUS with TPE in terms of power Consumption for transmission

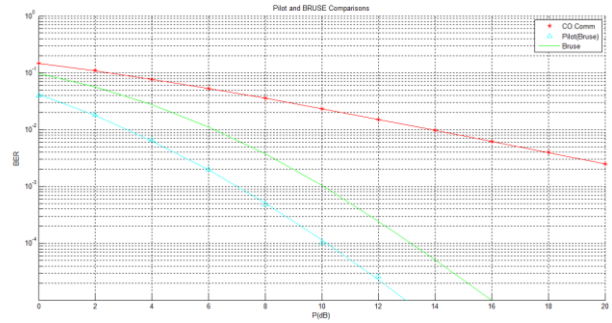

Fig. 6: Comparison of the cooperative communication BRUS and TVE in terms of BER

V. CONCLUSION

The literature review shows that out of the several methods for interference management in cooperative communication two efficient cooperative communication schemes with interference management have been proposed for multi-user cooperative wireless networks. The first scheme is on the basis of best relay and user selection (BRUS) technique. BRUS maximizes the received SNR while minimizing the interference by an optimal time slot allocation for the users. This cooperation scheme enhances the system performance and improves the interference management. The second scheme is power efficient algorithm (PVE) for interference management, which is a pilot signaling scheme by which we can reduce the power consumption of the entire system and thus increase the power efficiency of the system. In this paper, simulations are used for analysis and results are obtained a comparison which shows that that the PVE has a better performance than BRUS technique in terms of bit error rate (BER) and power consumption.

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