International Journal of Engineering Research and Reviews ISSN 2348-697X (Online)
Vol. 3, Issue 3, pp: (90-95), Month: July - September 2015, Available at: www.researchpublish.com

Cooperative Tactics for Amplify and Forward Relaying With Relay Selection

[1]Aswathy G., [2]Sangeeta T. R.

[1]Dept of Electronics and Communication, Sree Buddha College of Engineering for Women, Pathanamthitta, Kerala, India
[2]Dept of Electronics and Communication, Sree Buddha College of Engineering for Women, Pathanamthitta, Kerala, India

Abstract: **In wireless network signal fading occurs due to multipath propagation. It can be mitigated through the use of diversity. Cooperative diversity is a form of spatial diversity that uses a collection of distributed antennas belonging to multiple terminals, each with its own information to transmit. The broadcast nature of wireless medium is the key property that allows for the cooperative diversity among the transmitting terminals. OSTBC with amplify and forward (AF) cooperation protocols can be deployed in a system with FD relaying. This offers predominant advantage of achieving high coding gain. Also the performance of the system can be improved with selecting the best relay based on its SNR.**

Keywords: **Amplify and Forward (AF) cooperation, OSTBC, FD and HD communication, MIMO system.**

I. INTRODUCTION

The concept of cooperation in wireless communication networks has drawn significant attention recently from both academia and industry as it can be effective in addressing the performance limitations of wireless networks due to user mobility and the scarcity of network resources. Cooperation is the process of working together, opposite of working separately in competition. Recently, such a concept has been adopted from social sciences and economics to constitute a major research area in wireless communication networks. The idea of employing cooperation in wireless communication networks has emerged in response to the user mobility support and limited energy and radio spectrum resources, which pose challenges in the development of wireless communication networks and services in terms of capacity and performance.

With rising energy costs and rigid environmental standards, green communications have attracted considerable research attention in recent years, particularly for the fast-growing multimedia services in wireless networks since mobile devices are usually energy constrained. Due to the challenging issues imposed in wireless networks such as channel fading and user mobility, QoS provisioning for delay sensitive multimedia services is much more difficult than it is in wired networks. To deal with these challenges, attractive techniques, such as multiple-input-multiple-output (MIMO) systems and cooperative communications, have been developed by exploiting spatial diversity. Nonetheless, due to the size, cost, and energy limitations of mobile devices, it can be infeasible to deploy multiple antennas in some wireless terminals.

Half –duplex (HD) communication as well as full-duplex (FD) communication modes can be deployed at the relays. In HD mode the relay node have to perform communication in only one direction. Relays cannot perform simultaneous transmission and reception in this mode. Recently there has been an increasing need in FD cooperating mode where the participating relays can simultaneously transmit and receive at the same time.

To meet the ever increasing demands for multimedia services in future wireless networks, user cooperation is a promising low cost and energy efficient technique for providing spatial diversity. Taking advantage of the inherent broadcasting nature of the wireless medium, the nodes with good channel conditions can forward the overheard data to facilitate the transmission of one source-destination (S-D) pair, which includes a single source (S) and a single destination (D). As shown in Fig 1. the relay(s) that correctly overhear the packet from S can forward the data to D. There are various protocols proposed to choose the best relay among a collection of available relays.

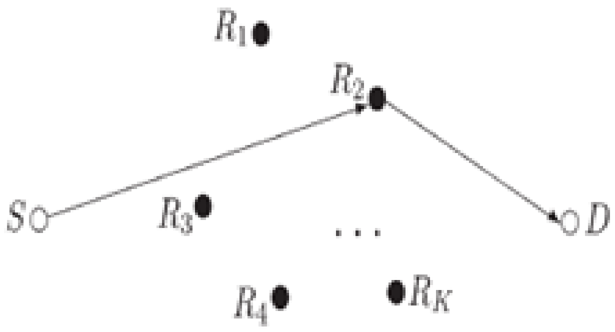

Fig 1: Cooperative communication model

In this paper, the focus is on amplify-and-forward (AF) dual-hop cooperative diversity network with orthogonal space time block codes (OSTBC) and the performance enhancement using the best-relay selection scheme over Rayleigh fading channel is deployed. The remaining sections of this paper is organized as follows. Section II deals with the system model for Amplify-And-Forward cooperative network over Rayleigh fading channel along with the performance enhancement through relay selection strategy; Graphical results are discussed in section III . Finally, the conclusions are given in Section IV.

II. MATERIAL AND METHODOLOGY

A. System Model:

A wireless network with one source-destination pair and relays N_r =2 number of relay nodes, are shown in Fig 2. Here the nodes are randomly distributed in a given region and they follow a homogeneous Poisson point process (PPP) with an unknown intensity.

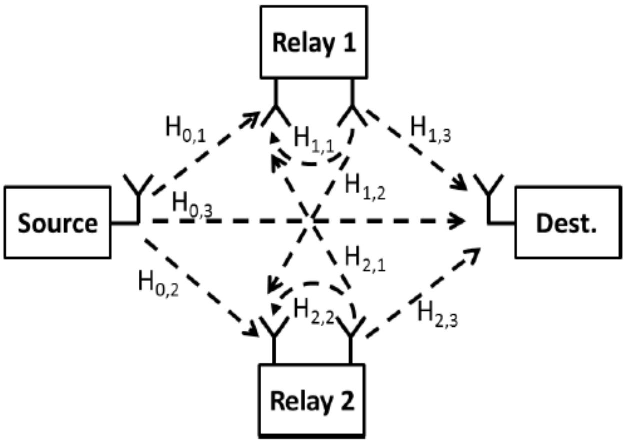

Fig 2: Network model for two relays with FD cooperation

S and D are equipped with one antenna each while the relays are equipped with two antennas (one for reception and the other for transmission) to implement a FD operation mode. L-finger rake receivers are deployed at the relays and the destination in order to capture the multi-path diversity and the general case where a direct link is present between S and D is considered here. The channel between the n-th and n' -th nodes is described by the matrix $H_{n,n}{}'$.

The signal received at the n-th relay during the k-th symbol duration is represented by the vector $Y_k^{(n)}$. Z_k represents the decision vector at D during the k-th symbol duration. For a relay processing that involves amplification and MRC, the signal transmitted by the n-th relay during the k-th slot can be written as:

$X_k^{(n)} = \beta\, H_{(0,n)}^T\, Y_{k'}^{(n)}$ such that k > k'

Where β stands for the amplifying factor at the n-th relay and the multiplication by $H_{(0,n)}^T$ ensures coherent combining of the useful signal energy along the link S-R_n.

B. Orthogonal Space Time Block Codes:

Orthogonal space-time block codes (STBC's) have received considerable attention in recent open-loop multiple-input-multiple-output (MIMO) wireless communication. They allow low complexity maximum likelihood decoding and guarantee full diversity. An orthogonal STBC is characterized by a code matrix $G_{P\times n}$ where *p* denotes time delay or block length and *n* represents the number of transmit antennas. The entries of **G** are linear combinations of k data symbols or their conjugate, $S_1, S_2, \ldots, S_k, S_{1,}^{*} S_2^{*}, \ldots, S_{K,}^{*}$ that belong to an arbitrary signal constellation. The columns of **G** are orthogonal to each other and

$G^H\ G = (|\ S_1|^2 + |\ S_2|^2 + \ldots + |\ S_K|^2) I_n$

Where G^H denotes the complex conjugate transpose of matrix G, and I_n is the size-n identity matrix. The code rate of G is defined as R = k/p (i.e., each code word with block length p carries k information symbols).

C. Relay Selection Method:

The conventional multi-node cooperative communication systems, where all the available relays actively participate in the communication by re-transmitting signals, have the potential of achieving full cooperative diversity gains. For instance, for a pair of sender and receiver with N relays participating in the cooperative communication, a packet transmission failure occurs only when all the N +1 links (sender- receiver plus sender-relays-receiver) experience deep channel fading simultaneously. However, the channel efficiency of the multi-node cooperative communication system is much lower than the non-cooperative communication system, because the total number of N + 1 time slots is needed for the packet transmission.

The packet transmission suffers extra delay due to the receiver deferring the packet decoding until all relays have completed their transmissions. To achieve full cooperative diversity gains while still obtaining high channel efficiency and low transmission delay, selective single relay cooperative schemes, i.e., only one optimal relay is selected from multiple relaying candidates to cooperate with the communication.

Relay selection is a challenging issue in cooperative communication networks. Cooperative diversity uses relays to assist source destination transmissions to reduce link outage rates in multipath fading environments.

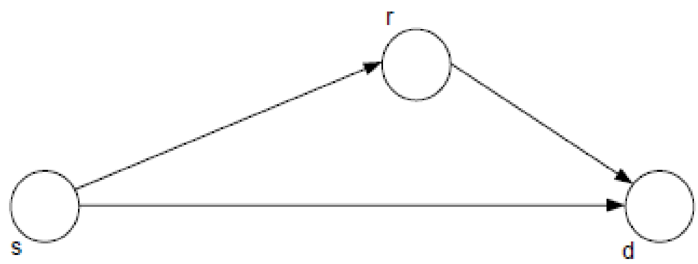

Fig 3: Single relay cooperative communication system

A cooperative communication over Rayleigh fading channel, consisting one direct channel and N amplify-and- forward (AF) dual-hop relay channels is considered. Source has one transmit antenna and destination employs one receive antenna. In the first step, the source terminal transmits the signal x to the relays and to the destination terminal. The signals received at the i-th relay and at the destination terminals are given respectively by

$SNR_{SR_i} = H_{SR_i}\ \mathrm{X} + n_{SR_i}$

$SNR_{SD} = H_{SR_i}\ \mathrm{X} + n_{SR_i}$

Where H_{SR_i} and H_{SR_i} are the channel gain between the source and the *i*-th relay terminals and the source and the destination.

In the second step of cooperation, the *i*-th relay terminal amplifies its received signal and forwards it to the destination through the channel. The destination terminal receives the relay transmission according to

$SNR_{R_iD} = \ G_i H_{R_{iD}}\ SNR_{SR_i} + n_{R_{iD}}$

Where H_{R_iD} is the channel gain between the i-th relay terminal and the destination terminal and $n_{R_iD}$is the complex additive white noise.

$G_i = \frac{E_S}{E_S|H_{SR_i}|^2 + N_0}$,where E_s is the average energy per symbol.

Source node (S) communicates with the destination (D) through the direct link and the indirect link. A number of potential relaying nodes R_i, (i = 1,….,N) are available to relay the signal to provide the destination with another copy of the original signal. All terminals are equipped with a single antenna. In the first time slot, the source sends its signal. All the N relays and the destination receive faded noisy versions of the source signal. Based on the SNR of the received signal at the destination, the destination decides whether relaying is needed or not because at the destination, the SNR of the received signal from the source is compared with SNR threshold (SNR_{th}), which defines the minimum SNR for which the destination can detect the signal successfully without the need of the relayed signal. For sufficient signal to noise ratio (SNR) at the destination, all the relays do nothing (the destination performs detection using the source signal) and the source sends a new message in the second time slot.

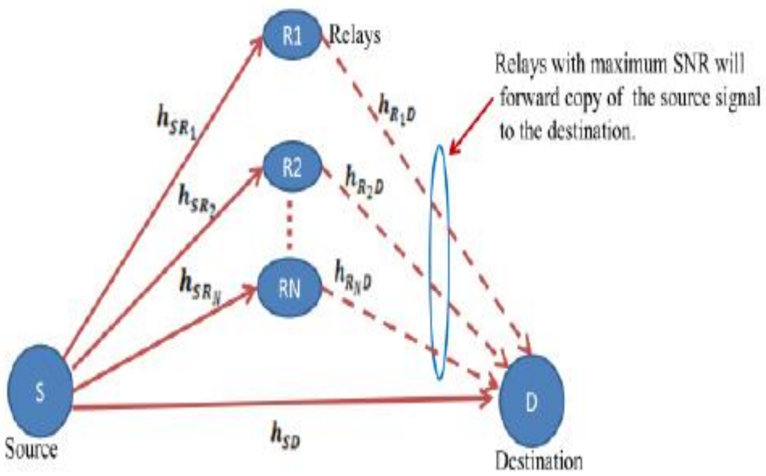

Fig 4: Cooperative communication network with the relay selection scheme

For insufficient signal to noise ratio (SNR) at the destination, the select-max protocol is used. Select-Max protocol selects relay with maximum SNR, to take part in the communication. In particular, the relay which maximizes an appropriately defined metric is selected. This metric accounts for both the S- R_i and R_i-D links and reflects the quality of the i-th end-to-end path.

SNR_i = min(SNR_{SR_i}, SNR_{R_iD})

Min (SNR_{SR_i}, SNR_{R_iD}) $\geq \frac{SNR_{SR_i} SNR_{R_iD}}{1+SNR_{SR_i}+SNR_{R_iD}}$

The minimum value of the intermediate link SNR is adopted as the quality measure of the i-th end-to-end path. The relay that is activated in the select-max protocol, is selected according to the rule:

$$A_r = arg \underbrace{max}_{i \in R} \{SNR_i\}$$

Where R = {1, 2, . . .,N}, SNR_i is the instantaneous SNR for the relay i. The relay that gives the maximum SNR at the destination forwards the received source signal to the destination.

III. RESULTS AND TABLES

Results are obtained from the mathematical expressions presented in the previous section .Using MATLAB coding the performance curves are plotted in the terms of SER(symbol error rate) versus the SNR of the transmitted signal (Es /N0 dB) where Es is the transmit energy signal. The system is implemented using OSTBC encoder with relays following AF relaying scheme. The modulation format used is BPSK and system can be modelled for any number of relays.

Fig 5. Shows the performance of the proposed system with one relay node and using 2-BPSK modulation From the results it can be seen that the proposed system with full duplex cooperation has high performance when compared to half duplex cooperation. Fig 6. Shows the performance of 2-BPSK with two relays for different values of L The proposed scheme outperforms with any modulation formats. For M –ary BPSK, as the values of M increases the performance level of the system is improved.

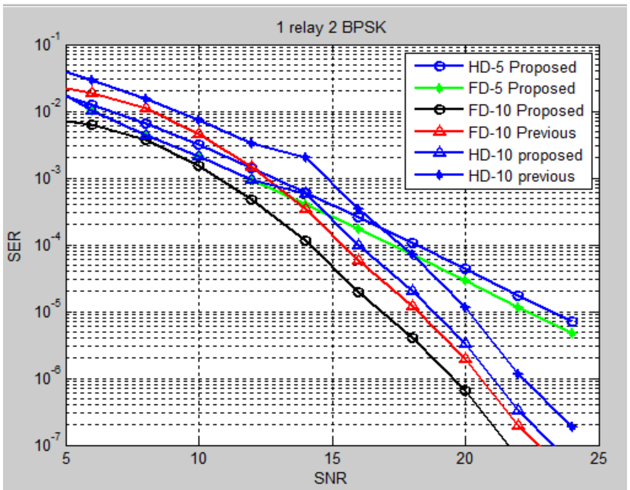

Fig 5: Performance of 2-BPSK with 1 relay

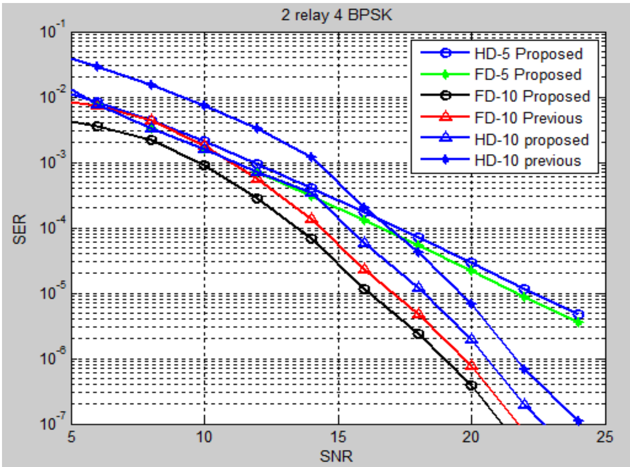

Fig 6: Performance of 4-BPSK with 1 relay

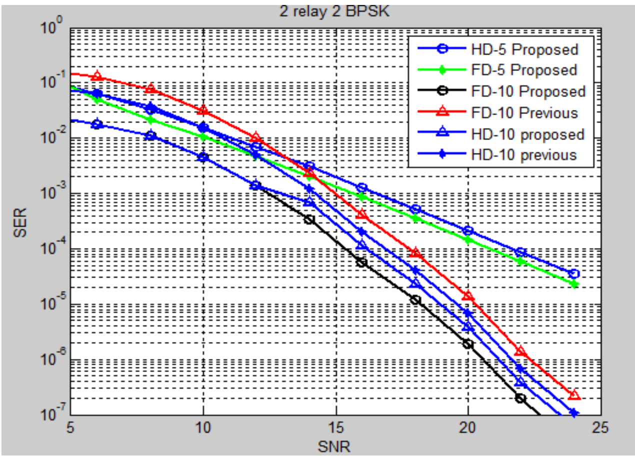

Fig 7: Performance of 2-BPSK with 2 relays

Fig 7. Shows the plot of SER Vs SNR of 2 relay 2- BPSK system It can be observed that, in all cases, increasing the number of rake fingers L decreases the average SER.

IV. CONCLUSION

In cooperative communications where a group of relays can overhear the transmission from S, and one or more relays can help forward the overheard data to D. The selection and coordination of the relays are essential to the achievable performance. The performance of the relay selection scheme for cooperative communication networks operating over Rayleigh fading channel is analysed. The relay selection scheme has a strong advantage in saving the channel resources. The problem of the inefficient use of the channel resources can be eliminated with the use of the relay selection scheme.

Orthogonal space time coding is needed so that all overhearing nodes could simultaneously transmit. In this work, we analyse “opportunistic relaying” where the relay with the strongest transmitter-relay-receiver path is selected among several candidates. Source transmits to destination and neighbouring nodes overhear the communication. “Best” relay among M candidates is selected to relay information.

REFERENCES

[1] Y. Lin, J.-H. Song, and V. W. Wong, “Cooperative protocols design for wireless ad-hoc networks with multi-hop routing,” Mobile Networks and Applications, vol. 14, no. 2, pp. 143–153, Apr. 2009.

[2] Bletsas, A. Khisti, D. Reed, and A. Lippman, “A Simple Cooperative Diversity Method based on Network Path Selection”, IEEE journal on Selected Areas in Communications, Vol. 24, No. 3, pp. 659-672, Mar. 2006.

[3] T. Kwon, S. Lim, S. Choi, and D. Hong, “Optimal duplex mode for DF relay in terms of the outage probability,” IEEE Trans. Veh. Technol., vol. 59, no. 7, pp. 3628 – 3634, September, 2010.

[4] T. M. Kim and A. Paulraj, “Outage probability of amplify-and-forward cooperation with full duplex relay,” in Proceedings IEEE Wireless Communications and Networking Conference, 2012, pp. 75–79.

[5] T. Riihonen, S. Werner, and R. Wichman, “Hybrid full-duplex/ halfduplex relaying with transmit power adaptation,” IEEE Trans. Wireless Commun., vol. 10, no. 9, pp. 3074 – 3085, September, 2011.

[6] Krikidis, H. A. Suraweera, S. Yang, and K. Berberidis, “Full-duplex relaying over block fading channel: a diversity perspective,” IEEE Trans. Wireless Commun., vol. 11, no. 12, pp. 4524 – 4535, December, 2012.

[7] Krikidis and H. A. Suraweera, “Full-duplex cooperative diversity with Alamouti space-time codes,” IEEE Wireless Commun. Lett., accepted for publication.

[8] Y. Liu, X.-G. Xia, and H. Zhang, “Distributed space-time coding for full-duplex asynchronous cooperative communications,” IEEE Trans. Wireless Commun., vol. 11, no. 7, pp. 2680 – 2688, July, 2012.

[9] T. Kwon, S. Lim, S. Choi, and D. Hong, “Optimal duplex mode for DF relay in terms of the outage probability,” IEEE Trans. Veh. Technol., vol. 59, no. 7, pp. 3628 – 3634, September, 2010.

[10] T. M. Kim and A. Paulraj, “Outage probability of amplify-and-forward cooperation with full duplex relay,” in Proceedings IEEE Wireless Communications and Networking Conference, 2012, pp. 75–79.