Efficient Cooperative Relay Network with Spatial Diversity and Digital Filtering

Priyanka Singh[1], Prof. Anoop Tiwari[2]
[1]*M-Tech Research Scholar,* [2]*Research Guide*
Department of Electronics & Comm. Sagar Institute of Science & Technology, Bhopal

Abstract – Wireless communication and its performance highly depends on the outage happens in the system. The outage of the respective system is should be as low as possible to make system better for communication. The cooperative network highly encountered with the lack of power during transmission over wireless channel. To improve the efficiency some techniques proposed in this paper and the proposed model achieved better outage probability than existing system.

Keywords: Spatial Diversity, Cooperative Relay systems, Outage probability.

I. INTRODUCTION

A large number of studies have been conducted to understand the performance of AF dual-hop systems in various popular fading channel models. In [6], the outage probability and error rate of dual-hop AF systems were studied in Rayleigh fading channels, while investigated the performance of dual-hop AF systems in Nakagami-m fading channels. The performance of dual-hop AF system in more general fading channels was considered in. While these studies have greatly improved our knowledge on the topic, they all assume that the communication takes place in an interference-free environment. However, because of aggressive reuse of frequency, wireless communications are generally affected by co-channel interference (CCI). Hence, there is a strong need to understand the impact of CCI on the performance of dual-hop systems. In the presence of CCI, there have been very few studies on the performance of dual-hop systems, most in Rayleigh fading channels.

Dual-hop relaying transmission, as a means to improve the throughput and extend the coverage of the wireless communication system, has recently received enormous interests in the context of cooperative communications [2], where an intermediate mobile device acts as a relay node and helps forward the signal received from the source node to the intended destination node. Among various relaying protocols proposed in [2], amplify-and-forward (AF) relaying scheme, where the relay node simply forwards a scaled version of the received signal, has received a great deal of attention because of its simplicity and ease of implementation. Depending on the availability of instantaneous channel state information (CSI) at the relay node, AF relaying scheme generally falls into two categories, i.e. Variable gain relaying [3] and fixed-gain AF relaying.

In [16], the outage probability of opportunistic decode-and-forward relaying dual-hop system was studied, and in [17], the outage probability of a fixed-gain AF relaying system with interference-limited destination has been investigated. The study analyzed the outage and error performance of dual-hop AF relaying with interference at the relay node, while [19, 20] studied the more general model where both the relay and the destination are corrupted by CCIs. In [21], the authors investigated fixed-gain AF relaying system in the presence of CCIs at the relay and destination assuming Rayleigh faded dual-hop channels with Rician fading interfering channels. While Rayleigh fading channel is an important channel model, understanding the performance of dual-hop systems in the more general Nakagami-m fading channels has also received much attention.

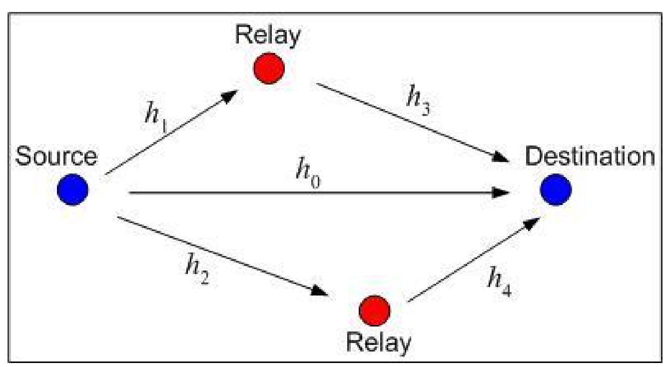

Figure 1. System Model

A closed-form expression for the general moments of the end-to-end signal-to-interference-and-noise ratio (SINR) is derived, which is then applied to investigate the ergodic capacity of the system. Moreover, to gain further valuable insights into the system, we also provide simple expressions for outage probability of the system at high signal- to-noise ratio (SNR) regime, which enable efficient characterization of the diversity order and coding gain achieved by the system. The remainder of this article is organized as follows:

Section 2 introduces the system model. Section 3 Related works. Section 4, give the idea about proposed methodology, in section 5, numerical results are provided to verify the accuracy of our analysis. Finally, we conclude the article in Section 6.

II. SYSTEM MODEL

Consider a dual-hop relay where a source node S transmits to a destination node D with the assistance of a relay node R. The entire communication takes place in two separate phases. In the first phase, S transmits the signal to R and hence the received signal at the relay node can be written as

$$y_r = h_{sr}x_0 + n_{sr}, \quad (1)$$

Where x_0 is the transmitted symbol with E {| $x_0|^2$} = P_0 and h_{sr} is the channel coefficient or the S-R link, $n_{sr} \sim C\mathcal{N}(_0, N1)$ denotes the additive white Gaussian noise, and E {·} denotes the expectation operation. In the second phase, the received signal at R is first scaled with a fixed gain $G \triangleq \sqrt{\frac{Pr}{P0\ \Omega 1+N1}}$ and then forwarded to D. The signal at the destination is corrupted by interfering signals from N co-channel interferers $\{xi\}^N_{i=1}$, each with an average power of P_i. As in [17], we consider the interference-limited destination case; therefore, the signal received at the destination can be expressed as

$$y_d = Gh_{rd}h_{sr}x_0 + Gh_{rd}n_{sr} + \sum_{i=1}^{N} h_i x_i, \quad (2)$$

where h_{rd} denotes the channel coefficient for the R-D link, $\{hi\}^N_i$ are the channel coefficients from interferers to D. We assume that the channel gains $|h_{sr}|^2$ and $|h_{rd}|^2$ follow the gamma distribution with different fading parameters $1/\Omega_1$, $1/\Omega_2$ and fading severity parameters m1, m^2, respectively. Similarly, the channel gains $|h_i|^2$, i = 1. . . N, are assumed to follow independent gamma distribution with parameters m_{Ii} and $1/\Omega_{I1}$.

Outage probability:

The outage probability is an important system performance metric, and is defined as the probability that the instantaneous SINR Υ_d falls below a predefined threshold, Υ^{th}_b mathematically, the outage probability of the end-to-end SINR Υ_d can be presented as

III. PROPOSED METHODOLOGY

In this paper firstly we initialize and create the simulation environment after that consider a dual-hop relay and create Nakagami Fading model for spatial diversity system.

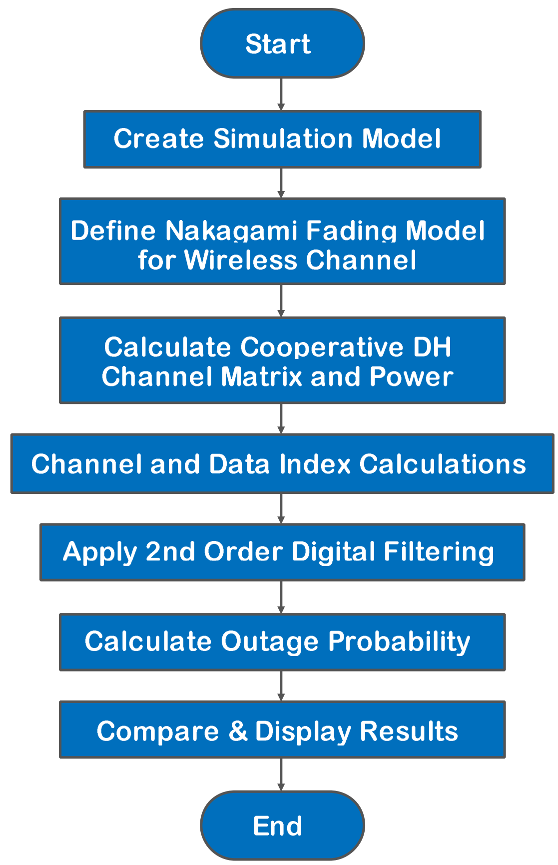

Figure 3.1. Shows Flow Graph of Proposed Methodology

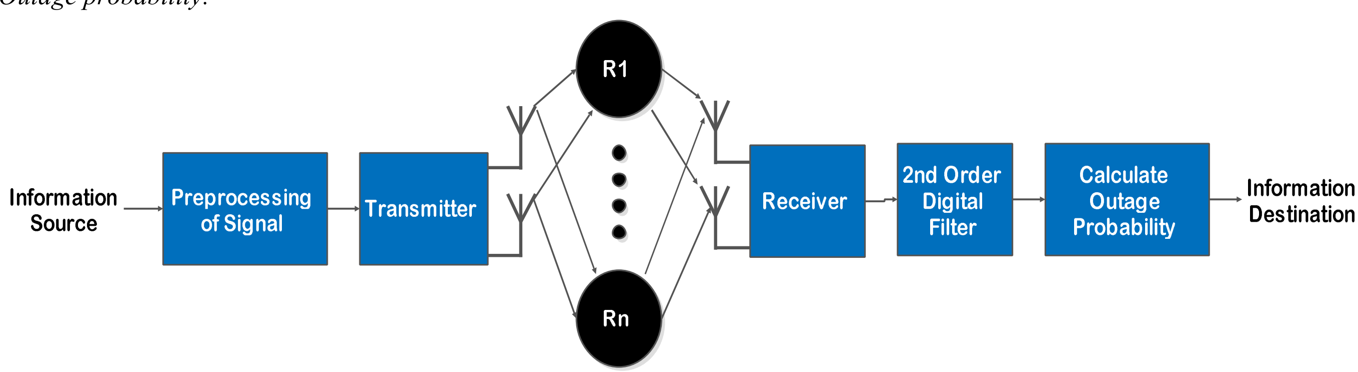

Figure 3.2. Block Diagram of Proposed Methodology

Dual-hop relaying transmission, as a means to improve the throughput and extend the coverage of the wireless communication system, has recently received enormous interests in the context of cooperative communications where an intermediate mobile device acts as a relay node and helps forward the signal received from the source node to the intended destination node. Apply Nakagami Model on spatial diversity system for multi antenna & multi relay. Finally calculate output probability for All SNR Values 0-30 dB. Compare those results with Different Values of Relays & Antennas.

IV. SIMULATION RESULTS

The antenna diversity based multi relay cooperative wireless system with consideration of Nakagami fading has been implemented on MATLAB. The simulation outcomes shown the system performance in terms of outage probability which is figure of merit in wireless cooperative communication system. The performance calculations can be done in using other figure of parameters like BER is the performance measure of the receiver and outage probability is a calculation of the channel, the channel capacity or throughput of information that can be analyzed via the communication channel affected by noise or signal fading letting to have smaller values of SNR. For a channel with the similar outage probability we could have two different BERs for two receivers.

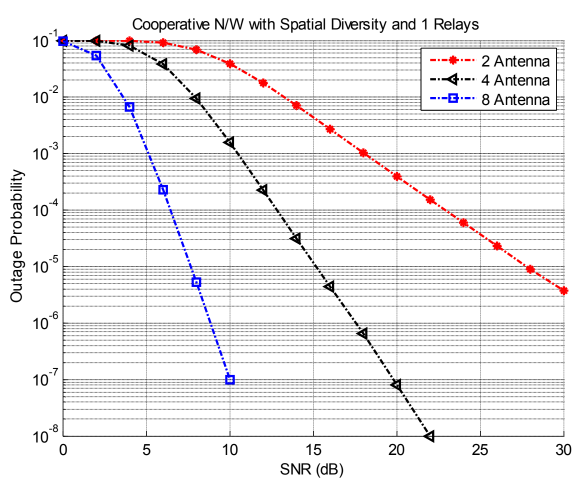

Fig. 4.1 Performance of Cooperative Network with Spatial Diversity and 1 Relay

The complete simulation is performed using different system configurations as shown in the results below. Fig. 4.1 shows the outage probability of the spatial diversity cooperative relay system with single relay and multiple antennas (here we have taken two, four and eight antennas). The system is simulated under Nakagami-Fading environment.

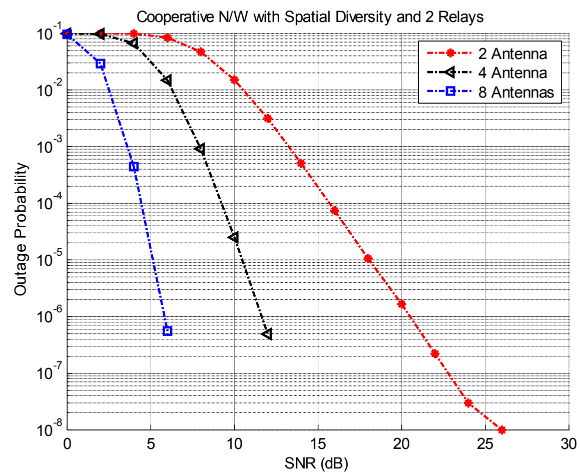

Fig. 4.2 Performance of Cooperative Network with Spatial Diversity and 2 Relays

From the comparison shown in the result shown in Fig. 4.1 we can say that the outage probability will be decreases with the increase of number of antennas keeping the relay constant i.e. one.

Fig. 4.2 shows the outage probability of the spatial diversity cooperative relay system with two relays and multiple antennas (here we have taken two, four and eight antennas). The system is simulated under Nakagami-Fading environment.

From the comparison shown in the result shown in Fig. 4.2 we can say that the outage probability will be decreases with the increase of number of antennas keeping the relay constant i.e. two. The comparison from the previous results it is also clear that the additional relay increases the performance of the system, which significantly reduces the outage probability of the cooperative relay system.

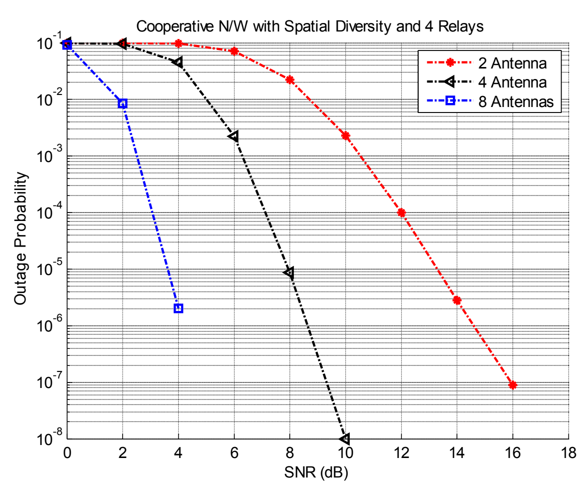

Fig. 4.3 Performance of Cooperative Network with Spatial Diversity and 4 Relays

Fig. 4.3 shows the outage probability of the spatial diversity cooperative relay system with three relays and multiple antennas (here we have taken two, four and eight antennas). The system is simulated under Nakagami - Fading environment.

From the comparison shown in the result shown in Fig. 4.3 we can say that the outage probability will be decreases with the increase of number of antennas keeping the relay constant i.e. three.

From the comparison shown in the result shown in Fig. 4.1 and Fig. 4.2 we can say that the outage probability will be decreases with the increase of number of antennas keeping the relay constant i.e. two. The comparison from the previous results it is also clear that the additional relay increases the performance of the system, which significantly reduces the outage probability of the cooperative relay system.

V. CONCLUSION AND FUTURE SCOPES

The proposed cooperative wireless communication system with the spatial diversity has been simulates with different relay system and the results are shown in previous section. From the simulated outcomes it can be analysed that the proposed methodology which has the more than one antenna and more than one relay enhances the performance of existing system. The outcome measured in terms of outage probability which should be as low as possible to make system more robust and efficient.

REFERENCES

[1] GK Karagiannidis, Performance bounds of multihop wireless communications with blind relays over generalized fading channels. IEEE Trans Wirel Commun. 5(3), 498–503 (2006)

[2] S Ikki, MH Ahmed, Performance analysis of cooperative diversity wireless networks over Nakagami-m fading channel. IEEE Commun Lett. 11(4), 334–336 (2007)

[3] DB Costa, MD Yacoub, Dual-hop transmissions with semi-blind relays over Nakagami-m fading channels. Electron Lett. 44(3), 214–216 (2008). doi:10.1049/el:20083507

[4] F Al-Qahtani, T Duong, C Zhong, K Qaraqe, H Alnuweiri, Performance analysis of dual-hop AF systems with interference in Nakagami-m fading channels. IEEE Siganl Process Lett. 18(8), 454–457 (2011).

[5] D Lee, I Lee, Outage probability for opportunistic relaying on multicell environment, in Proc IEEE VTC Spring 2009, Barcelona, Spain, pp. 1–5 (April 2009)

[6] HA Suraweera, HK Garg, A Nallanathan, Performance analysis of two hop amplify-and-forward systems with interference at the relay. IEEE Commun Lett. 14(8), 692–694 (2010)

[7] MO Hasna, MS Alouini, A performance study of dual-hop transmissions with fixed gain relays. IEEE Trans Wirel Commun. 3(6), 1963–1968 (2004). doi:10.1109/TWC.2004.837470

[8] JN Laneman, DNC Tse, GW Wornell, Cooperative diversity in wireless networks: efficient protocals and outage behavior. IEEE Trans Inf Theory. 50(12), 3062–080 (2004). doi:10.1109/TIT.2004.838089.

[9] TA Tsiftsis, GK Karagiannidis, SA Kotsopoulos, Dual-hop wireless communications with combined gain relays. IEE Trans Commun. 153(5), 528–532 (2005)

[10] HA Suraweera, DS Michalopoulos, R Schober, GK Karagiannidis, N Arumugan, Fixed gain amplify-and-forward relaying with co-channel interference, in IEEE International Conference on Communications (ICC2011), (Kyoto, Japan)

[11] TA Tsiftsis, GK Karagiannidis, SA Kotsopoulos, F-N Pavlidou, BER analysis of collaborative dual-hop wireless transmissions. Electron Lett. 40(11), 679–681 (2004). doi:10.1049/el:20040393

[12] MO Hasna, MS Alouini, Harmonic mean an end-to-end performance of transmission systems with relays. IEEE Trans Commun. 52(1), 130–135 (2004). doi:10.1109/TCOMM.2003.822185

[13] A Sendonaris, E Erkip, B Aazhang, User cooperation diversity–Part I: system description. IEEE Trans Commun. 51, 1927–1938 (2003). doi:10.1109/ TCOMM.2003.818096 .

[14] MO Hasna, MS Alouini, End-to-end performance of transmission systems with relays over Rayleigh fading channels. IEEE Trans Wireless Commun. 2(6), 1126–131 (2003). doi:10.1109/TWC.2003.819030

[15] S Ikki, MH Ahmed, Performance analysis of dual-hop relaying communications over generalized Gamma fading channels, in Proc IEEE Globecom'07, Washington, DC, USA, pp. 3888–3893 (November 2007)

[16] AA Abu-Dayya, NC Beaulieu, Outage probability of cellular mobile radio systems with multiple Nakagami interfers. IEEE Trans Veh Technol. 40(4), 757–768 (1991). doi:10.1109/25.108387

[17] Q Zhang, Outage probability of cellular mobile radio in the presence of multiple Nakagami interferers with arbitrary fading parameters. IEEE Trans Veh Technol. 44(3), 661–67 (1995). doi:10.1109/25.406635

[18] C Zhong, S Jin, KK Wong, Dual-hop system with noisy relay and interference-limited destination. IEEE Trans Commun. 58(3), 764–768 (2010)

[19] AM Cvetković, GT Dordević, MC Stefanović, Performance of interference- limited dual-up non-regnerative relays over Rayleigh fading channels. IET Commun. 5(2), 135–140 (2011). doi:10.1049/iet-com.2010.0019

[20] GK Karagiannidis, TA Tsiftsis, RK Mallik, Bounds for multihop relayed communications in Nakagami-m fading. IEEE Trans Commun. 54(1), 18–22 (2006)