Performance Analysis of Multiple Antenna Relaying Networks

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Abstract: ***In communication systems, Multiuser Multiple Antenna Relaying Networks has a great importance. They employing opportunistic scheduling mechanism with feedback delay and co-channel interference. In this paper, mainly considering the parameter characteristics such as outage probability, average symbol error rate and ergodic capacity of the system. An optimum power allocation scheme is also introduced in this paper. With the help of simulation results ,here prove the validity of analytical expressions. The findings of this paper suggest that when there is ideal feedback, then full diversity order can be achieved.***

Keywords: outage probability, multiple antenna system, ergodic capacity, feedback delay, optimum power allocation

1. Introduction

In wireless communication systems, multiple numbers of antennas and users are widely used. Most of the cases there existing the usage of a relaying network. Because relay networks has a great importance in this systems due to their ability to extend the coverage area and thereby improving the throughput. Relaying techniques are obey the amplify and forward protocol. The use of multiple antennas at transmitter and receiver in wireless systems popularly known as Multiple Input Multiple Output technology. MIMO technology constitutes a breakthrough in wireless communication system design.

For achieving the goal of improve the performance of multiuser relaying networks, a number of suggestions are introduced. In previous works, mainly using TAS/MRC technique. In which highest instantaneous signal to noise ratio is selected for transmission. But the key limitation of this works is the noise limited scenario. Motivating by the previous works, this paper introducing a multiuser multiple antenna AF relaying network with feedback delay and CCI over Rayleigh fading channel.

2. Motivation and Related Works

Multihop relaying networks[3] used for coverage extension in wireless network is an old concept, it became practical only recently. It presents an introduction to the upcoming IEEE 802.16j amendment. The performance of downlink[5]multiuser relay networks, which provides new concepts for channel state information based gain relaying and fixed gain relaying.

In low complexity co-operative diversity [6] protocols that discuss about the fading induced by multipath propagation in wireless networks. In previous works, they consider several strategies including fixed relaying schemes such as amplify -and -forward and decode-and-forward, selection relaying schemes, incremental relaying schemes etc. By the usage of distributed antennas, we can get a powerful benefit of space diversity.

The main point to be noted that, most of the prior works assume a concept of perfect channel state information of all the links. But it's a challenging task because of the time varying nature of fading channels.

By considering two variations of relay selection process, that is best relay and partial relay selection scheme. Here the selection process is depending on outdated channel estimates The closed form expressions corresponding to the outage probability is obtained in both cases.

Relay system with AF strategy is highly dependable on the level of correlation between the actual channel conditions and their outdated estimates. According to this, the channel coding gain and diversity gain can be calculated. So in practical applications, relay selection has a great importance. For compensating all these problems existing in the previous works here introducing a new concept of multiple antenna relaying network. Based on the three main characteristics such as outage probability, ergodic capacity and average symbol error rate, analyses the system performance.

3. System Model

Consider the system model of multiuser multiple antenna relaying networks which is illustrated in Fig 1. It mainly consists of source, relay and destination. Here using a single relay network and the source communicates with M destinations with the help of this single antenna relay. Take an assumption that the source consists of Ns antennas and destination consists of ND antennas, and also one more assumption that the each destination antenna is corrupted only by Additive White Gaussian Noise But the relay node subjected to Ni interferers and AWGN. Here we consider a Rayleigh fading channel for transmission purpose.

The relay network presented in this system model is using an AF protocol. That is Amplify and Forward protocol. According to this, the signal transmitted from the source is reached at the relay, then the signals just amplify and then the relay retransmitted the signal to the destination. Hence we can improve the strength of the received signal at the destination.

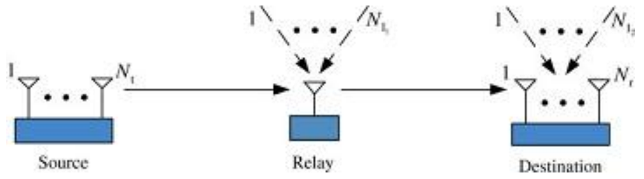

Figure 1(a): System model of multiuser multiple antenna relaying networks

The entire communications between the source and the destination antenna consisting of two phases. In the first phase, the source transmits signal symbol to the relay node and in the second phase the signal is retransmitted from the relay node to destination.

To achieve the maximum instantaneous Signal to Noise Ratio, the transmitter applies a combining technique known as Maximum Ratio Transmission at the relay network. In addition to provide multiuser diversity in multiuser communication systems, we use opportunistic scheduling mechanism. Here the relay first selects the user with best relay-destination link and then feedback the desired information to the source.

4. Performance Analysis

In this section, presenting an over -all performance analysis of important performance matrices such as outage probability, ergodic capacity and symbol error rate.

4.1 Outage Probability

Outage probability simply mean, what is the probability that a given rate will not be supported because of channel variations. The outage probability is defined as the probability that the instantaneous end to end SINR γD falls below a predefined threshold γth ,mathematically it can represented as,

$$P\ out(\gamma\ th) = \Pr(\gamma D < \gamma th) = F\gamma D(\gamma th)\ (1)$$

4.2Ergodic Capacity

Ergodicity related to stationarity of the random variable .It means that the value of random variable does not depend upon time. So the capacity which is time independent is called Ergodic Capacity. Which is represented as,

$$C = 1/2E[\log 2(1 + \gamma D)]\ (2)$$

4.3 Symbol Error Rate

It is an important metric to analyse the performance of wireless communication systems. Symbol Rate is the number of symbol changes made to the transmission medium per second. The error occurring in it is commonly known as Symbol Error Rate. Which is represented as,

$$Ps= aE\ [Q(\sqrt{2b\gamma D})]\ (3)$$

5. Optimum Power Allocation

For minimizing the asymptotic average SER value here we proposes an optimum power allocation method. Considering 2 cases, such as with or without feedback delay.

Mainly consider the equation that is

$$Ps + Pr = Pt \quad (4)$$

Here we consider that the total transmits power in between the source and relay network is fixed.
Equation used is

$$Po = [(\gamma th/\gamma 1\ )\text{^}MND] / (ND!)\text{^}M\omega\text{^}\ MND \quad (5)$$

Here, Po is the optimum power and γth is the threshold value. ND is the number of antennas at the destination.

5.1 Optimum Power Allocation with Perfect Feedback

When NS< MND condition, more power should be allocated to the source to suppress the interferers at the relay network. On the other hand, when NS >MND the relay node should be allocated more power to suppress the channel fading.

5.2 Optimum Power Allocation with Delayed Feedback

When $\rho 1<1$ and $\rho 2<1$, It should be more power is allocated to the source. And also there should be more than a single antenna in each destination node. Here$\rho 1$and $\rho 2$ are the correlation coefficients.

6. Simulation Results

In this section, conducting the numerical simulations for validating the analytical expressions discussed in the previous sections. Moreover, here define the SNR as $\gamma 1$,and assume the condition that $\gamma 1=\gamma 2$.

The graph in figure 2(a) shows the outage probability of multi user multiple antenna a relaying networks with feedback delay and co-channel interference. Here $\rho 1$ and $\rho 2$ are the correlation coefficients.AF relaying networks with different $\rho 1$ and$\rho 2$ is considered here. From the graph we can observed that the Monte carlo simulations and analytical results are in exact agreement. At the entire SNR range of interest, the outage lower bound is sufficiently tight.

The figure 2(b) illustrates the impact of number of users on the outage probability under perfect feedback condition.
From the figure we can say that when SNR values increases then the Montecarlo simulations and analytical lower bound are become closer.

The figure 2(c) illustrates the ergodic capacity of the system for different values of correlation coefficients. The lower and upper bounds overlaps with the corresponding Monte carlo simulation results in the high SNR regions.

The graph in figure 2(d) shows the average SER under different values of correlation coefficient. The verification of correctness of our analysis is clearly plotted in this figure. That is the Monte carlo simulation results and average SER lower bound is very tight in the high SNR regions. Through this graph we get an overview of diversity order and array gain of the system.

The graph in figure 2(e) illustrates the optimum power allocation versus equal power allocation in multiple antenna relaying systems. By the usage of optimum power allocation instead of equal power allocation, we can minimize the average SER. There by enhancing the system performance in a large scale.

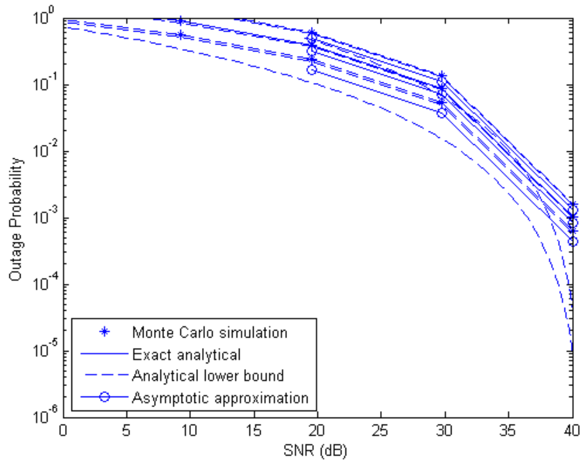

Figure 2(a): The outage probability under different values of correlation coefficients.

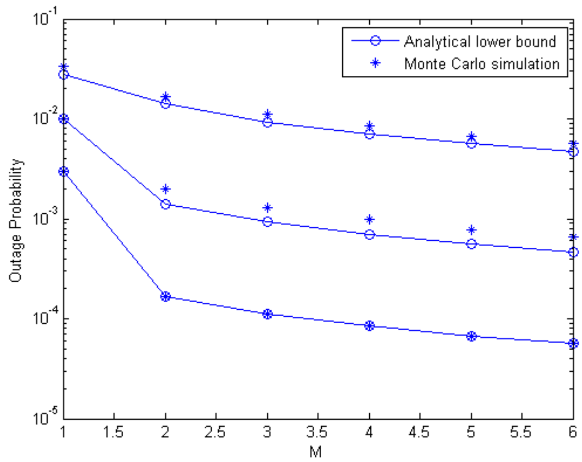

Figure 2(b): Impact of number of users on the outage probability under perfect feedback

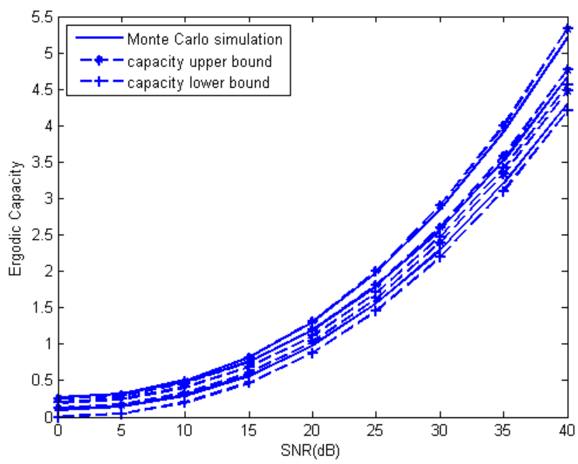

Figure2(c): Impact of feedback delay on ergodic capacity

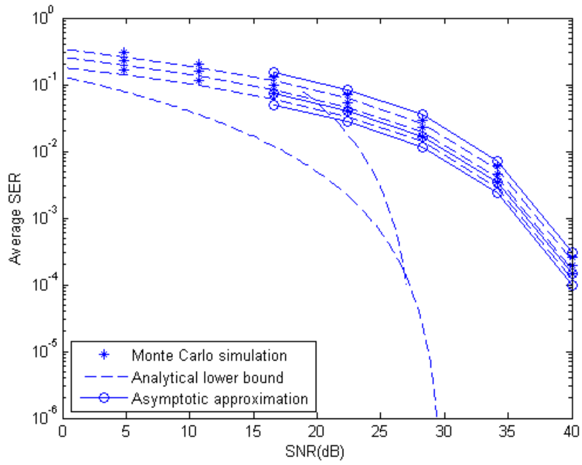

Figure 2(d): The average SER under different values of Correlation coefficient

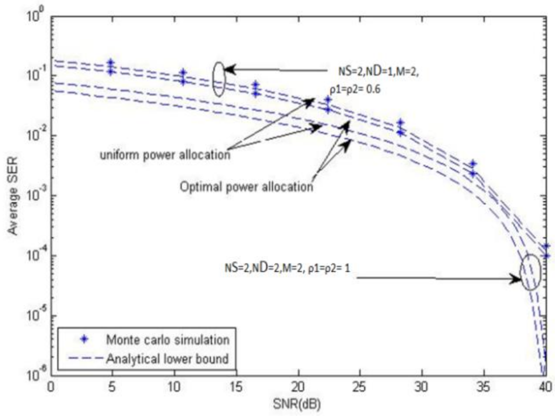

Figure 2(e): The average SER of multiple antenna relaying Systems with the optimum power allocation versus equal power allocation

7. Conclusion

The performance analysis of multiple antenna, multiple user antenna relaying network is considered for detailed analysis. Also gave importance to feedback delay and co-channel interference. For getting precise results ,take three main parameters which affecting the system characteristics.

The parameters under considerations are outage probability, ergodic capacity and average SER of the system. The relation between the correlation coefficient and the parameter under study are deeply evaluated here. In this paper we also gave importance to optimum power allocation method instead of equal power allocation scheme. By using this method we can minimize the average SER of the multi user multiple antenna system. And as a result an enhanced performance is obtained. This paper findings suggested that, feedback delay results in loss of multiuser diversity and spatial diversity and full diversity order can be achieved only in the presence of ideal feedback.

References

[1] N.Yang,P.L . Yeoh, M .Elkashlan, J .Yuan, and I. B. Collings, "Cascaded TAS/MRC in MIMO multiuser relay networks, "IEEE Trans.Wireless Commun., vol 11, no.10, pp.3829-3829, oct. 2012.
[2] J.Kim,D.S.Michalopoulos, and R. Schober ,"Diversity analysis of multi- user multi relay networks ,"IEEE . Trans. Wireless Commun., vol.10, no . 7,pp.2380-2389, July 2011.
[3] C. K .Sung and I. B Collings, "Cooperative multiplexing with interference suppression in multiuser wireless networks," IEEE Trans. Wireless Commun., vol.91 no.8, pp.2528-2538, Aug. 2010.
[4] J. Sydir and R. Taori, "An evolved cellular system architecture incorporating relay stations," IEEE Comn. Mag.,vol .47,no.6,pp.115-121,June 2009.
[5] L. Yang and M. S .Alouini, "Performance analysis of multiuser selection diversity," IEEE Trans .Veh. Technol., vol.55, no.6, pp.1848-1861, Nov.2006.
[6] Y .Chen and C .Tellambura, "Distribution function of selection combiner output in equally correlated Rayleigh, Rician, and Nakagami – m fading channels," IEEE Trans Commun., vol.52 ,no. 11, pp.1948-1956 Nov.2004.

Author Profile

Arya .R received the B. Tech degrees in Electronics and Communication Engineering from M. G University, Kerala at Musaliar College of Engineering in 2013. And now she is pursuing her M.Tech degree in Communication Engineering under the same university in Mount Zion College of Engineering.