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Cooperative Communication Performance Analysis Using Different Scheme of Relay Selection

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Abstract

In the wireless network with large area coverage with high data speed reduction of multipath fading effect is important issue for modern telecommunication research under the MIMO schemes. But the application of multiple antennas is complicated due to power losses, area, and cost constrains. To improve the MIMO systems cooperative wireless systems is applied having virtual antenna array concepts. In this scheme the relays and source cooperation with information exchange is performed. The relay node selection is very crucial in co-operative networks. This article focuses on the performance on relay selection for opportunistic and random scheme. Opportunistic relaying depends on max-min selection of relay, harmonic mean selection of relay, threshold dependent on max-min and threshold dependent harmonic mean is applied. These schemes are analyzed using simulation model. The results are described by bit error probability. It is observed that opportunistic relay selection scheme is outperforming over conventional selection approach.

Keywords: cooperative communication; relay selection; MIMO; wireless network

1. Introduction

As the use of wireless technology is growing as the significant approach of connectivity the high data rate demand is also growing rapidly in wireless communication. This is due to hike in the number of users and the transportation of high quality data. The wireless communication system technology is developing rapidly but some of the physical parameters have limitations. Generally limited bandwidth, channel fading & battery capacity are challenging issues for the research to overcome. Cooperative communication is becoming very popular approach to enhance the battery life time and improving the capacity of data transmission and wireless network quality of service. The concept of applying relay in telecommunication was introduced in the work of **Gamal El and Cover T. M. (1980) and Sendonaris et al. Part1&2 (2003)**. In the cooperative communication the basic principle is use of other communication devices for relaying the data transmission. The information is sent by source to a relay node (see Fig.1). The data-information is relayed (transfer) to destination through the relaying-node. The source node treats the relay as a virtual antenna.

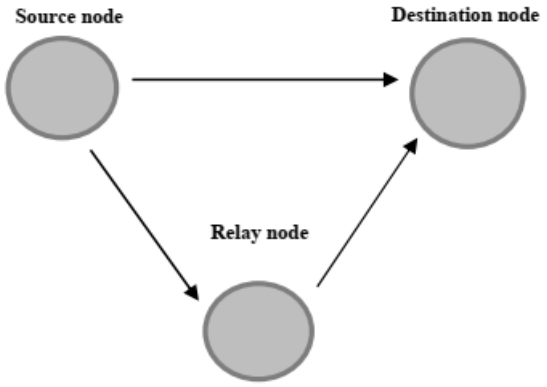

Figure 1: Wireless Cooperative communication using relay node.

In the co-operative communication scheme best channels selection for relaying is performed by source to channel the data to the destination to ensure reliability of transmission in the destination and the source. Power losses reduction depends on nearest relay selection.

Selection of the channels of relay node is very significant part because the transmission from the source to destination is dependent on relay nodes working as medium for data transfer. In this way selection of relay optimize the performance of the system. Selection of the appropriate relay for transmission, improves the network performance through less number of resources. In this article the challenges under allocation of resource and optimum selection of relay is focused.

The paper layout follows the Section II on discussion of methodologies of selection of relay, Section III describes the system model and Section IV represent the design of simulation model and comparative analysis. The Section V gives the overall conclusion of proposed scheme under this article.

2.Relay Selection Scheme

In co-operative communication wireless system selection of relaying node is a challenging work. Selection of appropriate relay gives lower energy loss and better throughput hence helps in enhancing performance of network with lower error-rate at receiver end. The parameters used to describe performance of using relaying is observed by, Channel state information (CSI) ,BER etc. The relay selection not only depends on transmitter to receiver end performance but also complete performance of network. The procedure of selection of relay node classified by:

A. Opportunistic selection of relay:

(1) Selection of Relay based on measurement: This selection works on the measurements obtained about the channel status. It do not depends on information of the topology used **Shan H., Wang W. Z. P. and Wang Z. (2008)**. This scheme helps to select the best available relay from 'N' devices which may need estimations for state of 2N-channels.

Under this selection scheme, the information of the state of channel is recorded for all relays to get the measurements of transmitter to relay and relay to receiver channels using information of RTS/CTS signal. Thus, the information of state of the channel depends on fading of channel occurs in transmitter -relay- receiver channels. Once the state information is calculated, a timer is set by each relay equivalent to inverse of the estimated values. The timer having the highest value is selected as the relay node. The finally selected relay sends the request about other available relays to eliminate the problem of "hidden" relaying node.

(2) Selection of the relay based on the performance: In this scheme selection of relay depends upon estimates of delay, energy efficiency etc. **Zhou Z., Zhou S., Cui J., and Cui S. (2008)**. This scheme works as:

Step-I, the desired value of relay performance is sent by the transmitter.

Step-II, information of state of channel and level of performance is calculated at relaying nodes.

Sometimes overhead estimation add some constrains in this scheme and if the performance not satisfactory then transmission occurs over the direct path.

(3) Relay Selection on the basis of threshold:

This Threshold-dependent selection scheme is based on the level of threshold such that minimum number of relays is required. This scheme works as:

Step-I, the quality of the received signal through the source is measured and observation are compared to a specified threshold of delay, throughput or BER **Hwang K.-S. and Ko Y.-C. (2007) and Siriwongpairat W. P., Himsoon T., Su W. and Liu K. J. R. (2006).**

Step-II, the relays having the performance estimate above desired level of threshold may be permitted to operate as the relay. The selected nodes having transmitter-to-relay channels and relay-to-receiver channels lowest SNR value selected as the relaying node. This scheme sometime undergoes through a complex state. If M numbers of nodes satisfies the level of threshold, the estimated number of the channel is double i.e. 2*M. In this scheme the value of threshold is taken under constraints. As the threshold level is decided, the relaying operation would be unable to respond with respect to the variations in the channel.

(4) Adaptive Selection of Relay:

BER between the transmitter and receiver may be reduced such that the use of relaying over a helping node is not desired due to variations in channel. Selection of relay is performed if there is a large demand of relaying **Adam H., Bettstetter C., and Senouci S. M. (2008) , Bletsas A., Lippman A., and Reed D. P. (2005) , Raja Adnan and Viswanath Pramod (2014), Ranjan Anand, Singh O P, Mishra G R, Katiyar Himanshu (2020) and Ranjan Anand, Singh O P, Mishra G R, Katiyar Himanshu (2020).** The adaptive selection of relay works as following:

The strength of the received signal is compared to the specified level of threshold. If strength is lower than a threshold, then the relay scheme is operated. The transmission collision issue is addressed in adaptive selection scheme such that the spatial diversity may benefit the system.

B. Random relay selection

In the scheme of random selection of relay all the nodes have equivalent chances of selection irrespective of their residual power and state of the channel.

3.System Model

A wireless cooperative communication network scheme consist of a transmitting node as source S, a receiver node as destination D and a set of relay $R_i \in \kappa$ (Figure 1) is considered under the simulation model. Let $S \in C^{1xN}$ represents complex data of M-point constellation as an output on applying MPSK modulation. Let y_{SR}^{i} represents the data received on i^{th} relay with H_{SR}^{i}, H_{DR}^{i} are channel coefficient and with AWGN noise in path from source to i^{th} relay and i^{th} relay to the destination. Suppose H represents the coefficients of channel in between links from Tansmitter ➔Relay➔Receiver.

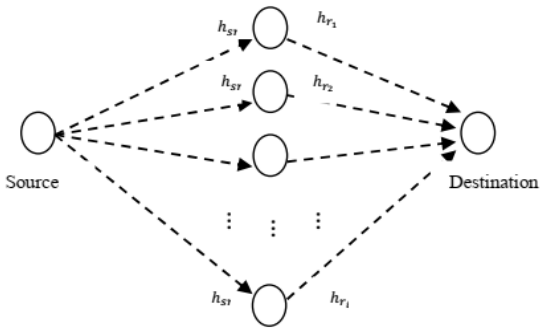

Figure.2: Cooperative Communication Model with Relay Nodes.

In this simulation model at first best S ➔ R➔D is selected from the available set of available relay from the instantaneous channel state information using different relay selection scheme for following conditions **Bletsas A., Lippman A., and Reed D. P. (2005)**.

Condition I: h_i= minimum $\{|h_{si}|^2 * |h_{di}|^2\}$ (1a)

Condition II: $h_i=(2*|h_{si}|^2 *|h_{di}|^2) /(|h_{si}|^2 + |h_{di}|^2)$ (1b)

The communication scheme divided into two stages; in stage 1 represents the scenario when data stream (X) transmission from S to D through broadcast over the channel, relays are able to sense the transmitted data. In stage 2 , best relaying node from the available set. The Rayleigh fading from source relay and D is applied with no line sight component present between S and D. Complex Random variable with is individual and identical distribution is followed as:

$$H = \frac{1}{\sqrt{2}}\left(normal(0,1) + \sqrt{-1}.normal(0,1)\right) \quad (2)$$

The received signal at i^{th} relaying node and destination end are supposed to be y_{sr}^{i} and y_{SD}. In stage 2 transmission, relay end amplifies the received signal and forward it to D. Received signal at D after relay stage has beta channel gain between S and the i^{th} relaying node. At D, received signal from both stages is combined and BER is estimated.

4.Result Using Simulation Model

The result shows the performance results for the schemes of opportunistic and random selection of relaying nodes for wireless cooperative communication model. Simulation is performed using MATLAB for Rayleigh channel fading with AWGN. Simulation parameters are described below:

TABLE I. SIMULATION PARAMETER

constellation M	
Number of bits per symbol K=$\log_2$(M)	1
Energy per symbol-to-noise power-spectral-density ratio Es/N0	0:2:30
Noise Power	1
Message Length	256 bit
Combining Technique	EGC
Fading Environment	Rayleigh

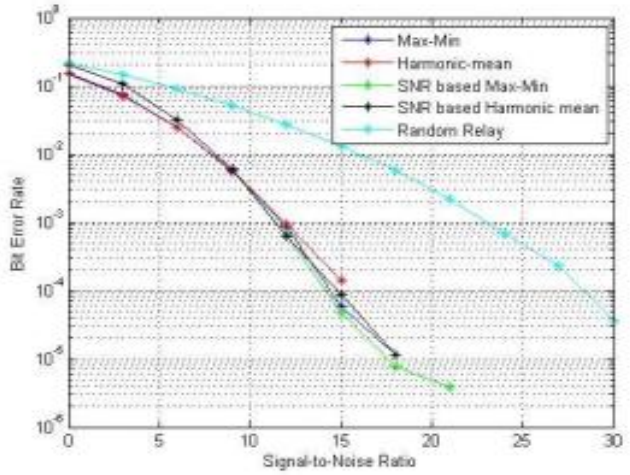

Figure 3: Comparison of relay selection algorithm for cooperative communication system

5.Conxlusion

This article describes the results for comparing performance of opportunistic and random relaying node selection under the wireless cooperative communication model. Opportunistic relaying scheme of relay selection based on max-min selection of relaying nodes, harmonic mean based selection of relay, threshold level dependent max-min and threshold dependent harmonic mean selection scheme is executed along with random selection of relaying node. BER is chosen as evaluation of performance and results are shown SNR vs. BER. Analysis of result represents that for same bit error probability the opportunistic relay node selection method performs better than other relay selection scheme.

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