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Impact of Relay Selection on Dual-hop Relay Communication Systems in Rayleigh Fading Channels

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Abstract

Recently, many studies have been performed on the relay communication networks in order to effectively improve the performance of communication systems in wireless fading channels. However, previous researches have not relatively focused on the case when there is only an indirect path to the destination (i.e. source-relay-destination path) without the direct route between the source and the destination. In this paper, we evaluate and compare the performance of a dual-hop relay communication system in accordance with the relay selection when there is only indirect path to the destination. We also analyze the strengths and weaknesses of each relay selection strategies. Our simulation results show that the partial channel information, the entire channel information, and the effect of the presence and exchange information between the relays via the backhaul make an effect on the relay selection. In addition, the system performance has a significant difference according to these channel information and system complexity.

Keywords: *Relay Communications, Dual-Hop, Selection, Rayleigh Fading, Indirect Path.*

1. Introduction

Recently, the study on the communication system using a relay network has been done to reduce the power consumption as well as to extend a call coverage distance, and also to crease the reliability of communications in mobile communication environments [1]. Relay communication researches have initially performed using multiple parallel relays, but relay transmission using a chance to select one among the multiple relays was introduced in order to save communication resources as well as to improve the signal degradation due to the wireless fading channels [2]. So far, many studies on the opportunistic transmission relays mainly dealt with the way to combine the signals received from the indirect path to the destination (i.e. source-relay-destination) and the signal received from the direct path to the destination (i.e. source-destination). However, in this case, the distance or obstructions between the source and destination paths are not easy to directly present.

In this paper, we consider a method for selecting the relay if there is not a direct path between source and destination, and analyze how this selection policy have an impact on the performance of a dual-hop relay communication system. We assume that decode-and-forward (DF) relaying is used, and the source to the relay and the relay to the destination is assumed to undergo the same respective Rayleigh fading channel. We also assume a block fading channel in which the fading characteristics of the channel do not change for a period of time that the mobile unit moves slowly multiple hop transmission [3].

In order to examine relay selection methods, we can divide the methods into using partial channel information and using full channel information. In this paper, we will consider the partial channel information, the entire channel information, and information exchanged between the relay via the backhaul, and also discuss their impact on the performance of the relay system. In addition, we will investigate the mutual trade-off between the performance of the relay communication system according to the channel information and the complexity of the system based on the simulated and analyzed performance evaluation.

2. System Model and Relay Selection

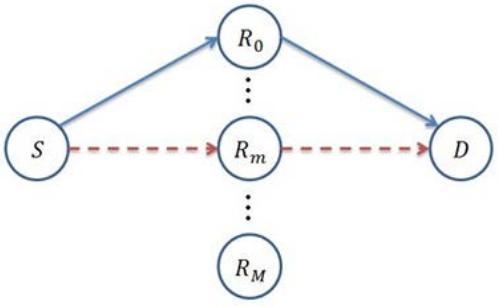

Fig. 1 System model for dual-hop relay communication systems.

In this paper, according to the channel information the selected relay method is classified as follows. First, the partial channel information is used for the *Max Selection*, *2nd Max Selection* scheme. And full channel information to the user is employed for *Max-Max Selection*, *Max-Min Selection*, and *Opportunistic Incremental Relaying* (OIR) method. Specific description of each of the above selection method is as follows.

Max Selection method is a method to select and then transferred from the source to relay the received signal-to-noise ratio (SNR) in the relay is large relay (as in Fig. 1) to transmit to the destination. In this way the source - so choose based upon a partial cross-channel relay information relay - do not use information channels between the relay and the destination.

2nd Max Selection method is first transmitted after using the *Max Selection* method to select (from Fig. 1), the relay and, when a failure in the transmission destination that the next time slot (that is, the 3rd time slots) of the remaining relays except for the by selecting the relay (as in Fig. 1) has the largest received SNR from among a method of retransmission from the relay to the destination. The destination may be the two signals received from the first to combine the two signals received at the second relay 2nd Max to the maximum ratio combining to get a diversity gain.

Max-Max Selection scheme is a scheme for transmitting by selecting the best channel from each of the interval-relay and destination. This selection method is the complete channel information and the source to each other via a wired backhaul between the relay. It can be shared with the assumption that all of the received information between the relay. In other words, the selection scheme is also very high system complexity because of the way that is meaningful as the upper bound of the performance of the relay selection method for implementing this, on the other hand to guarantee maximum system performance.

Max-Min Selection method using the full channel information is determined by the minimum selection methods, the source-relay and the relay selects the destination link-purpose from the span channels, the value of the worse channel largest source-relay. This is one of the most frequently selected relay method used in previous studies when using the full channel information [3].

OIR method, the first source select a relay having the largest received SNR between the relays. If after the goal span transmission, it is determined that if the failure at the destination the next time slot (i.e., a method of selecting as the Max-Min method retransmission from among the remaining relay except for the 3rd time slots). When receiving a signal using up to the third time slot is to combine the two signals received from the source signal is received from a maximum ratio combining.

The threshold SNR to determine the destination to the transmission failure is determined by the mutual information for the target at the destination, the mutual information at the destination is as follows.

$$I = \frac{1}{N}\log_2\left(1+SNR\right) \quad (1)$$

In the formula (1), N is a value indicating whether the information is using a few timeslots to reach the destination. In the first time slot, the data being sent from the source to the relay, the relay information is transmitted to the destination in the second time slot. Source-relay and relay-destination so along the path of the information is transmitted sequentially in two basic time slot. Thus, if called mutual information required by R [bps/Hz], it have a threshold value of $2^{2R}-1$.

When the selected relay method from 2nd Max Selection and determines that the failure in the destination by selecting a relay scheme for OIR again and retransmits the information once again, this case is the use of the three time slots. Therefore, the threshold value $2^{3R}-1$ in the case of using the three time slots are compared to set the amount of information that is sent per time/frequency scheduling is therefore a fair performance comparison.

3. Simulation Results and Discussions

This study is conducted to compare the simulation, evaluating the performance difference according to the relay selected. Set the relay number five for simulation, and the source-object is span average signal-to-noise ratio is represented by the average SNR between the relays. Fig. 2 shows the outage performance of the system according to each relay selection method described in the previous point.

While using the entire channel information from the source in Fig. 2 through the backhaul between each relays, selection of Max Max-sharing information between the receiving relays can be seen that show superior performance as expected. However, if the Max-Max Selection scheme would require a very high complexity in the implementation is required to exchange information between the relay as well as the overall channel side information. On the other hand, using the full channel information only when the case of Max-Min Selection and

OIR method, using the full channel information both However, in the case of a Max-Min Selection always while OIR method using the entire channel information is failed in the first transmission therefore, reducing the probability of relatively use the full channel information can provide more efficient information transfer.

When using the partial channel information is Max Selection scheme is that the number of two or more relays, 2nd Max selection scheme can be observed that the number of the relay does not increase any more in the diversity order three or more. This means that a portion of the channel information does not obtain the full diversity that can be obtained when using the full channel information. However, if the selected relay method using partial channel information instead of the information channel does not use the full implementation complexity it can be seen that significantly reduced.

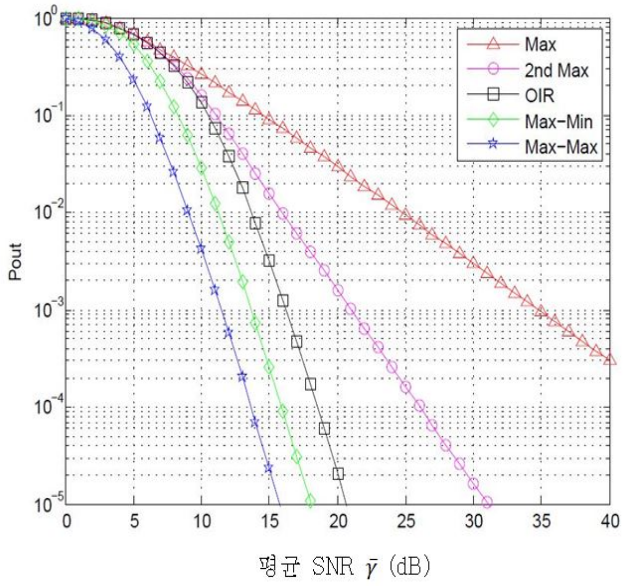

Fig. 2 Outage performance comparisons for each relay selection schemes.

4. Conclusions

In this paper, we analyzed and compared the performance of a dual-hop relay communication system with respect to the relay selection when there is only indirect path to the destination. We discussed the strengths and weaknesses of each relay selection strategies, and our simulation results show that the partial channel information, the entire channel information, and the effect of the presence and exchange information between the relays via the backhaul should be carefully considered in the relay selection because the system performance is significantly affected by the relay selection method.

Acknowledgments

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References

[1] J. N. Laneman, D. N. C. Tse, and G.W. Wornell, "Cooperative diversity in wireless networks: Efficient protocols and outage behavior," IEEE Trans. on Information Theory, Vol. 50, No. 12, Dec. 2004, pp. 3062-3080.

[2] A. Bletsas, H. Shin, and M. Win, "Cooperative Communications with outage-optimal opportunistic relaying," IEEE Trans. on Wireless Communications, Vol. 6, No. 9, Sep. 2007, pp. 3450-3460.

[3] Y. Jing and H. Jafarkhani, "Single and multiple relay selection schemes and their achievable diversity orders," IEEE Trans. on Wireless Communications, Vol. 8, No. 3, March 2009, pp. 1414-1423.

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