

Reduced Energy Consumption in Multi-Hop MIMO-AF Relay Systems

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ABSTRACT :Energy consumption is an important performance indicator for ensuring both the economical and environmental sustainability of the next generation communication networks. Co-operative communication is an effective way of improving the communication system performances. In the proposed system, the energy consumption is reduced by means of reducing the BER in MIMO-AF systems. The total transmission power and the Energy Efficiency based problem can be solved. For an application perspective, the energy consumption of multi-hop MIMO-AF system is compared with MIMO systems. Thus the BER can be further reduced in the multi-hop MIMO-AF systems and the usage of relay is energy efficient when the quality of direct link is very poor.

KEYWORDS: MIMO, Amplify and Forward, BER.

INTRODUCTION

Information and communication technology (ICT) is playing a more and more important role in global greenhouse gas emissions since the amount of energy for ICT increases dramatically with explosive growth of service requirement. Thus the total energy consumed by the infrastructure of cellular wireless networks, wired communication networks, and internet takes up more than 3% of the worldwide electric energy consumption nowadays and the portion is expected to increase rapidly in the future. As an important part of ICT, wireless communications are responsible for energy saving. On the other hand, mobile terminals in wireless systems require energy saving since the development of battery technology is much slower compared with the increase of energy consumption. Therefore, pursuing high energy efficiency (EE) will be the trend for the design of future wireless communications.

Improving the Spectral efficiency (SE) remains the criterion of choice for assessing system performances and designing reliable and scalable communication systems. However, network operators require the next generation of communication systems to be low-energy consuming for ensuring both the economic and environmental sustainability. Therefore, energy efficiency (EE) is becoming increasingly important as a system performance criterion. Although, EE has been obtained for power limited as well as battery-driven systems, it remains a fairly new concept for power-unlimited communication systems, such as cellular networks. The demand of high data rate services has been increasing very rapidly since there is no slowdown in sight and the data transmission includes both wired and wireless medium. Often, these services require very reliable data transmission over very harsh environment. Most of these transmission systems experience much degradation such as large attenuation, noise, multipath, interference, time variance must meet the finite constraints like power limitation and cost factor. One of the possible approaches to make networks more energy efficient is the use of cooperative communication.

Cooperative communication is a new class method which mitigates the degradation effects of fading channels by exploiting the diversity gain achieved via the relay nodes. Cooperative communication provides an effective solution for increasing the spectral efficiency and/or the coverage of cellular networks as well as reducing the cost of network deployment. Cooperative communication can also be deployed to improve EE by using relays for reducing the transmit power at the base station (BS). Among the existing relaying techniques, e.g. amplify and forward (AF), decode and forward (DF) as well as compress and forward (CF), AF remains the most simple and practical approach for implementing cooperative multi-input multi-output (MIMO) communication.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Special Issue 6, May 2015

Many advanced communication techniques, such as multiple-input multiple output (MIMO) techniques, and relay transmission, have been fully exploited in wireless networks to provide high SE. EE-based resource allocation is gaining momentum over SE based resource allocation. The MIMO energy-efficiency transmission scheme is particularly useful for WSN where each wireless node has to operate without battery replacement for a long time and energy consumption is the most important constraint. Using fixed relays boosts coverage in cellular networks when carefully placed at the cell edge or in regions with significant shadowing. Because they implement a subset of base station functions, fixed relays are a low cost and low complexity solution to meet the requirement of high data rate communication far from the base station at the cell edge.

Wireless relay based cooperative communication is a promising technology in improving coverage, link reliability and system sum rate. With the growing importance of EE in communication, EE-based resource allocation is becoming popular such that EE-optimal resource allocation schemes for the uplink and downlink of MIMO systems over a frequency selective channel have been obtained. A multi-hop MIMO power model and joint optimization of all the transmitting nodes are considered to generalize the problem to N hops instead of two hops. Multi-hop MIMO AF can be beneficial for reducing the energy-per-bit consumption when the direct link quality is poor.

II.RELATED WORKS

The use of cooperative communication makes the network more energy efficient. In cooperative MIMO systems, transmit and receive diversity are achieved in a distributed manner by the sending group and receiving group[6]. The sending and receiving groups include multiple sending nodes and receiving nodes, each with a single antenna. Therefore, achieving transmit and receive diversity distributive becomes the major design issue in the cooperative MIMO systems. Cooperative MIMO system provides a reliable transmission with low power[2]. AF is the most simple and practical approach for implementing co-operative MIMO communication. It simply amplifies and retransmit the signal without decoding. In this protocol, the received signal at the relay will be amplified and then forwarded to the destination. The destination will receive multi version of the same information from the relay and from source when there is direct transmission between the source and destination[3]. The AF protocol is better for uncoded systems where the error propagation effect outweighs the noise amplification.

A.SYSTEM ANALYSIS

In this system, consider a multi-hop MIMO AF system composed of Source Node(SN), three Relay Nodes(RN) and the Destination Node(DN). The SN transmits data to the DN through the RN in which there is no direct communication between source and destination due to severe path loss. Here all nodes operate in half-duplex mode such that all transmission phase have equal duration. Assume each node knows its previous and next relay links channel state information. Where the full CSI is available at the RNs and the transmit CSI is available at the SN. By making good use of CSI, the relay becomes able to carry out some further signal shaping. The relay has knowledge about all the links involved in communication.

Power consumption

During the propagation of the signal from the SN to the DN via the relays, each of these nodes will either transmit, receive or be inactive, except for the SN which does not receive and the DN which does not transmit. Accordingly, these different types of power consumptions should be reflected in the total power consumption of the system.

III.EXISTING SYSTEM

In the case of a long source-destination distance, single or multiple MIMO relay nodes may be necessary to relay signals from the source node to the destination node. Incorporating the MIMO technique into the two-hop relay system is expected to further increase the system throughput but the power consumption also increases.

The SN is composed with n antennas, a non-regenerative RN is composed with q antennas and the DN with r antennas. The SN transmits data to the DN through the RN over two phases of equal duration. The direct link between

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Special Issue 6, May 2015

the source and the destination is ignored due to the larger distance and additional path loss compared to the relay links[5]. The usage of a relay improve the link quality by around one order of magnitude per hop for the two-hop MIMO-AF to be more energy efficient than MIMO system, when the relay is mid-way between the SN and DN.

For the two-phase transmission, the power consumption can be obtained based on the nodes i.e., the SN will either transmit or be inactive, the RN will either receive or transmit, and the DN will either receive or be inactive. The extra fixed power consumption induced by transmitting over two hops disadvantage MIMO-AF over MIMO systems.

IV. PROPOSED SYSTEM

It involves the use of multi-hop transmission of signal from the source to destination through various relay nodes. As far as resource allocation for multi-hop MIMO-AF system is concerned, jointly allocating resources at the source node (SN) and relay nodes (RNs) are based on SE maximization or mean square error minimization. If the SN does not communicate directly to the DN then the use of intermediate node called RN is used to transfer the data. In this method, energy per bit consumption is reduced to provide the reliable communication when the direct link quality from the source to destination is poor and it is suitable for only long distance communication. Reducing the total power Consumption and BER provides the channel efficiency and thereby reduce the energy consumption which makes the scalable and reliable communication.

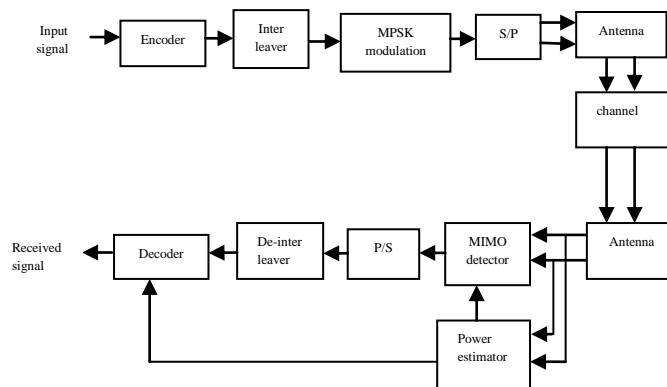


Fig.1. Block diagram of Multi-hop MIMO-AF relay system

In the proposed system shown in fig 1, at the transmitter side, the input signal is given in the form of bits to differential encoder which makes the data to be transmitted to depend not only on the current bit (or symbol), but also on the previous one. Then the signal is random interleaved to control errors in data transmission over unreliable or noisy communication channel and an array of bits can be modified by means of MPSK modulation. Thus the transmitted signal is propagate through the relay channels.

The source and destination cannot communicate directly to each other because the distance between source and destination is greater than the transmission range of both of them, hence the need for intermediate node relay. The relay channel are used to send data from a source to a destination. Fixed relays are low cost and low transmit power elements that receive and forward data from the base station to the users via wireless channels, and vice versa.

At the receiver side, the signals from the relay channels are transmitted to the destination node and the power estimation is carried out to minimize the mean square error. The receiver collects all the data from the antenna and reverses the operation to decode the data.

International Journal of Innovative Research in Science, Engineering and Technology

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Vol. 4, Special Issue 6, May 2015

V. MIMO-AF SYSTEMS AND APPLICATIONS

MIMO system uses the space time coding technique to maximize the spatial diversity and allow simple decoding algorithm based on linear processing. MIMO-AF incurs extra power consumption compared with MIMO system. The usage of relay must provide channel gain improvement for MIMO-AF to be low systems can support higher data rates at the same transmission power and BER requirements. Hence it requires less transmission energy. Reducing the total power consumption reduces the energy per bit consumption and the position of the relay is important for MIMO-AF systems.

A.AF RELAY

AF is the most simple and practical approach for implementing Co-operative MIMO communication. It simply amplifies and retransmits the signal without decoding. In this protocol, the received signal at the relay will be amplified and then forwarded to the destination. The destination will receive multi version of the same information from the relay and from the source when there is direct transmission between the source and destination[4]. The AF protocol is better for uncoded systems where the error propagation effect outweighs the noise amplification.

B.CHANNEL STATE INFORMATION

The energy efficient resource allocation that jointly allocate the source and relay precoding matrix subject to power and Qos constraints is considered. It is used to optimize the ration between the systems achievable rate and the total consumed power. The optimization is carried out with respect to the source and relay precoding matrices, subject to quality of service(QOS) and power constraints. The various CSI assumptions at source and relay are:

- Perfect CSI is available for both source to relay and relay to destination channel.
- Perfect CSI is available only for the relay to destination channel while the source to relay channel is only statistically known.
- Perfect CSI is available only for the source to relay channel while the relay to destination is only statistically known.

The CSI is used to reduce the complexity of the resource allocation phase. Resource allocation has been utilized for improving the spectral efficiency of peak rate performance of communication systems. By making good use of CSI, the relay becomes able to carry out some further signal shaping[1].

VI. BER ANALYSIS AND FLOW CHART

BER is used to describe the performance of communication system and analyze system energy consumption[1]. In digital transmission, the number of bit errors is the number of received bits of a data stream over a communication channel that have been altered due to noise, interference, distortion or bit synchronization errors. In a noisy channel, BER is expressed as a function of normalized carrier to noise ratio measure denoted by E_b/N_0 (energy per bit to noise power spectral density ratio). In a communication system the receiver side BER may be affected by transmission channel noise, interference, distortion, wireless multipath fading, attenuation.

Flow chart

The flow chart indicates how the information can be transferred from the source to destination through the relay. The transmitter and receiver side can be obtained. At the transmitter side the input signal is acquired from the source node and it is transferred to the channel and at the receiver side the signal from the relay is passed through various process until the original signal is obtained at the destination node.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Special Issue 6, May 2015

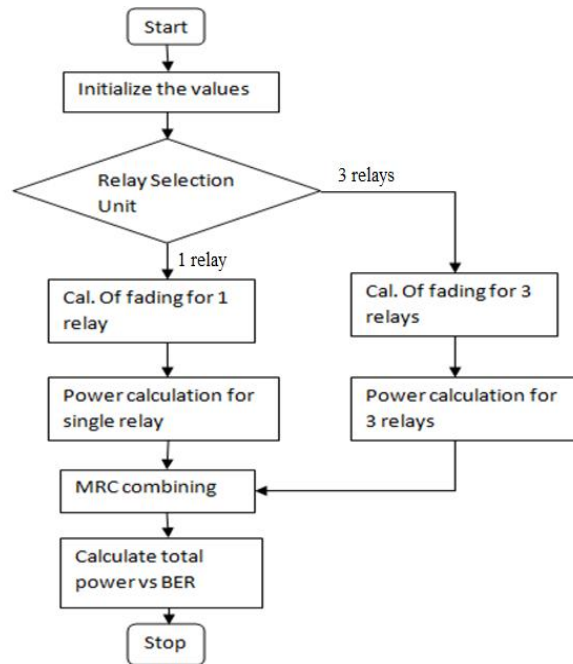


Fig 2: Flowchart for MIMO-AF relay system

The relay selection unit is considered to carry out the process with single or multiple relay. Fading is one of the important problem occurs in wireless communication. Therefore to reduce the fading effect makes the effective communication. Then the power calculation is carried out using single and multi relays and the power consumption is reduced while using multi relays in comparison with the single relay. Maximal Ratio combining is used to add the signal from each channel. Then, finally the total power and BER is calculated and compared.

VII. SIMULATION RESULTS

The simulation results shows that the energy consumption is reduced by means of reducing the BER. Thus the graph is plotted between BER and the total power. The graph obtained while using single relay is as follows

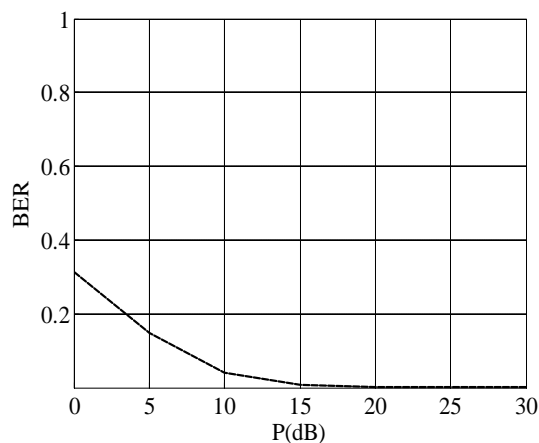


Fig 3: Graph between BER vs power using single relay

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Special Issue 6, May 2015

By placing the relay between the source and destination provides the signal strength and can be used for long distance communication. Thus, by means of using the single relay provides the BER reduction and makes the scalable communication. For the power consumption scenario the two-hop MIMO-AF relay systems consuming more power. Therefore reducing the power consumption is an important factor for the effective communication between source and destination. By using three relays the graph obtained between BER and the total power is plotted as

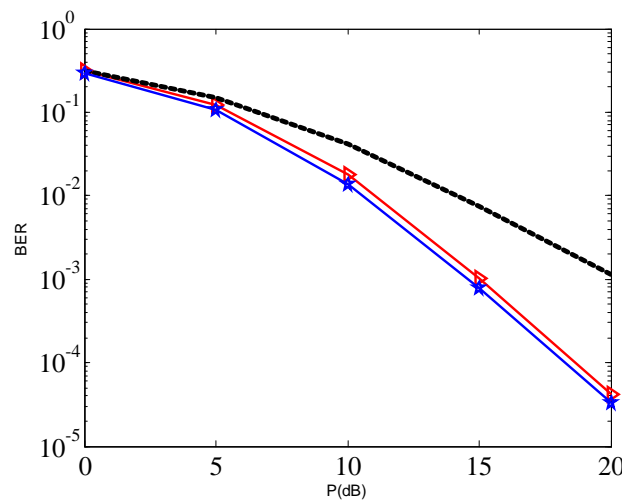
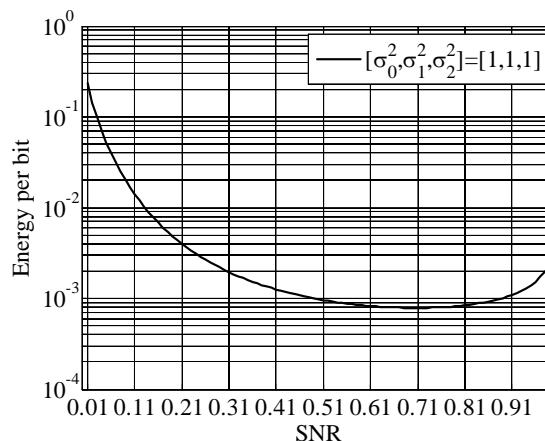


Fig 4: Graph between BER vs power using three relays

Using three relays instead of single relay makes further reduction in BER and energy consumption. These multi-hop system provides the transmission in long distance communication with low power consumption. For the power allocation perspective in the multi-hop MIMO-AF relay systems the energy per bit consumption and the SNR values are considered for reducing the total power consumption and the graph has been plotted.



VIII. CONCLUSION

This method is both reliable and accurate when comparing the EE-optimal performances of the two-hop MIMO-AF and MIMO systems with CSI[5]. Based on the simulation results the energy consumption is reduced and it is used to increase the spectral efficiency. The usage of a relay must improve the communication performance when it is placed between the SN and DN. The BER is reduced in multi-hop MIMO-AF systems. In the future, the total Power consumption can be further reduced to make the effective communication.

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