Cooperative Communication Technology

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Abstract

O ne major advantage of cooperative communication technology can improve the reliability of the wireless communication link, so its application in various fields of research has been more and more got the attention of the researchers. This article mainly expounds the cooperative communication technology of cooperative diversity, cooperative communi cation relay transmission model and collaborative communication network structure, and summarizes the full text.

Keywords

Cooperative communication technology, cooperative diversity, cooperative communication relay transmission model, collaborative communication network structure.

1. Introduction

In order to solve some practical problems of the multiple Input multiple Output (MIMO), Cooperative, the researchers put forward a kind of technology-Cooperative Communication Technology(CCT). CCT makes the mobile terminal of the single antenna by sharing other mobile terminal's antennas in a multi-user environment, acquiring multiple independent transmission paths and multi-antenna diversity gain, which improves the performance of communication system. This cooperative communication network, through the network of multiple users to share each other's antenna to form the way of distributed systems, constitutes a virtual MIMO network, to achieve space diversity of the single antenna's mobile terminal, which makes MIMO technology be widely applied to the small limited mobile terminal equipment, thus is more practical. In recent years, CCT, whose applications in cellular networks, sensor networks, wireless local area network (LAN) and Ad hoc network and etc., has been paid more and more attention by researchers, and has become a research hot spot. The innovation point of CCT is that part of the nodes in the network (or mobile client, etc.) as a relay node forwarding source node information effectively.

2. Cooperative communication technology

2.1 Cooperative diversity

Fig. 1 shows the communication model for two cooperative users under the environment of the cellular system. In the traditional communication system, the mobile user 1 and 2 exchange information with base station only by single frequency and time. The communication link between users and the base station in the event of serious decline or middle appear obstacles, will lead to communication quality to decline seriously. While CCT can well solve the above problem.

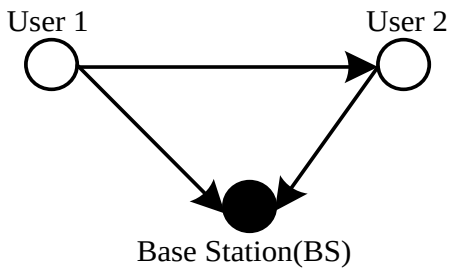

Fig. 1 Schematic diagram for two cooperative users

The diagrammatic figure for the multi-user cooperative communication is as shown in Fig. 2. Under this model, each source node has multiple partners (or relay nodes), the specific implementation process is that in the first phase, the source node sends information in the form of broadcast, and all the relay nodes and destination nodes receive information at the same time; in the second phase, all the relay nodes respectively deal with processing the received signals, and then forward to the destination node; in the third stage, the destination node merges and processes the receiving information of the two stages.

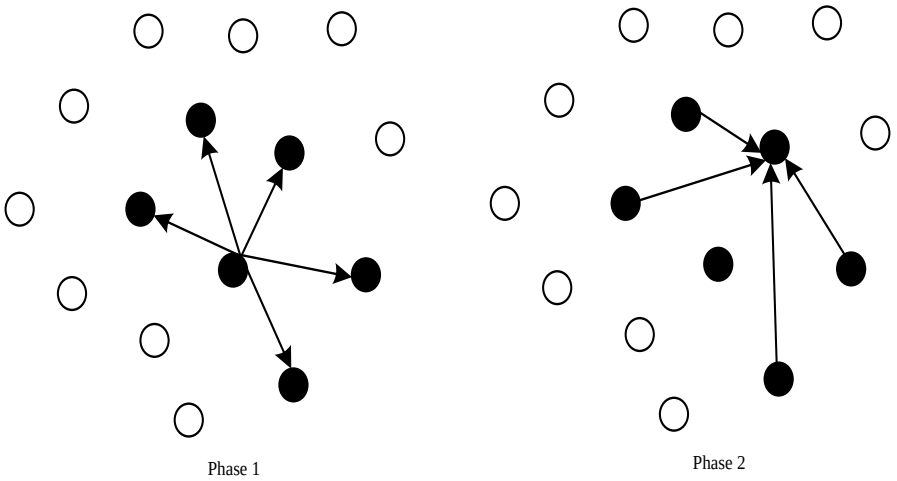

Fig. 2 Schematic diagram for multiple cooperative users

2.2 The transmission mode of cooperative communication relay

In the cooperative communication system, the design of relay nodes have a great influence on transmission quality and system performance. According to the relay node to process the different methods of receiving signals, the relay transmission mode is roughly divided into: Amplify-and-Forward(AF), Decode-and-Forward(DF), and coded cooperation(CC). The AF way: relay nodes firstly make the received information for simple zoom adjustment, and then directly forward to the lower nodes. DF method: relay nodes firstly makes the received information for demodulation and decoding process, and then reconstruct the transmitting signals by coding and modulation to forward to the destination node. CC mode is a kind of way to combine the DF and channel coding.

2.3 The network structure of cooperative communication

In the multi-node cooperative network, each node usually allocates a fixed time slots for transmission. According to the different network topology structure, the dual-hop cooperative relay network transmission model can be divided into: single-relay dual-hop relay model, single-relay dual-hop cooperative model and multi-relay parallel cooperative mode. Single-relay dual-hop relay mode is as shown in Fig.3, whose structure model is relatively simple. Single-relay dual-hop cooperative mode is as shown in Fig.4 that increases the direct communication link between the source node and the destination node in Fig.3.

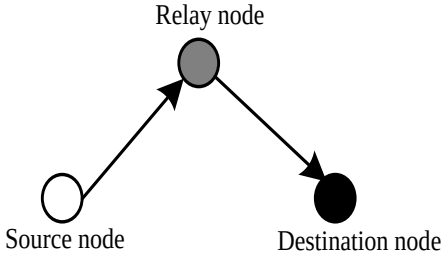

Fig.3 The system model for single-relay dual-hop cooperation

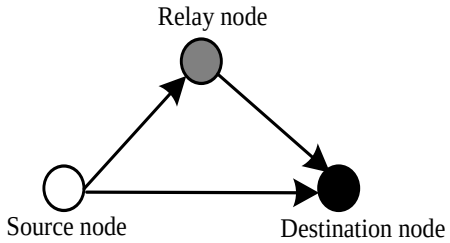

Fig. 4 The system model for single-relay dual-hop relaying

Multi-relay parallel cooperative mode is as shown in Fig.5 makes single-relay dual-hop cooperative model in Fig.4 generalize the multi-relay environment, which is multi-relay parallel cooperative mode.

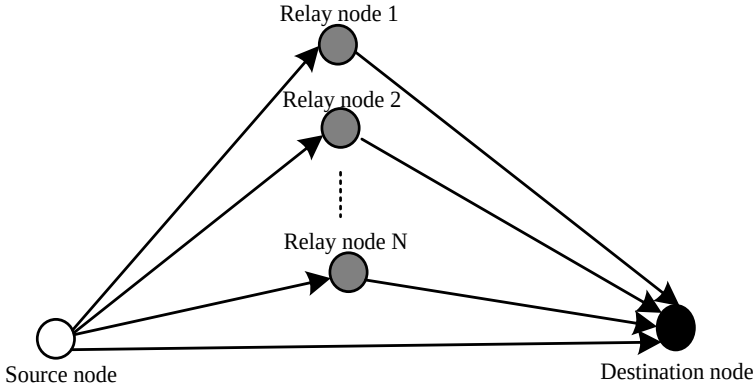

Fig. 5 The system model for multi-relay parallel cooperation

The diversity gain of these three communication models in Rayleigh fading channel environment is respectively "1", "2" and "N + 1".

3. Cooperative communication system based on the large-scale relay

This section focuses on relay coordination three-node system, containing a single source node, a single destination node and a single relay node equipped with large-scale antenna array of relay nodes. Diversity technique is an effective technology to overcome fading channel effect. As shown in Fig. 6 relay cooperative diversity models include three kinds of nodes: the source node, the destination node and the relay node. Information transmission goes through two phases: the first stage, the source node sends the signals to relay nodes of multiple receiving antennas in the form of broadcast, and a relay node uses Maximum Ration Combining(MRC) or Selection Combining(SC) to merger and receive signals and generate renewable information; The second stage, a relay node of multiple antennas use Maximum Ration Transmit(MRT) or Selection Transmit(ST) to forward regenerated information to a destination node, and the destination node receives the information.

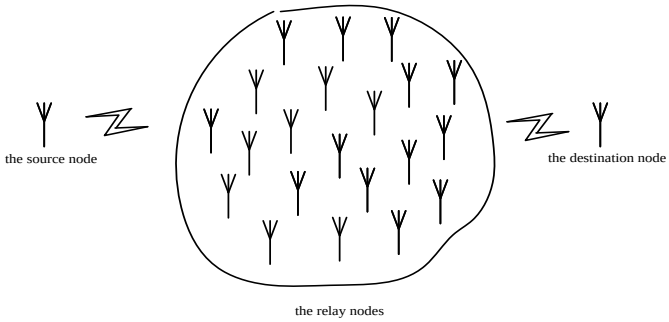

Fig. 6 The system model for single-relay cooperative diversity

The system model for receive diversity at relays is as shown in Fig. 7. Assuming that the number of relay's antennas is N, the N diversity branch between the source node and the relay nodes are independent of each other, all subject to Rayleigh fading, and signals use the way of BPSK modulation. The required $N \times 1$ received vectors at relays are

$$y_r = \sqrt{P_1} h_{s,r} x + \eta_{s,r} \tag{1}$$

Where, P_1 means the average symbol power of the source node, x represents the data symbol for the unit variance of the source node sending, $\eta_{s,r}$ is that each element subjects to CN(0, 1) of complex additive white Gaussian noise vector, and $h_{s,r}$ is the dimension of $N \times 1$ channel vector between the source node and the relay node, which each element subjects to CN(0,1) of independent identically distributed complex additive white Gaussian noise vector.

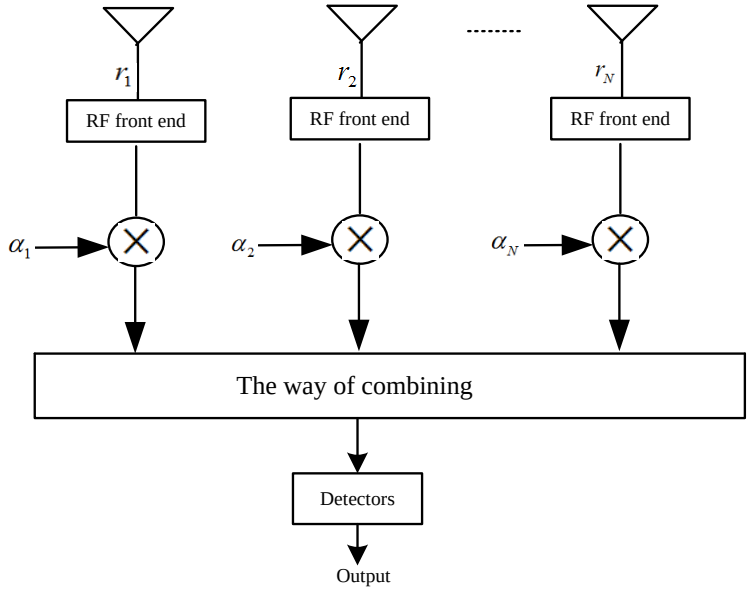

Fig. 7 The system model for receive diversity

The relays adopt the linear detector to combine and process the received signals, if the relays can ideally estimate the channel and acquire the perfect channel side information(CSI) of the uplink, it can use the detector of MRC and SC, the output signals are the each branch's signals of weighted sum, i.e.,

$$r = \sum_{i=1}^{N} \alpha_i r_i \tag{2}$$

There into, r_i represents the received signal of the ith receiving antenna, and α_i means the variable weighting factor of the corresponding ith receiving antenna.

4. Conclusion

In recent years, the cooperative communication technology has become one of the research hot spots in the field of wireless communications. This communication system can be more deep mining spatial dimension wireless resources, not only can effectively reduce the transmission power and resist to multi-path fading, but also can improve the system of spectrum utilization, capacity and reliability, increase transmission rate, extend network coverage, and effectively reduce the energy consumption to build green wireless communication system.

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