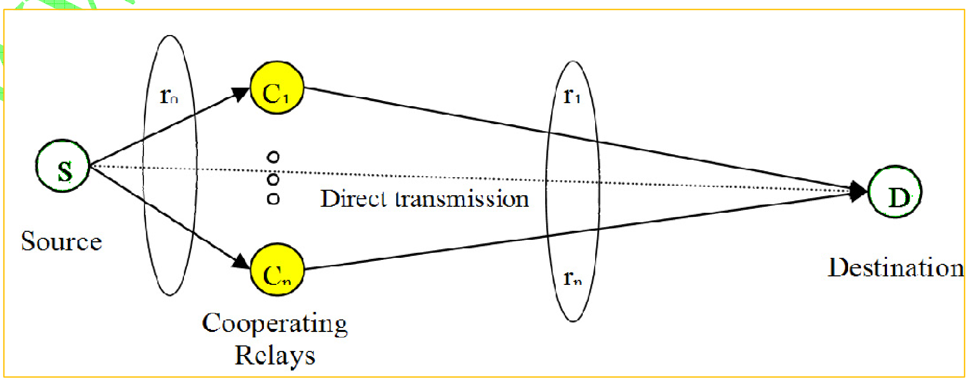
Optimal Power Allocation in Multi-Relay MIMO Cooperative Networks: Theory and Algorithms

Abstract

Cooperative networking is known to have significant potential in increasing network capacity and transmission reliability. Although there have been extensive studies on applying cooperative networking in multi-hop ad hoc networks, most works are limited to the basic three-node relay scheme and single-antenna systems. These two limitations are interconnected and both are due to a limited theoretical understanding of the optimal power allocation structure in MIMO cooperative networks (MIMO-CN). In this paper, we study the structural properties of the optimal power allocation in MIMO-CN with per-node power constraints. More specifically, we show that the optimal power allocations at the source and each relay follow a matching structure in MIMO-CN. This result *generalizes* the power allocation result under the basic three-node setting to the multi-relay setting, for which the optimal power allocation structure has been heretofore unknown. We further quantify the performance gain due to cooperative relay and establish a connection between cooperative relay and pure relay. Finally, based on these structural insights, we reduce the MIMO-CN rate maximization problem to an equivalent scalar formulation. We then propose a global optimization method to solve this simplified and equivalent problem.

Architecture



Existing System

In Existing System, the multi-hop ad hoc networks most works are limited to the basic three-node relay scheme and single –antenna systems. These two limitations are interconnected and both are due to a limited theoretical understanding of the optimal power allocation structure in MIMO cooperative networks (MIMO-CN). So, capacity level is very low. Indeed, most of current works on wireless networks attempt to create, adapt, and manage a network on a maze of point-to-point non-cooperative wireless links. Such architectures can be seen as complex networks of simple links.

Disadvantages:

1. Low Network Capacity.
2. Communications are focused on physical layer issues, such as decreasing outage probability and increasing outage capacity, which are only link-wide metrics.

Proposed System

In Proposed system we use Cooperative diversity. It is a cooperative multiple antenna technique for improving or maximizing total network channel capacities for any given set of bandwidths which exploits user diversity by decoding the combined signal of the relayed signal and the direct signal in wireless multi hop networks. A conventional single hop system uses direct transmission where a receiver decodes the information only based on the direct signal while regarding the relayed signal as interference, whereas the cooperative diversity considers the other signal as contribution.

Advantage

1. To make larger or more powerful; increase.
2. To add to, as by illustrations; make complete.
3. To exaggerate.
4. To produce amplification of: amplify an electrical signal.

Modules

1. Three-node relay transmission
2. Network Constraints
3. Relaying Strategies
4. Cooperative Communications & Optimal Power allocation
5. Multi-hop Transmission

Three-node relay transmission

With physical layer cooperative communications, there are three transmission manners: direct transmissions, multi-hop transmissions and cooperative transmissions. Direct transmissions and multi-hop transmissions can be regarded as special types of cooperative transmissions. A direct transmission utilizes no relays while a multi-hop transmission does not combine signals at the destination. The cooperative channel is a virtual multiple-input Multiple-output (MIMO) channel, where spatially distributed nodes are coordinated to form a virtual antenna to emulate multi-antenna transceivers.

Network Constraints

Two constraint conditions need to be taken into consideration in the *network connectivity*, which is the basic requirement in topology control. The *end-to-end network connectivity* is guaranteed via a hop-by-hop manner in the objective function. Every node is in charge of the connections to all its neighbors. If all the neighbor connections are guaranteed, the end-to-end connectivity in the whole network can be preserved. The other aspect that determines network capacity is the path length. An end-to-end transmission that traverses more hops will import more data packets into the network. Although path length is mainly determined by routing, MIMO – CN limits dividing a long link into too many hops locally. The limitation is two hops due to the fact that only two-hop relaying are adopted.

Relaying Strategies

- ✓ Amplify-and-forward
- ✓ Decode-and-forward

In amplify-and-forward, the relay nodes simply boost the energy of the signal received from the sender and retransmit it to the receiver. In decode-and-forward, the relay nodes will perform physical-layer decoding and then forward the decoding result to the destinations. If multiple nodes are available for cooperation, their antennas can employ a space-time code in transmitting the relay signals. It is shown that cooperation at the physical layer can achieve full levels of diversity similar to a MIMO system, and hence can reduce the interference and increase the connectivity of wireless networks.

Cooperative Communications & Optimal Power allocation

Cooperative transmissions via a cooperative diversity occupying two consecutive slots. The destination combines the two signals from the source and the relay to decode the information. Cooperative communications are due to the increased understanding of the benefits of multiple antenna systems. Although multiple-input multiple-output (MIMO) systems have been widely acknowledged, it is difficult for some wireless mobile devices to support multiple antennas due to the size and cost constraints. Recent studies show that cooperative communications allow single antenna devices to work together to exploit the spatial diversity and reap the benefits of MIMO systems such as resistance to fading, high throughput, low transmitted power, and resilient networks.

Multi-hop Transmission

Multi-hop transmission can be illustrated using two-hop transmission. When two-hop transmission is used, two time slots are consumed. In the first slot, messages are transmitted from the source to the relay, and the messages will be forwarded to the destination in the second slot. The outage capacity of this two-hop transmission can be derived considering the outage of each hop transmission.

HARDWARE & SOFTWARE REQUIREMENTS:

HARDWARE REQUIREMENTS:

- System : Pentium IV 2.4 GHz.
- Hard Disk : 40 GB.
- Floppy Drive : 1.44 Mb.
- Monitor : 15 VGA Color.
- Mouse : Logitech.
- Ram : 512 MB.

SOFTWARE REQUIREMENTS:

- Operating system : Windows XP Professional.
- Coding Language : C#.NET