Energy Efficient Precoding Design for Swipt in MIMO Two-Way Relay Networks

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ABSTRACT

This project explains about the energy efficiency (EE) maximization problem in multiple-input multiple-output (MIMO) two-way relay networks with continuous wireless information and power transfer (SWIPT). The network consists of a multiple-antenna amplify-and-forward relay node which provides bidirectional communications between two multiple antenna transceiver nodes. According to this, one of the transceivers is considered battery limited and has the capability of energy harvesting from the received signals. Assuming the network EE as the objective function, we design power splitting factor and optimum precoding matrices at the relay node and two transceivers. In addition, sufficient conditions for optimality are derived and the computational complexity of the proposed algorithm is analyzed. Simulation results are provided to evaluate the performance and confirm the efficiency of the proposed scheme as well as its convergence.

KEYWORDS

Simultaneous Wireless Information and Power Transfer (SWIPT), Energy Efficiency, Energy Harvesting, Two-way Relay Networks (TWRNs), Multiple-Input Multiple-Output (MIMO), Convex Optimization

INTRODUCTION:

Wireless relaying is a well-known technique to provide reliable transmission, high throughput, broad coverage and agile frequency reuse in modern wireless networks. In a cellular environment, relays are usually deployed in areas where a significant shadowing effect is present such as tunnels or the inside of buildings, as well as in areas that are far away from the transmitter and that otherwise would not be covered. In this context, AF is one of the most widely used choices because it does not require the relays to decode and know the users' codebooks, thus allowing a faster and simpler design and placement of the relays. This relaying strategy is also one candidate approach in the standard LTE-Advanced and is usually referred to as layer-1 relaying. Another key-factor in modern communication systems is the use of multiple antennas. It is established that the use of multiple antennas grants higher data rates and lower bit error rates. As a result, recently a great deal of research has focused on MIMO relaying, where a multiple antenna, non-regenerative relay precodes the signal received from the source by an AF matrix, and then forwards it to the destination.

In the wireless networks, the capability and lifetime of battery powered devices are limited by their battery capacities. In recent years, different energy harvesting (EH) techniques are introduced to address the problem of battery limitation in wireless devices by harvesting energy from surrounding environment [5]. Recently, some other methods have been introduced for simultaneous wireless information and power transfer (SWIPT) that can harvest energy from the received signals [6], [7]. In SWIPT, the receiver in each node can simultaneously be an information decoder and an energy receiver [8]. To implement SWIPT, receivers apply time switching (TS) or power splitting (PS) mechanisms [9], [10]. The TS receiver periodically switches between information decoding and energy harvesting, whereas the PS receiver splits thereceived power into decoding power and harvesting power. One of the schemes that can be used to improve EE of the wireless networks is multiple-input multiple-output (MIMO) technique. Thanks to the diversity gain achieved by the MIMO, much less power is required to get the same performance as a single-antenna system, which leads to higher energy efficiencies [11]. On the other hand, another method for increasing EE in the wireless networks is cooperative communications based on relaying schemes [12]. Two-way relay network (TWRN) which allows bidirectional communications between two end nodes provides a high EE [13]. The EE of the TWRN can also be improved by combining with MIMO techniques [4], [14]–[16]. The authors in [14] maximized the EE of a MIMO TWRN with the optimal power allocation. In [15], an energy efficient antenna-selection algorithm for a MIMO TWRN was proposed. The authors in [4], considered an energy efficient beamforming design for a MIMO TWRN in which the beamforming in the relay node is designed based on zero-forcing (ZF) criterion and just the beamforming vectors of the transceivers are optimized based on EE maximization. In [16], the authors studied an energy efficient beamforming design in a MIMO TWRN.

In green radio communications, a main network design objective is to reduce the amount of energy consumption while maintaining satisfactory quality of service (QoS). Two motivations are behind this