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Low Density Parity Check Code in Cooperative MIMO Communication at Wireless Sensor Network

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Abstract—Energy efficient data transmission is one of the key factors for energy constrained wireless sensor network. Cooperative communication explores the energy efficient wireless communication schemes between multiple sensors and data gathering node. In this paper, an energy efficient cooperative multiple input multiple output technique, which uses low density parity check codes, is suggested. The result shows that the suggested cooperative communication technique outperforms single input single output transmission with error correction code. Bit error rate analysis is also performed.

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1. INTRODUCTION

Energy efficient data transmission is one of the key factors for energy constrained wireless sensor network (WSN). Recent advances in technology of micro-electro-mechanical systems have enabled the development of wireless sensor nodes in WSN. These tiny sensor nodes can sense, process and communicate with each other [1, 2].

Since battery capacity in each node is limited and the goal is to maximise the network's lifetime, WSNs have strict energy consumption constraints [3]. A wireless sensor network typically consists of a large number of sensor nodes distributed over a certain region. A monitoring node (MN) monitors its surrounding area, gathers application-specific information, and transmits collected data to a data gathering node (DGN) or a gateway. Energy issues are more critical in the case of MNs rather than in the case of DGNs since MNs are deployed remotely and it is not easy to frequently change energy sources. Therefore, the MNs have been the principal design issue for design of energy limited wireless sensor networks.

MIMO [10, 11] is a potential candidate for energy efficient design given the target probability of bit error rate at the receiver. But the MIMO techniques require complex transceiver circuitry and signal processing leading to large power consumptions at the circuit level. Moreover, physical implementation of multiple antennas at a small-size sensor node may not be feasible.

The solution came in the form of cooperative MIMO [10–13]. Cooperative MIMO is a kind of MIMO technique where multiple inputs and outputs are formed via cooperation. The concept has been suggested to achieve MIMO capability in a network of single antenna nodes. Sensors cooperate with each other to form a multiple input multiple output structure.

The results in [10] show that cooperative MIMO based sensor networks may, in fact, lead to better energy efficiency and smaller end-to-end delay. In spite of these works on cooperative MIMO, the use of error correction codes is yet to be analyzed. There are several works devoted to applying error control codes in WSNs, in which the performance of block codes and Viterbi decoded convolutional codes is investigated [4, 5]. Also, the iterative decoding algorithm justifies the ability of turbo codes in solving the hot-spot problem and prolonging the network's lifetime [6].

Low-density parity-check (LDPC) codes are more reliable than the block and convolutional codes and are serious competitors of turbo codes. In particular, LDPC codes exhibit asymptotically better performance than turbo codes and allow for a wide range of trade-offs between performance and decoding complexity [7].

Sartipi and Fekri [8] compare the performance of LDPC codes and Reed-Solomon (RS) codes. The issue of joint source-channel coding using LDPC codes is also considered. From the recent works, it is known that LDPC codes are attractive in WSNs because of their applications in compression, joint source-channel coding and distributed source coding [8, 9]. However, to the best knowledge of the authors, there has been no document on the implementation of LDPC encoder/decoder in a wireless sensor node using cooperative communication.