Abstract

The goal of this thesis is to provide a unified concept of lossy-forwarding from the theoretical analysis to practical scheme design for the decode-and-forward-based multiple access relay channel (MARC) system. To improve the performance of MARC with the relay subject to resources or/and time constraints, the erroneous estimates output from simple detection schemes are used at the relay are forwarded and exploited. A correlation is then found between two sequences: one is the network-coded sequence sent from the relay, and the other is their corresponding exclusive-OR-ed information sequence. Several joint network-channel coding (JNCC) techniques are provided in which the correlation is utilized to update the log-likelihood ratio sequences during the iterative decoding process at the destination. As a result, the bit error rate (BER) and frame error rate (FER) are improved compared with those of MARC with select DF strategy (SDF-MARC). The MARC proposed above is referred to as erroneous estimates-exploiting MARC (e-MARC). To investigate the achieved FER performance of the e-MARC system, the outage probability for e-MARC with two source nodes is theoretically derived. We re-formulate the e-MARC system and identify its admissible rate region according to the Slepian-Wolf theorem with a helper. Then, the outage probability is obtained by a set of integral over the rate region with respect to the probability density functions of all the links' instantaneous signal-to-noise power ratios. It is found through simulations that, as one of the source nodes is far away from both the relay and destination, e-MARC is superior to SDF-MARC in terms of outage performance. Furthermore, a joint adaptive network-channel coding (JANCC) technique is then proposed to support e-MARC with more source nodes. A vector is constructed at the destination in JANCC to identify the indices of the incorrectly decoded source node(s), and re-transmitted to the relay for requesting additional redundancy. The relay performs network-coding only over the estimates specified by the vector upon receiving the request. Numerical results show that JANCC-aided e-MARC is superior to e-MARC in terms of FER and goodput efficiency. In addition, compared iterative decoding is performed at relay with SDF-MARC, the use of differential detection with JANCC-aided e-MARC significantly reduces the computational complexity and latency with only a small loss in the FER.

Keywords: cooperative communication, decode-and-forward (DF), joint network-channel coding, multiple access relay channel (MARC), Slepian-Wolf theorem