A Novel Decoding Algorithm of Superposition Modulation for Cooperative IoT System

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***Abstract* – In this paper, we propose a novel decoding strategy for superposition modulation (SM) for cooperative IoT system. Unlike the conventional method where the SIC (successive interference cancellation) decoding is applied, whose performance degrades when the decoder fails to detect the main signal, we propose a novel decoding algorithm which derive the LLR (log likelihood ratio) directly from the received signal. The new decoding scheme performs well even when the main signal detection fails and outperforms conventional SIC based decoding method by more than 2 dB in the fading environment.**

1. INTRODUCTION

Recently, there has been a lot of research on improving the reliability of the IoT communication system. Since there exist power and cost limitations it is not easy to deploy multiple antennas in IoT devices to get the diversity gain. Therefore, cooperative communication technique obtaining a space diversity effect is a proper alternative [1]-[4]. Among several choices of relaying methods such as AF (amplify and forward), DF (decode and forward) and CF (compress and forward) we consider only DF in this paper.

To increase the data rate and save transmission powers, the authors in [5] and [6] proposed a cooperative transmission where the relay sends both the received packet from the source and its own transmission packet using the SM method. In the receiver, main signal is detected first and then the secondary superposed signal is decoded using the SIC algorithm.

The problem of this method is that the BER performance of the secondary signal degrades when there exists a detection error in the main signal. To mitigate the error propagation effects, we propose a novel decoding method where we extract the LLR information directly from the received signal without using the SIC.

1. SYSTEM MODEL

In this paper, we consider a hoped relay network system, source node, relay node and destination denoted by , , and as shown in Fig.1. We assume all nodes have a single antenna. The channel coefficients between nodes, denoted by and , are random variables having a complex Gaussian distribution with mean 0 and variance per dimension of 0.5. Also, and are the complex Additive White Gaussian Noises with mean 0 and variance per dimension of SNR depending on each node relation. For simplicity, we assume channel information is perfectly estimated, and transmission channel between and is error free. The information bits of the source node and the relay node are denoted by and .

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We consider a sensor node uplink scenario where transmits a packet containing only its own information() to and in the 1st phase. It is attempted for and to decode the received signal().

 (1)

If decoding fails, sends a NACK to request retransmission. At this time, retransmits power by superposing power ratio on and on in the 2nd phase. The received retransmitted signal is as follows.

 (2)

 (3)



Fig.1 Cooperative network phase diagram

1. PROPOSED DECODING ALGORITHM

SIC decoding can be performed only if information bits having a large power ratio are successfully decoded in the conventional SM retransmission method as shown in Fig.2. Depending on the channel

conditions, it is determined that SIC is applied. The SIC step effects directly the opportunity of decoding the small power ratio signal, in this example.

Fig.2 Conventional and Proposed Decoding Algorithm

If large power ratio signal is not decoded in the retransmission phase, it is a waste of resources for both phases and nodes. In the proposed decoding algorithm, LLR for each node is derived directly by the adaptive power ratio mapping table. For example, adaptive power ratio QAM mapping table is used to derive bit LLRs for each node regarding the conditions in the case of QPSK modulation used. Without SIC step, bit LLRs are generated for BLC decoding algorithm with the previous derived LLR.

1. .SIMULATION RESULT

For practical demonstration, we run Monte Carlo simulation, setting log MAP method to generate LLR win Turbo Code(13, 11), QPSK modulation and Equal Gain Bit Level Combining under Quasi-static Rayleigh fading channel condition between the nodes. The BER for the conventional and the proposed algorithm is measured in case of (SNR between and ) 1 and 3.16, 0dB and 5dB in log scale.

Similar BER performance was shown due to high BER of the small power ratio signal in the low region. The proposed decoding algorithm gained 1.5dB and 2dB in respectively over the conventional SM decoding method at the BER and region as shown in Fig.3.

1. CONCLUSIONS

In this paper, we propose a method for decoding information of each node without SIC supposed to be used in SM transmission. The proposed method obtains SNR gain by decoding information of each node regardless of whether it is decoding conventional large power information.



Fig.3 Comparison of BER between Conventional SIC and Proposed SM decoding scheme

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