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, as IoT is applied to various fields, there is a need for research on high-reliability communication systems. In the IoT communication system, it is difficult to install a plurality of antennas in order to obtain a diversity effect in a low-cost small device. Therefore, cooperative communication technique obtaining a space diversity effect is a proper alternative.[1]-[4] AF, DF and CF is considered in a cooperative network system, but only DF is focused on in this paper

In previous SM scheme, multi users collaborate to use SM for the information of the partner user so that saving resources.[5] Also, It is proposed that source node and relay node, assuming a hoped relay system, incrementally SM of each node in a hooped relay communication system.[6] In the previous works, SIC decoding can be applied depending on the information bit having a large power ratio. In this paper, a method of independently decoding information of each node is introduced. This solves the bottleneck of the existing SM scheme.

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 byand , 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 betweenand 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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