Adaptive Cooperative Communication Method in the Hierarchical Modulation with Reed Solomon Coding

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Abstract. To overcome limitations of the mobile devices, the cooperative communication has been focused. Cooperative communication has a lot of methods. The decode-and-forward(DF) method is one of methods in cooperative communication. The DF method is able to be more powerful by using channel coding like Reed Solomon(RS) coding. By using the RS code, the destination node can get the information whether error signals can be recovered or not. The proposed method uses the error correct capability of RS coding that is able to overcome the error in wireless communication system.

Keywords: cooperative communication, decode-and-forward, Reed Solomon coding

1 Introduction

In wireless communication, one of problems is fading. It causes power decline in received signals. So the destination node has difficulty in determining original signals. Multiple input multiple output(MIMO) is one of solutions to overcome the fading. But mobile devices have some limitations like size and power. To apply MIMO to the mobile devices, cooperative communication is the best solution. It is possible to create a virtual antenna array among the spatially distributed nodes through relaying. Amplify-and-forward(AF) and decode-and-forward(DF) are the methods in cooperative communication. The AF method is that the relay node receives a noisy added version of the signal and re-transmits amplified version. The DF method is that each node receives noisy added signals by its appointed partner and decodes them. If the decoding process is successful, each node re-encodes and transmits signals [1]-[3]. The DF method is able to use channel coding. Because of this, the DF method has more powerful decoding process. One of channel codes is Reed-Solomon(RS) codes. RS codes are represented as (n, k) on m-bit sequences where n is the total number of code symbols in the encoded block and k is the number of data symbols being encoded. The symbol

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error correcting capability t is (n-k)/2 [4]. In this paper, a proposed method shows the adaptive result by using the error correcting capability of RS coding with the DF method [5].

2 System Model of the Proposed Method

In this section, the system model which is used in the proposed method is shown. Fig. 1 shows the system model used in this paper. In the first time slot, the source

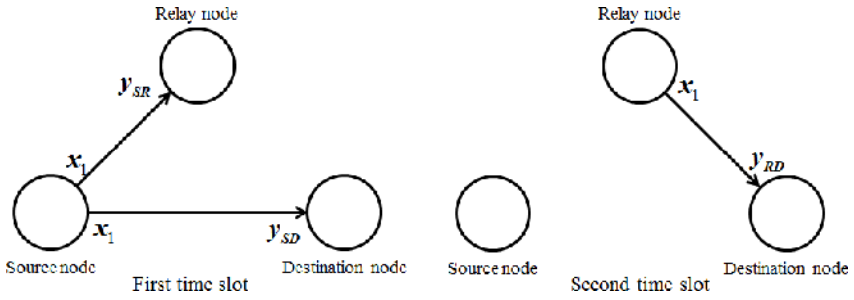

Fig. 1. Basic System Model of the DF.

node encodes the message sequence by using RS code. After RS encoder, the source node encodes the important message by using shortened RS code additionally. After the channel encoder, the source node processes QPSK in 16QAM. Therefore, important message can be demodulated as 16QAM or QPSK. The modulated signals are broadcasted through fading channel. Upon receiving the transmitted signals from the source node, the relay node decodes them and determines whether the relay node re-encodes the decoded signals or not. If the relay node has a successful result of the decoding, the relay node processes by the same way with the source node. The re-encoded signals are equal to the source node at the relay node. Therefore, the source node and the relay node transmit the same structured signals. If the relay node has a failure for the result of the decoding process, the relay node is idle.

In the second time slot, the relay node transmits signals to the destination node. Upon receiving the signals, the destination node uses maximal ratio combining(MRC) about two signals from the source node and the relay node. Eq. (1) and (2) are the process of maximal ratio combining(MRC). This process is presented as,

$$r_{x1} = h_{SD} y_{SD} + h_{RD} y_{RD}, \tag{1}$$

$$\tilde{x}_1 = \frac{r_{x1}}{|h_{SD}|^2 + |h_{RD}|^2} \tag{2}$$

where h^* are the complex conjugated fading channel coefficients. Next, the destination node demodulates as 16QAM. After demodulation, the destination node

sends the signals to RS decoder for checking whether the RS decoder is able to correct the error or not. If the RS decoder is able to correct the error, the signals are decoded by RS decoder. If the RS decoder is not able to correct the error, the destination node re-demodulates the signals as QPSK. After that, the demodulated signals are decoded by shortened RS decoder. In this case, the destination node has an effort to guarantee the reliable communication by recovering the important message.

3 Simulation Result

In this paper, an OFDM system is considered. The RS code and shortened RS code associated with important message are used. Modulation is QPSK in 16QAM. Channel is Rayleigh fading with multipath 7. Total number of subcarriers is 128 and the number of guard subcarriers is 32. All channels are independent and all nodes know channel state information(CSI). It is assumed that the channel state between the source and the relay node is good. Fig. 2 shows a simulation result of the proposed method, QPSK and 16QAM. The proposed method has the similar BER performance of the QPSK in low SNR because the proposed method chooses the demodulation method according to the error correct capability of the RS decoder. Therefore, the destination node is able to get more important message than the destination node which uses the 16QAM demodulation. The proposed method has lower BER performance than QPSK and higher BER performance than 16QAM in high SNR. This shows that the proposed method is able to utilize more bits than the destination node which uses

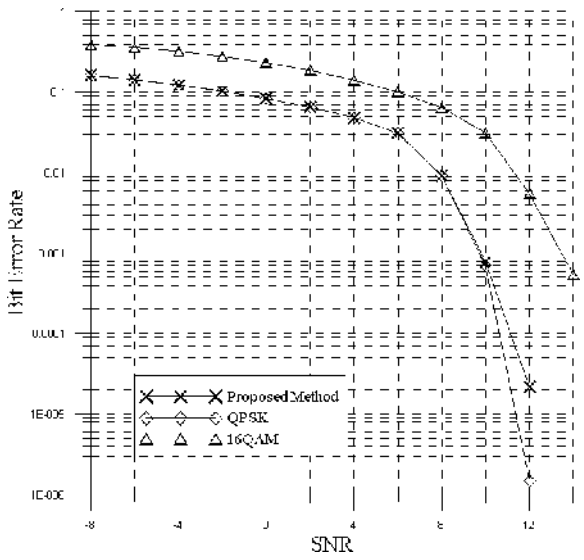

Fig. 2. A Simulation Result of the Proposed Method.

the QPSK demodulation and more reliable communication than the destination node which uses the 16QAM demodulation.

4 Conclusion

To overcome the fading, the DF method is considered. To get more reliable communication, the DF method is combined with channel coding. In this paper, error correct capability of RS code is used. In low SNR, the proposed method focuses on transmitting the important message to guarantee reliable communication. In high SNR, the proposed method focuses on transmitting lots of messages to give high quality data messages. Therefore, the proposed method is able to be used according to the channel environment adaptively due to the error correct capability of the RS code.

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