Enhanced Reliability Using Adaptive Modulation Coding in the Cooperative Communication

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Abstract: - Recently, the wireless communication requires robust and spectrally efficient communication techniques for fading channel. Thus, for reliable communication, this paper proposes the enhanced adaptive modulation coding in the cooperative communication. The proposed scheme uses modulation coding according to the channel state. When the channel can be estimated and this estimate sent back to the transmitter, the transmission scheme can be adapted relative to the channel characteristics. The relay between source and destination uses precoding vector for efficient detection that the receiver recovers the received signal. The simulation results show enhanced performance compared with the conventional cooperative and adaptive modulation coding communication.

Key-Words: - AMC, cooperative communication, pre-coding

1 Introduction

Nowadays, high reliability and throughput of communication are required in the wireless communication. In order to these demand, current system uses orthogonal frequency division multiplexing (OFDM) and multiple input multiple output (MIMO). The symbols are allocated over orthogonal subcarriers in the OFDM system and MIMO system is a valuable way to obtain high reliability and throughput [1][2].

But, the increase of antennas is difficulty in term of size and resource. Thus, cooperative communication system is proposed. The cooperative system is consist of source, relay and destination. The source and relay send same symbol that suffer the different channel to the destination. Antennas of source and relay are used in multiple antenna system. The relay has two operations such as amplify-and-forward (AF) and the decode-and forward (DF). The AF scheme operates the amplified data and noise at the relay. Then, the destination decides estimated data. The DF scheme operates the decoded data and this scheme is possible to remove the added noise between source and relay[3][4].

The diversity techniques are used to mitigate degradation in the error performance due to unstable wireless fading channels. The probability that multiple statistically independent fading channels simultaneously experience deep fading is very low. There are various ways of realizing diversity gain.

The space diversity sufficiently separated multiple antenna are used to implement independent wireless channels. The time diversity is repeatedly at sufficiently separated time instances. The Frequency diversity is repeatedly transmitted at sufficiently separated frequency bands. The angle diversity that multiple receive antennas with different directivity are used to receive the same information –bearing signal at different angles. In time diversity, data is transmitted over multiple time slots. In frequency diversity, the same data is transmitted at multiple spectral bands to achieve diversity gain. The time and frequency diversity require additional time and frequency resource. But space diversity do not require any additional time or frequency resource. The proposed scheme uses the diversity techniques of space, time and frequency.

This paper is organized as follows, the system model show adaptive modulation using pre-coding vector in cooperative system. The section 3 and 4 explain the concept of cooperative communication and AMC. The proposed scheme is explained in the section 4 and the section 5 shows the simulation results of the proposed and the conventional scheme. The conclusion is mentioned in section 6.

2 System Model

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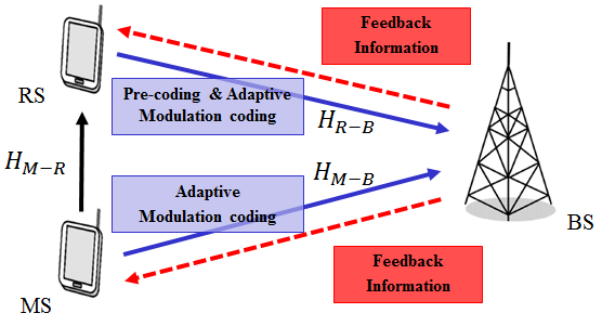

Fig.1 System model of proposed adaptive cooperative transmission scheme

The system model of the proposed scheme is shown in the Fig.1. The system model is consist of relay station (RS), mobile station (MS) and base station (BS). The channel between RS and MS is H_{M-R}. The channel between RS and BS is H_{R-B} and between MS and BS is H_{M-B}. The BS sends the feedback information of channel state to the RS and MS.

3 Cooperative Communication

Recently, in a cooperative communication system, each user is assumed to transmitted data as well as act as a cooperative relay for another user. A typical cooperative method can be modeled with two phase in the wireless communication. In phase 1, source sends data to the destination and the data also received by the relay at the time. In phase 2, the relay can help the source by forwarding or retransmitting the data to the destination.

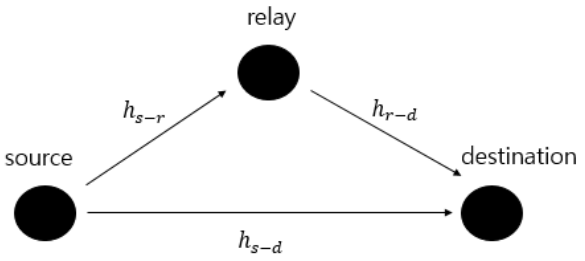

Fig.2 System model of cooperative communication

Fig.2 shows a general of cooperative communication system. The cooperative system is consist of source, relay and destination. The h_{s-r} is a channel between source and relay and the h_{s-d} is a channel between source and destination. The h_{r-d} is a channel between relay and destination. In phase 1, the source broadcasts data to the both destination and relay. The received signals are as follows,

$$\begin{aligned} Y_{s-d} &= \sqrt{P}h_{s-d}x + n \\ Y_{s-r} &= \sqrt{P}h_{s-r}x + n \end{aligned} . \quad (1)$$

P is transmission power at the source and n is the additive white Gaussian noise (AWGN). The x is the data. In phase 2, the relay forwards a processed version of the source's signal to the destination, and this can be modeled as

$$Y_{r-d} = h_{r-d}Q(y_{s-r}) + n, \quad (2)$$

where the function $Q(\bullet)$ is AF or DF.

4 AMC

Adaptive transmission requires exact channel estimates at the receiver and a reliable feedback information between the receiver and transmitter. Adaptive modulation coding (AMC) have offered an alternative link adaptation method that promises to raise the overall system capacity. AMC provides the flexibility to match the modulation-coding scheme to the average channel conditions for each user. With AMC, the power of the transmitted signal is held constant over a frame interval, and the modulation and coding format is changed to match the current received signal quality or channel conditions.

The implementation of AMC has difficult problems. First, AMC is sensitive to measurement error and delay. In order to select the proper modulation, the system should be aware of the channel state. Errors in the channel state cause the system to select the wrong data rate and either transmit at too high a power, wasting system capacity, or too low a power, raising the block error rate. Delay in reporting channel measurements also reduces the reliability of the channel state estimate due to the constantly variety mobile channel. Furthermore changes in the interference add to the measurement errors. Hybrid ARQ (HARQ) enables the implementation of AMC by reducing the number of required MCS levels and the sensitivity to measurement error and traffic fluctuations.

5 Proposed Scheme

This section introduces an adaptive modulation using pre-coding in cooperative communication. The proposed scheme acquires high reliability and data rate based on channel state. RS and MS should

use same modulation scheme in order to diversity gain. Because adaptive modulation method according to H_{M-B} is not suitable for channel through signal of RS. Also, adaptive modulation method according to H_{R-B} is not suitable for channel through signal of MS. Thus, the proposed scheme apply pre-coding at RS in order to diversity gain.

The process of adaptive modulation scheme divided into four steps. The step 1: MS broadcasts the signal to the RS and BS. The step 2: RS uses AF or DF for the reliability of transmitted signal and sends modified signal to the BS. The step 3: BS knows the channel state of RS, BS and MS through header of received signal and BS sends feedback information of channel state between RS and BS to the RS. The step 4: RS sends the signal with pre-coding vector to the BS. The pre-coding vector G is as follows,

$$G = \frac{H_{M-B}}{H_{R-B}}. \tag{3}$$

Finally, the received signal is as follows,

$$Y_{BS} = XH_{M-B} + XH_{R-B}G + N, \tag{4}$$

where X is transmission signal and the H_{R-B} is a channel between RS and BS. The H_{M-B} is a channel between MS and BS. The G is pre-coding vector and N is the AWGN.

The proposed scheme is divided into four case according to modulation classification. The case 1 consist of binary phase shift keying (BPSK) and quadrature phase shift keying (QPSK). The case 2 consist of QPSK and 16 quadrature amplitude modulation. The case 3 consist of 16 QAM and 64 QAM. Finally, the case 4 consist of BPSK, QPSK, 16QAM and 64QAM. The proposed scheme adaptive uses the cases according to the channel state of good or poor. Table 1 shows a configuration of cases of the estimated channel value.

Table 1 modulation case of channel state

Channel value	Cases	Classification modulation
0.4 or less	1	BPSK, QPSK
0.4 ~ 0.8	2	QPSK, 16QAM
Close to 0.6	3	16QAM, 64QAM
1 or more	4	BPSK, QPSK, 16QAM, 64QAM

The proposed scheme adaptive uses the modulation according to the estimated channel value. Because when channel state is good, high modulation order is used thus, total throughput is increased. Also when the channel state is poor, lower modulation order like case 1 is used thus, the reliability of system is increased. Therefore, the performance of proposed system is improved.

5 Simulation Result

This section shows the simulation results of the proposed scheme and the conventional scheme using AMC in the cooperative system and the cooperative communication.

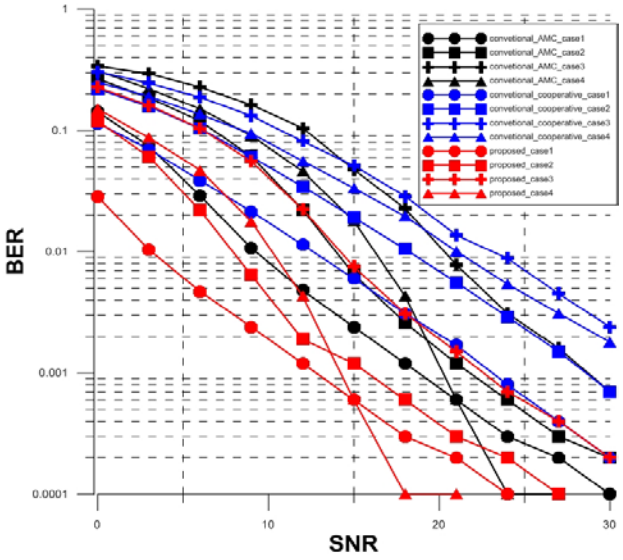

Fig 3 BER performance of the proposed scheme compared with the conventional scheme

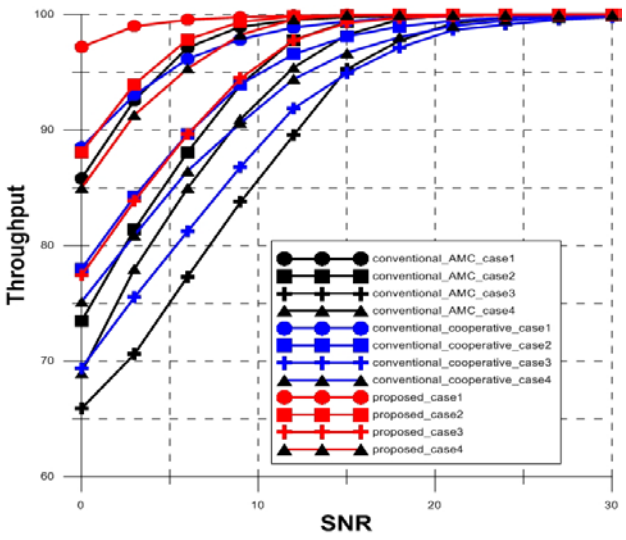

Fig.4 Throughput of the proposed scheme compared with the conventional scheme

The simulation result are based on the OFDM and parameters are as follows, the number of the sub-carrier 256 and the cyclic prefix is 64. A 7 path Rayleigh fading channel is considered. Fig.3 shows the performance of adaptive transmission with AMC and pre-coding compared with the conventional scheme. The proposed scheme has better performance of about 6dB SNR gain. Fig.4 shows the throughput of the proposed scheme. Because the proposed scheme conducts adaptive modulation in accordance with channel state. This scheme expresses efficiency.

6 Conclusion

This paper proposes the adaptive transmission with AMC and pre-coding in the cooperative communication. The conventional scheme that only uses AMC or cooperative transmission has limit of performance but the proposed scheme solves the these problem. Additional RS conducts the efficient detection with pre-coding according to channel state. The simulation results show enhanced performance in the wireless communication.

Acknowledgment

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