Performance Analysis of the Combined AMC-MIMO Systems using MCS Level Selection Technique

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Abstract: In this paper, we propose and observe a system that adopts Independent MCS (Modulation and Coding Scheme) level for each layer in the combined AMC-V-BLAST (Adaptive Modulation and Coding-Vertical-Bell-lab Layered Space-Time) system. Also, comparing with the combined system using Common MCS level, we observe how much throughput performance is improved. As a result of simulation, Independent MCS level case adapts modulation and coding scheme for maximum throughput to each channel condition in separate layer, resulting in improved throughput compared to Common MCS level case. Especially, the results show that the combined AMC-V-BLAST system with Independent MCS level achieves a gain of 700kbps in 7~9dB SNR (Signal-to-Noise Ratio) range.

Key-Words: AMC, V-BLAST, MIMO, MCS

1. Introduction

In the next generation mobile communication systems, the data throughput performance improvement will be very hot issue. In order to fulfill the need for ultra-high speed service, active researches about multiple input multiple output (MIMO) that uses multiple transmit and receive antennas have been in progress. Generally in MIMO systems, the main schemes considered are the MIMO diversity scheme and the MIMO multiplexing scheme[1][2][3].

In order to improve throughput performance, together with MIMO system, Adaptive Modulation and Coding (AMC) has drawn much attention in the field of the next generation mobile communication systems[4][5]. The AMC scheme adapts coding rate and modulation scheme to channel condition, resulting in improved throughput and guarantees transmission quality. Consequently, the combination of MIMO system and AMC could be the solution for improved throughput performance.

In this paper, we are going to show the performance analysis of the AMC scheme with MIMO system using MCS (Modulation and Coding Scheme) level selection technique for simulation and will analyze the consideration factors during the system implementation. As the scheme of MIMO system that is combined with AMC, considering the complexity, we will select V-BLAST (Vertical-Bell-lab Layered Space-Time) [6][7][8][9][10].

The remainder of this paper is organized as follows. In Sect. 2, we will show the transmitter and receiver structure of both combined AMC-MIMO system with Common MCS and combined AMC-MIMO system with Independent MCS, then will analyze the considerable factors for system implementation. In Sect. 3, the performance of each system is verified by computer simulation and the AMC-MIMO combined system using MCS level selection technique is analyzed and compared. Finally, conclusions are drawn in Sect. 4.

2. The combined AMC-MIMO system using MCS level selected technique

The system configurations of the combined AMC-MIMO systems with MCS level selection technique are shown in this section. In addition, some considerable factors for the proposed system are discussed.

2.1 The combined AMC-MIMO system using Common MCS level

Fig. 1. shows transmit and receive structure of the combined AMC - V-BLAST system. The information bits are transmitted using LST (Layered Space-Time) of V-BLAST after channel encoding, interleaving and modulation of AMC. Received signal is decoded by V-BLAST procedure. This procedure consists of repetition structure of ordering, nulling, slicing and canceling.

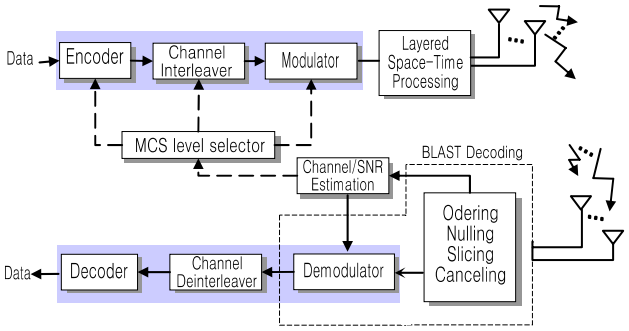

Fig. 1 Transmitter and receiver structure of the combined AMC - V-BLAST system

When we apply modulation and channel coding technique using Common MCS level, each transmit antenna has different SNR. Therefore we should consider applying MCS level based on which antenna's SNR.

In this paper, minimum SNR threshold is applied to our implemented system. In case of applying the maximum SNR or the average SNR to the threshold, even poor channel layer selects MCS level that has high order modulation and high code rate. This leads to an increased error probability and a degraded total throughput performance.

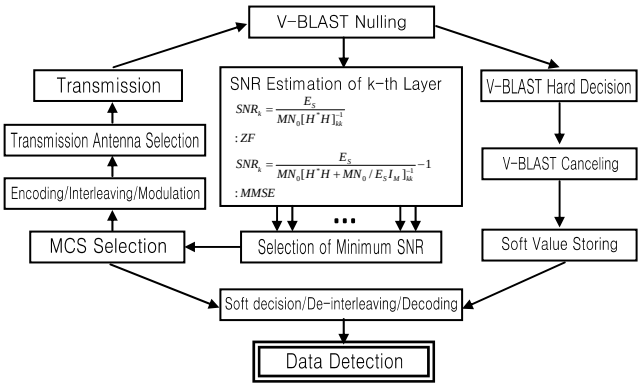

Fig. 2 The combined AMC-V-BLAST system process of operation

Fig. 2. shows operation process of the combined AMC-V-BLAST system. In this part, the variation of the conventional V-BLAST structure occurs since Turbo decoding procedure with the combined AMC-V-BLAST was considered. That is, instead of the hard decision values, the soft decision values are inputted to decoding stage for Turbo decoding.

2.2 The combined AMC-MIMO system using Independent MCS level

Considering their complexity, the combined AMC-MIMO systems in Sect. 2.1 used Common MCS level to all layers such as transmit antenna. In this section, the structure of system that applied Independent MCS level on each layers is proposed and performance of the proposed system is examined. Also compared to the performance using Common MCS level, how much throughput improvement will be investigated. Next, we will verify how the diversity can affect to the difference of performance between two MCS level selection technique.

Fig. 3. showed the example structure of the combined 2X2 AMC-V-BLAST system using independent MCS level. The difference with the combined AMC-V-BLAST system in Sect. 2.1 is that there are each process of coding, interleaving, modulation of the transmitter and each process of de-modulation, de-interleaving, decoding of the receiver according to each layer. Accordingly, modulation and coding schemes of layer1 and layer2 can be different through the channel condition.

In this structure, the minimum SNR is not necessary to be estimated in contrast with the previous case using Common MCS level since estimated SNR in each transmit antenna is applied separately to MCS level selection of adapted layer. Also because modulation and coding

technique are selected to achieve maximum throughput in the appropriate range to each channel condition, compared to the case of applying Common MCS level, throughput performance is expected to be superior.

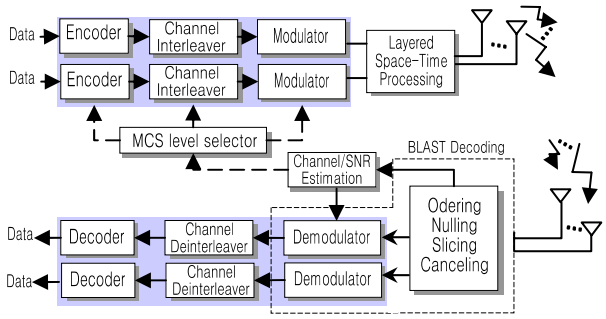

Fig. 3 The Combined AMC-V-BLAST system using Independent MCS level

3. Simulation Results

In this section, we show simulation results and discussion of the throughput performance of the combined AMC-V-BLAST system with MCS level selection technique.

3.1 MCS level and simulation parameter

Table 1 and 2 show the MCS level selection thresholds and simulation parameters, respectively. The simulation parameters in Table 1 are established based on the 1X EV-DO Standard[11].

Table.1 MCS level

MCS level	Date Rate (kbps)	Number of bits per frame	Code rate	Modulation
1	614.4	1024	1/3	QPSK
2	1228.8	2048	2/3	QPSK
3	1843.2	3072	2/3	8PSK
4	2457.6	4096	2/3	16QAM

Table.2 Simulation parameters

Parameter	Value
Bandwidth	1.2288MHz
Slot length	1.67msec
Modulation	QPSK, 8PSK, 16QAM
Code rate	1/2, 2/3
Channel coding	Turbo coding (Number of iterative decoding : 4)
Number of Tx. antennas	1, 2, 4
Number of path	1
Channel	Flat Rayleigh fading

There are many references in the selection of the MCS level selection threshold. As an example, we can select the threshold to satisfy required BER (Bit Error Rate) and required FER (Frame Error Rate). In this paper, since we put emphasis on data transmission rate, we select the threshold that maximizes throughput. Accordingly, each MCS level selection threshold is based on the throughput performance cross point in Fig. 4. MCS level selection thresholds decided by the former reference are 3.25dB, 8.70dB and 9.55dB, respectively.

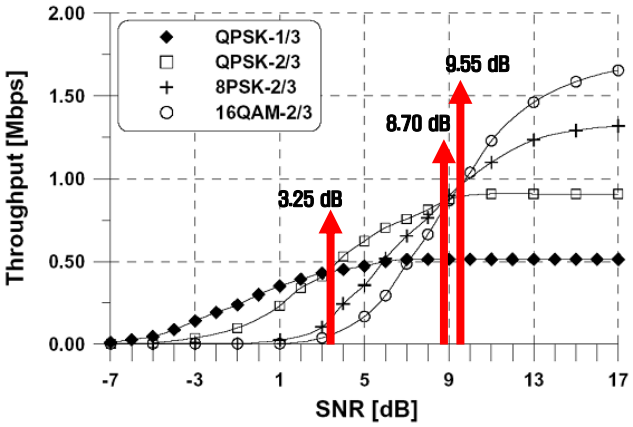

Fig. 4 The throughputs (Mbps) of each MCS level in Rayleigh fading channel

3.2. Performance of the combined AMC-V-BLAST systems using MCS level selection technique

Fig. 5. shows throughput performance of the combined AMC-BLAST system using 2 transmit and 2 receive antennas. In this part, 'Independent MCS' means throughput performance that adopts independent modulation and coding scheme for each layer and 'Common MCS' means throughput performance that adopts common modulation and coding scheme over all. We can see throughput performance improvement between about 7dB~13dB

SNR with adopting the combined AMC-V-BLAST system using Independent MCS level.

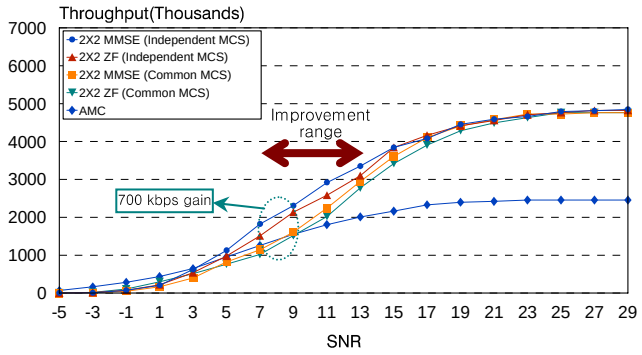

Fig. 5 The throughput performance of the combined 2X2 AMC-V-BLAST system

Especially, the combined 2x2 MMSE AMC-V-BLAST system between 7~9dB range shows that the throughput difference depending on MCS level selection technique is represented by about 700kbps.

Fig. 6. depicts the throughput performance of the combined AMC-V-BLAST system using MMSE nulling technique in case of applying receive diversity. It is verified that the difference of throughput between Independent MCS level system and Common MCS level system in 7dB~9dB SNR is about 350kbps more or less.

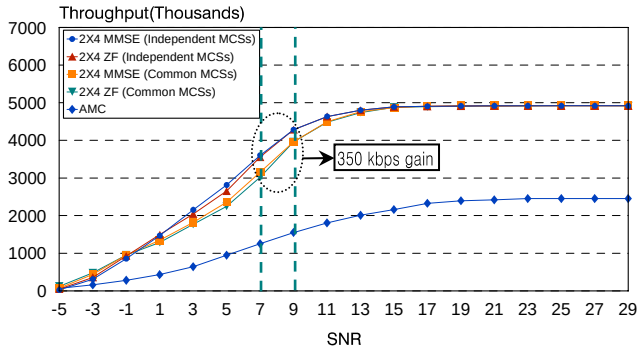

Fig. 6 The throughput performance of the combined AMC-V-BLAST system applying receive diversity

As a result of the simulation, in the combined AMC-V-BLAST system, Independent MCS level selection technique has higher throughput gain than Common MCS level technique in case of not applying diversity scheme.

However, in case of applying diversity scheme, throughput performance difference according to two MCS level selection technique tends to be decreased due to received SNR improvement.

4. Conclusion

In this paper, in order to improve throughput performance in downlink, we implemented the combined AMC-MIMO system using MCS level selection technique, considered and compared the performance of the combined system. As a result of simulation, by applying AMC and V-BLAST scheme, it is shown that the maximum throughput was increased but the rate of throughput improvement was little in low SNR. The results prove that as SNR increased, the characteristics of V-BLAST appeared regularly and range of throughput became increased.
We have considered the technique that applies Independent MCS level for each layer in the transmitter and the scheme that applies the Common MCS level for all layers when it comes to combing AMC and MIMO as well. As a result of implementation on performance comparison of the combined AMC-V-BLAST system about both the Independent MCS level technique and the Common MCS level technique, Independent MCS level selection technique showed superior performance in the combined AMC-V-BLAST system not applied diversity scheme. However, as a transmit diversity is applied, the difference of performance tends to be decreased.

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