A Dual-polarized MIMO System based on DVB-T2 for UHDTV Transmission

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Abstract

Serving a huge data rate of the ultra-high definition television (UHDTV) standard requires an enhancement of the transmission data rate of the conventional digital terrestrial transmission (DTT) systems. In order to improve the data rate, adopting dual-polarized MIMO techniques and higher order modulation schemes has been spotlighted. However, there are only few performance evaluations of the system in literature. In this respect, as one of possible candidates for UHDTV transmission, we implement a dual-polarized MIMO system based on the digital video broadcasting-2nd generation terrestrial (DVB-T2) and investigate its performance with various combinations of parameters.

Keywords: UHDTV, High Order Modulation, Dual-polarized MIMO, DVB-T2.

1. Introduction

UHDTV broadcasting service is expected to provide very high-resolution videos resulting in a much greater required transmission data rate. For example, the required data rate of the 4K-UHDTV standard may range from 15Mbps to 90Mbps assuming 1/200 video coding performance [1], [4]. Since the conventional DTT system cannot afford such a high data rate, increasing data rate has been one of the major subjects on developing the next generation DTT systems. The dual-polarized MIMO system along with higher order modulation schemes, such as 4096-QAM, have been studied as key techniques for developing the UHDTV DTT system [2].

The receiver performance and the transmission data rate of the dual-polarized MIMO DTT system may vary with the combination of the modulation order and the code rate of the channel coding. In this respect, as one of possible candidates for UHDTV transmission we implement a dual-polarized MIMO DTT system based on the DVB-T2 standard which is known as the most advanced DTT system in terms of the spectral efficiency but does not have any MIMO configuration [3]. Then, we evaluate the reception performance of the implemented system according to the various combinations of the parameters, i.e., the modulation orders and the channel code rates.

2. System model

The block diagram of the dual-polarized MIMO DVB-T2 system is described in Fig. 1. Two source data streams are encoded by each LDPC encoder and the codewords are interleaved by the bit mapper. The interleaved bits are mapped into the QAM symbols. After the QAM symbol is interleaved to combat the burst noise, it is OFDM modulated to be transmitted over a MIMO channel via dual-polarized antennas. At the receiver side, the soft MMSE demapper is employed. The soft MMSE demapper firstly decouples the cross antenna interference and channel induced interference, secondly generates LLR values to be fed into the bit demapper and the LDPC decoder.

The transmission data rates of the system corresponding to the modulation orders and the code rates are given in Table 1. Dealing with higher required data rate of 4K-UHDTV, we focus on transmission data rate of the MIMO DVB-T2 system higher than 70 Mbps. It is noted that some combinations of code rate...
and modulation order may result in the same transmission data rates. For example, the transmission data rate of 72.0 Mbps can be obtained with 2 different combinations. Letting the pair of \((M, C)\) denote the combinations of the modulation order and the code rate, the corresponding two pairs are \((8, 5/6)\) and \((10, 2/3)\). Each of the pairs shows the different bit-error-rate (BER) performance after the channel decoding since the error protection capability of each one is not the same. The code rate and the modulation order, therefore, are very important for the reception performance as well as the achievable transmission data rate.

3. Simulation results

In order to analyze the reception performance of the system, we performed computer simulations and its simulation parameters are specified in Table 2. In Fig. 2, the LDPC coded BER performances corresponding to the transmission data rate of 72.0 Mbps and 86.4 Mbps are colored in red and blue, respectively. For the data rate of 72.0 Mbps cases, the case of \((10, 2/3)\) outperforms the case of \((8, 5/6)\) at high SNR environment. In these cases, the coded BER performance with smaller LDPC code rate and denser constellation can provide smaller reception performance. Especially, the latter case outperforms the former one by 0.7 dB SNR at \(10^{-4}\) BER. On the other hand, for the transmission rate of 86.4 Mbps, the case of \((10, 4/5)\) outperforms the case of \((12, 2/3)\) by 0.2 dB SNR at \(10^{-4}\) BER. Contrary to the previous results, the BER curves show that the sparse constellation case of \((10, 4/5)\) may provide better reception performance than the dense case.

4. Conclusion

In this paper, we provided BER performance comparisons of a dual-polarized MIMO DVB-T2 system with different combinations of LDPC code rates and modulation orders. With the same transmission data rate achieved, the performance of the MIMO system may be affected by both of the parameters. It is expected that these analyses may be used as a preliminary knowledge to the future DTT system and standardization and implementation.

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References