A Study on the Low-Priority Symbol Transmission in AT-DMB System

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ABSTRACT

Since the research of advanced terrestrial digital multimedia broadcasting system is still in progress, and in our previous paper, in which we introduced how to combine one conventional transmitted symbol with two additional bits to form a new symbol transmission, the bit error performance of LP bits is not realizable, because even we implemented the turbo code to protect the LP bits transmission, to obtain a certain good bit error probability, the value of E_b/N_0 cost highly. In this paper, we modified the composition of low-priority symbol and high-priority symbol, and through the system presented in previous paper we get a better simulation result of the LP symbol transmission.

Keywords

T-DMB Hierarchical modulation, Low-Priority symbol, Turbo Codec

Ⅰ. Introduction

Korean T-DMB(Terrestrial Digital Multimedia Broadcasting) derived from the European DAB (digital audio broadcasting) criterion, which is well known as Eureka-147 [1], and T-DMB only adopts the transmission mode 1 in Eureka-147. From December 1, 2005 to nowadays, Korean T-DMB systems have been well deployed almost in the entire country. In 2007, the development of advanced T-DMB system, which is supposed to obtain higher data transmission rate without any effect to the existed systems, was placed on the agenda. To achieve such a goal, hierarchical modulation [2] has been considered as a good multiplexer. In [3], we introduced how to insert the hierarchical modulation into the conventional T-DMB system, and how to implement the turbo code to protect the LP data transmission. However, the performance results in [3] are not well-pleasing, which is that we need pay large energy in transmission, to obtain acceptable bit error ratio.

In this paper, we present a way to use one additional bit to combine with the original symbol in the existed T-DMB transmission, to reduce the energy requirement. In section 2, we can see how to realize one LP bits combining to one HP symbol. Section 3 shows the simulation model and the corresponding results. Section4 is the conclusion.

Ⅱ. Modified Constellation of Hierarchical Modulation

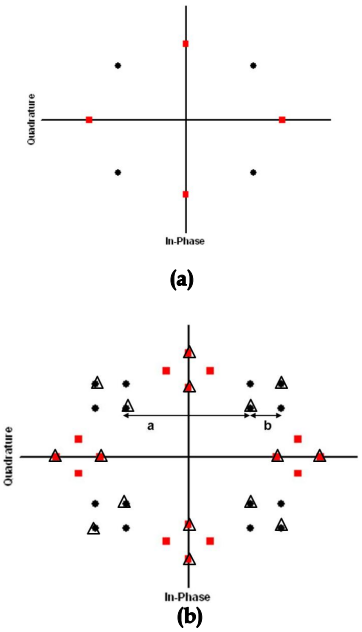


Fig 1. (a) π/4-DQPSK Constellation used in the conventional T-DMB system, (b) Hierarchical Constellation used in advanced T-DMB system

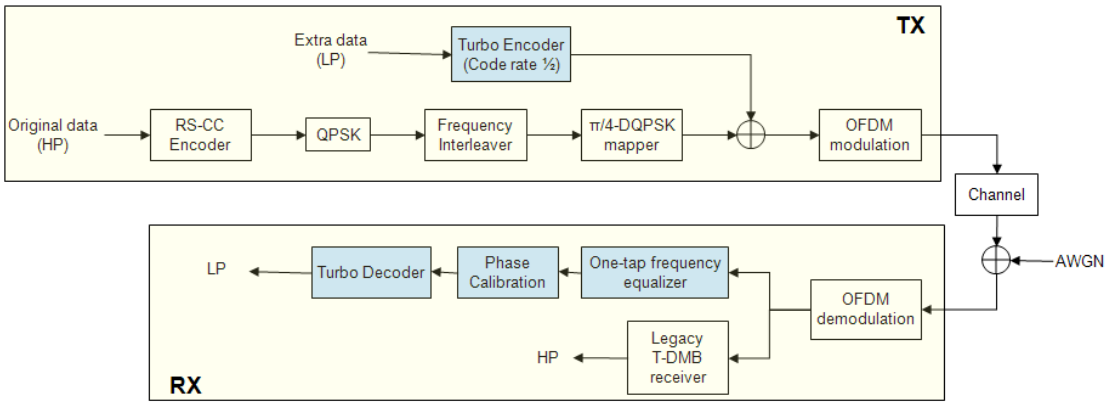


Fig 2. Block diagram of the T-DMB system with hierarchical mode

From [2], we can see that the symbols in hierarchical modulation constellation can be divided into two types: high-prority (HP) symbols and low-prority (LP) symbols, and they have been defined for carrying the original data bits and the additional data, respectively. Fig 1 shows two constellations that are used in conventional T-DMB system and advanced T-DMB system. With two additional bits as a LP symbol, each mixed symbol should locate in the constellation of fig 1(b), and all symbols in fig 1(b) mean the possible locations of the new symbol. However, the simulation results in [3], which are shown in fig 4, are not acceptable, because, to obtain a better error probability 10^{-4}, we should provide E_b/N_0 more than 32dB under time-invariance Rayleigh channel, and even under AWGN channel, we should spend at least 15dB. They could cost such much in implementing new services. To solve this costing problem, we combine one HP symbol with one LP bit in this paper, and the location of a new symbol should map to the one with triangle in fig 1(b). From the fig 1(b), we can see that the definition of hierarchy parameter α is same, as is given by:

$$\alpha = \frac{a}{b} \qquad (1)$$

since we define the hierarchy parameter in the same way, the comparison of the difference in energy consuming between the simulation result here and the one in [3] is feasible.

III. Simulation Model and Simulation

In this paper, we use the simulation model as same as the one shown in [3], here, it has been re-drawn in fig 2. Since we also use the hierarchy parameter α with the same definition, and the effect from the LP data on to the HP data would be same, then we can still select the value α=4 to achieve the compatibility.

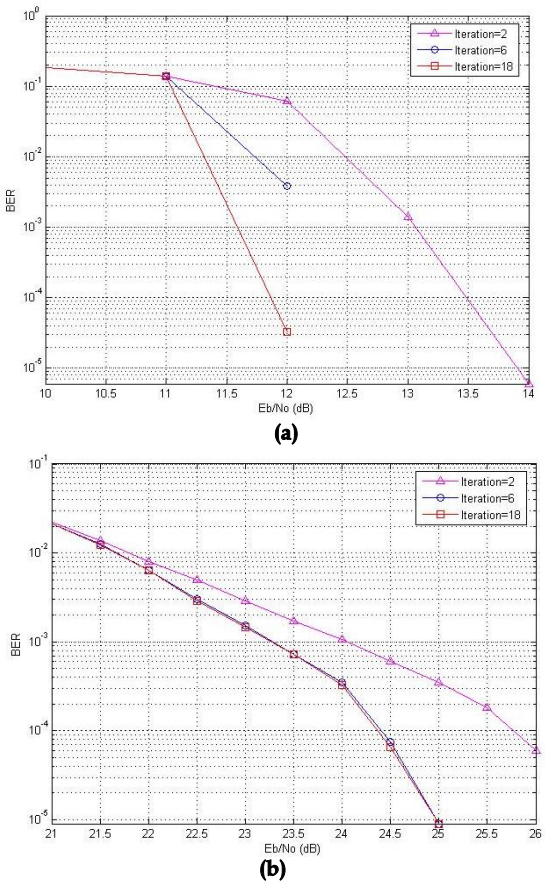
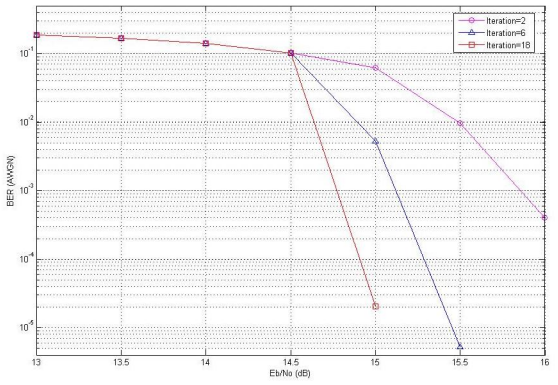


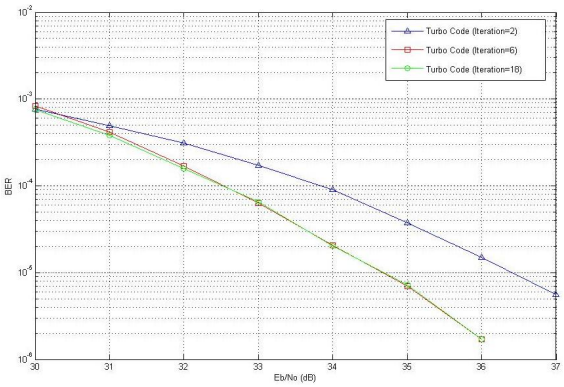
Fig 3. Error performance of LP data (1 LP bits combined with one HP symbo) with different turbo code iteration levels (a)under AWGN channel, (b) under time-variance Rayleigh channel.

In fig 2, the turbo coding algorithm [4] is also as same as the one design in [3], which means all parameters in turbo code is remained same. The deferences in fig 2 is the way of hierarchical modulation and the LP data transmission rate. Fig 3 shows the simulation results corresponding to the different iteration-levels, fig 3(a) shows the error performance got under the AWGN channel, and (b) shows the one got under the time-invariance Rayleigh channel.

Comparing the simulation results with the ones in [3], we can get that, to obtain the $P_B = 10^{-4}$, we could save more than 3dB by using the iteration=18, under AWGN channel, and nearly 10dB by using the same iteration-level, under the time-invariance AWGN channel.



(a)



(b)

Fig 4. Error performance of LP data (2 LP bits combined with one HP symbo) with different turbo code iteration levels (a)under AWGN channel, (b) under time-variance Rayleigh channel.

Ⅳ. Conclusion

The simulation results show us the cost of energy can be reduced by adding only one LP bit to the conventional HP symbol. However, from the simulation, we also can point out that, to achieve this target, the LP data transmission rate should be decreased.

Reference

[1] ETSI EN 300 401 v1.3.3 (2001-05), "Radio Broadcasting Systems; Digital Audio Broadcasting (DAB) to mobile, portable and fixed receivers".

[2] ETSI TR 102 377 v1.2.1 (2005-11), "Digital Video Broadcasting (DVB); DVB-H Implementation Guidelines".

[3] Li Erke, Sunggaun Kim, Hanjong Kim, "Turbo Code for Low-Priority Symbol Transmission In Advanced Terrestrial Digital Multimedia Broadcasting System", Proceedings of Microwave and radio wave propagation conference, Soul, Korea, May, 2008.

[4] Berrou, C., Glavieux, A., and Thitimajshima, P. "Near Shannon Limit Error-Correcting Coding and Decoding: Turbo Codes", IEEE Proceedings of the Int.conf. on Communications, Geneva, Switzerland, May 1993(ICC'93), pp.1064-1070.