플랫 페이딩 채널에서의 적응 채널 부호화 기술

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Adaptive Channel Coding for Flat Fading Channel

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Abstract

This paper examines an adaptive coding scheme for flat fading channels to maximize the average code rate of a coded system. The proposed adaptation technique is employed by using the required free distance of a rate compatible code depending on the channel realization. First, the system will calculate the required free distance based on the instantaneous channel gain. Based on this channel gain we will select a set of convolution code to optimize the code rate with a certain performance requirement. Simulation results show that our proposal can achieve a higher code rate.

I. Introduction

Adaptive transmission is a promising technique to increase the throughput over flat fading channel. There are different forms of adaptation technique like; adaptive transmission power, adaptive modulation, adaptive coding rate etc. have been discussed in literature [1]-[2] and the references herein. In [2] adapting modulation and coding using trellis coded modulation has been investigate. However, in some applications adaptive power and modulation scheme may not be applicable.

In such scenario where transmit power and modulation are fixed an independent adaptive coding is efficient to AWGN performance. This paper investigates the adaptive coding to improve the coding rate with implementation issues considering fixed transmit power and modulation scheme. A variable rate convolutional code from a base ½ rate code with wide range of free distances has been constructed in [3] utilizing the puncturing and code combining technique. We utilize these codes for adaptive coding scheme where free distance of code is considered as a performance parameter.

II. Code Construction

To implement the adaptive coding with convolutional code, we need to construct a variable rate code with simple encoder and decoder. In literature there are two type of rate compatible convolutional code: rate compatible puncture convolutional (RCPC) code that construct a high rate code from a basic ½ rate code and rate compatible repetition convolutional (RCRC) code that construct a low rate code from a basic ½ rate code. Combining these two type of code a Rate Compatible Convolutional (RCC) code has been proposed in [3] that constructs a variable rate (from very low to very high rate) convolutional code from a basic ½ rate convolutional code. The table below shows an example of RCC using a ½ rate convolutional code with constraint length 7.

Table 1. RCC codes with different d_{free}

Rate (R)	Perforation/ Repetition matrix	Free distance (d_{free})	Rate (R)	Perforation/ Repetition matrix	Free distance (d_{free})
3/4	1 1 0 1 0 1	5	3/12	2 2 2 2 2 2	20
3/5	1 1 1 1 0 1	7	3/14	3 3 2 2 2 2	22
3/6	1 1 1 1 1 1	10	3/16	3 3 2 3 2 3	25
3/8	2 2 1 1 1 1	12	3/18	3 3 3 3 3 3	30
3/10	2 2 1 2 1 2	15	3/24	4 4 4 4 4 4	40

Ⅲ. Addaptive Channel Coding

In our analysis we consider the Viterbi's upper bound on BER [4] that can be given as,

$$P_b \le \sum_{d=d_{free}}^{\infty} c_d P_d \qquad (1)$$

where, d_{free} is the free distance of the code, C_d is so called distance spectra on all paths with $d \ge d_{free}$ and $P_d = Q(\sqrt{2d\gamma_c})$ is the pairwise error probability at distance d. Considering only one term of summation and Q function as exponent, we can approximate eqn (1) as,

$$P_b \approx C_{d_{free}} \exp(-d_{free}\gamma_c) \qquad (2)$$

This approximation is very close to the exact upper bound of eqn (1). Using (2) we can easily find the instantaneous value of d_{free} for frame i as,

$$d_{free}(i) \approx \frac{-1}{\gamma_c(i)} ln\left(\frac{P_b}{C_{d_{free}}}\right) \qquad (3)$$

Using the instantaneous free distance of equation (3) we can chose a code from Table 1 that fulfills the requirement of target BER.

Ⅳ. Simulation Result

For our simulation we choose a set of variable rate RCC code given in Table 1. Fig. 2 shows the average code rate of our proposed protocol with average received SNR. Adaptive coding technique proposed here, shows a significant amount of code rate improvement with SNR. In this simulation we use the same code set as Table 1 where the code rate is varied from 3/4 to 1/8. At low SNR the average code rate is very close to 0.125 which is the minimum rate of the system and at high SNR it is close to 0.75 which is the maximum achievable rate of the system. The maximum rate limit causes a restricts throughput improvement at high SNR region than low SNR region.

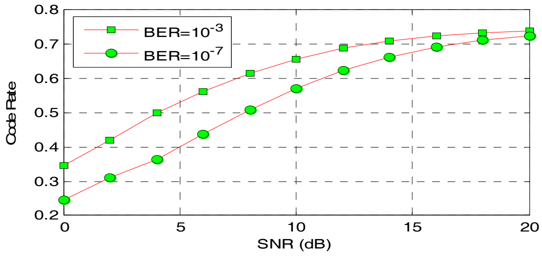

Fig. 2. Average code rate achieved by adaptive coding

Ⅴ. Conclusion

We develop a novel adaptive channel coding technique for fading channel with rate compatible convolutional code. We have shown that our proposal can achieve a very high code rate under an instantaneous BER requirement.

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References

[1] A. J. Goldsmith and P. Varaiya, "Capacity of fading channels with channel side information," IEEE Trans. Inform. Theory, vol. 43, Nov. 1997.

[2] A. J. Goldsmith and S. Chua, "Adaptive coded modulation for fading channels," IEEE Trans. Commun., vol. 46, May 1998.

[3] S. Kallel, D. Haccoun, "Generalized type-II hybrid ARQ scheme using punctured convolutional coding" IEEE Trans on Comm, vol. 38, Issue 11, Nov. 1990.

[4] A. Viterbi and J.K. Omura, "Principles of Digital Communication and Coding", McGraw-Hill, 1979.