Adaptive channel coding scheme for QoS guarantees

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Introduction

- Due to the advent of software defined radio, the availability of flexible and reconfigurable transceivers has renewed interest in adaptive techniques.

- To maximize the use of wireless channel resources, it is important that the design of wireless multimedia communication systems has to consider the variation in channel condition fluctuation and QoS (Quality of Service) requirements of applications such as voice, data, video and etc.

- One of the methods fully utilizing the channel capacity is the adaptation technique.

- This paper focuses on an adaptive channel coding scheme and proposes new channel quality metric.
System Model

Source

Channel Encoder 1

Channel Encoder 2

Channel Encoder 3

Modulator

Feedback information

Transmitter

Soft output Demodulator

Buffer

Channel Decoder 1

Channel Decoder 2

Channel Decoder 3

Re-encoder 1

Re-encoder 2

Re-encoder 3

Channel quality metric

Feedback information

Receiver
Overview of channel quality metric (1)

- For the use of effective channel resources, it is important to measure the channel quality.

- The points to be considered, when designing the channel quality metric, are a variety of wireless channel, measurement period, complexity, particular signal for measurement and so on.

- So far, there have been some methods such as measuring average SNR (Signal to Noise Ratio) and Euclidean distance at demodulator, counting PER (Packet Error Rate) at link layer, SINR at the equalizer’s output, and etc.
Overview of channel quality metric (2)

- In TDMA system, channel quality is estimated at the receiver and the information is provided to the transmitter through appropriately defined messages.

- Metric that have been proposed for estimating channel quality are as follow
  - Frame error rate
  - Mean and standard deviation of symbol error rate or BER (Counting error)
  - Average SINR, which may be computed using the minimum Euclidean distance metric derived from a Viterbi decoder or alternatively computed using subspace projection techniques.

Design of channel quality metric

- Demodulated signals represent points on the signal constellation. These are distorted by channel noises and represent a channel condition.

- When varying AWGN channel, variance $\sigma_0^2$ and mean change. However mean has a small change because it is revised at demodulator. Therefore primary channel quality metric is the variance $\sigma_0^2$.

- If channel condition is good (Eb/No is high), they increase. If channel condition is bad (Eb/No is low), they decrease.

- Therefore Look-up table of channel quality metric is made by simulation results that channel condition (Eb/No) correlates to variance $\sigma_0^2$. 
Procedure of channel quality metric

1. Re-encoded input
2. Calculate the variance with mapping samples
3. Comparison
4. Mapping
5. Calculation (Variance)
6. Look up Table
7. Feedback Information

4-bit Soft decision input

Mapping for re-encoded input "1"

1110 0101 1000 1100 0010 0110 1011 0000

1110 1000 1100 0110

10 1 1 0 1 0 0
Example (1)

Source → Encoder → Channel → Buffer → Decoder → Re-Encoding

- Code rate = 1/2
- AWGN
- 4bit Soft Decision Input
- (1) Received bit sequence
  - 1010
- (2) Re-encoded bit sequence
  - 10110100
- (3) Comparison and Mapping
  - 1110 1000 1100 0110
- (4) Calculation (Variance)
  - “a”
Example (2)

(1) When channel condition is good.

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<th>0001</th>
<th>0010</th>
<th>0011</th>
<th>0100</th>
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(2) When channel condition is bad

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<th>0001</th>
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</table>

(1) (2)
Adaptive channel coding scheme

- For maintaining the desired BER $= 1e-6$,
- Section is divided as follows.
- Section A (3 ~ 4.5dB) means bad channel condition to use convolution code 1/2.
- Section B (4.5 ~ 5 dB) means not bad channel condition to use convolution code 2/3.
- Section C (5 ~ 6dB) means good channel condition to use convolution code 3/4.
Simulation Results

- Varying AWGN 1, 2, 3, and 4 change Eb/No from 4.5dB to 6dB, 4dB to 6dB, 3.5dB to 6dB, and 3dB to 6dB respectively.
- Adaptive channel coding scheme shows to maintain the desired BER $\approx 1e^{-6}$
Conclusions

- This paper proposes the simple method to know the channel condition and performs a simulation. Through the proposed channel quality metric, adaptive channel coding can maintain the desired BER over varying AWGN channel.
Future works

- This paper showed the results of adaptive channel coding scheme with proposed channel quality metric over AWGN environment. However, the real channel environment is close to the Rayleigh and Rician multi-path fading channel. Therefore, we are planning to apply it over the multi-path fading channel at more complicated wireless systems.
References