Lab Exercise 6

Convolutional Coded Systems with BPSK, 8PSK, 16QAM

(Report submission deadline: May 2, 2012)

1 Goal

In this lab exercise, we will simulate convolutional coded systems using BPSK, 8PSK, and 16QAM modulations. Hard decision decoding is used at the receiver. We will observe the performance gain from the convolutional code by comparing with the results of our previous lab exercises.

2 Hard Decision Decoded Convolutional Coded System

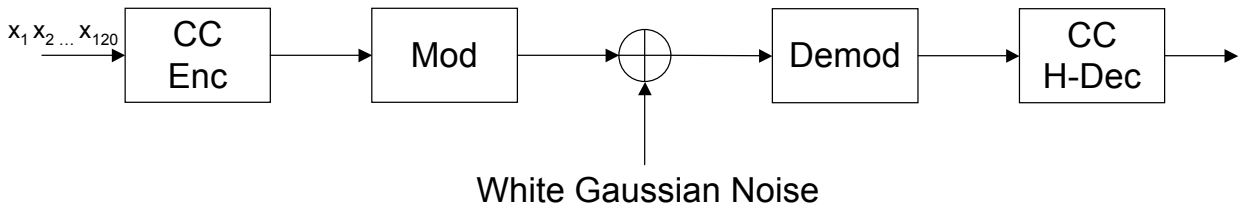

Figure 1: Hard decision decoded convolutional coded system diagram.

The block diagram of the convolutional coded systems to be simulated is shown in Fig. 1. The receiver first demodulates the received signal in to bits and then feeds those to the hard decision decoder. The hard decision decoder is implemented by Viterbi algorithm. You are free to use C/C++, Matlab, or Simulink to simulate the system. However, it is not allowed to use the readily made functions or toolboxes from Matlab and Simulink for convolution or Viterbi decoding. The encoder and the decoder parts have to be written from scratch using very basic functions or toolboxes. Note that to get the optimal performance, you should implement trellis termination in your convolutional code simulation program, i.e. append m zero bits at the end of the input sequence to force the encoder ending at the zero state. You are encouraged to find more details about trellis termination via Google search.

3 Exercises

1. Build your simulation programs for CC ($g_1 = [101]$, $g_2 = [111]$) with BPSK, 8PSK, and 16QAM respectively. Each data packet consists of 120 random bits and thus the codeword length is 240 bits. Plot the BER curves all together on one figure, and the PER curves on another. The curve of each CC/Modulation setup should start from $\frac{E_b}{N_0} = 0$ dB all the way to the $\frac{E_b}{N_0}$ that generates the BER of 10^{-5}. Use the same SNR values for the associated PER curve. You should have no less than 10 simulation points spreading evenly on each curve.

2. Search for simulated or analytical BER/PER versus $\frac{E_b}{N_0}$ curves in books, literature, or internet. Plot those on your corresponding figures to verify the correctness of the simulation results. You should specify where you find those curves in the figure caption. The sources of the curves should be creditable.

3. Compare the simulation results to the results of your previous lab exercises (without channel coding). Comment on the performance gain your get from the convolutional code.

4. Modify your program to simulate the transmissions of Lena's image using convolutional code with BPSK, 8PSK, and 16QAM respectively. Compare the performance of the image transmission under different CC/Modulation setups. Also compare the results to your previous lab exercise (without channel coding) and discuss about the performance difference.

5. Modify your convolutional coded system to simulate the transmissions of the Handel audio clip using convolutional code with BPSK, 8PSK, and 16QAM respectively. Compare the performance of the audio transmission under different CC/Modulation setups. Also compare the results to your previous lab exercise (without channel coding) and discuss about the performance difference.

6. (Optional) Modify your hard decision Viterbi decoder into a soft decision Viterbi decoder for the case of BPSK. Compare the performance of the soft decision decoding to that of the hard decision decoding.

7. (Optional) Build the simulation program (hard decision) for CC: $g_1 = [133], g_2 = [171]$ with BPSK, 8PSK, and 16QAM. Do as many of the above tasks as possible for the CC of memory 6. Compare and comment on the performance difference between the two CC of different memory lengths.

4 Lab Report

There is no format requirements for your lab report. In the report, you should address the results of the exercises mentioned above. You should also include your simulation program in the appendix of the report. Include whatever discussions about the new findings during the lab exercise, or the problems encountered and how are those solved. Do not limit yourself to the exercises specified here. You are highly encouraged to play around with

your simulation program on self-initiated extra lab exercises/discussions. Extra points are usually given by TA when grading those reports.