E9-251: Signal Processing for Data Recording Channels

Project

Rules and Regulations:

- You are welcome to refer to your class notes, reference books and the internet. Do not consult/collaborate with any one except the instructor on any of these problems.
- Turn in a well documented report on your project not exceeding (4-5 pages) excluding the Appendix. Outline the procedure for the computations in detail along with your Matlab/C source code within the Appendix. The Matlab source code <u>must</u> be your own with adequate comments.
- Turn in your report by December 5th 2012.
- Good Luck!

In this project, you will implement the MAP/BCJR algorithm for signal detection. You can implement the algorithm in the probability domain for this purpose since the length of data we will consider here is very small. Alternatively, if you work the algebra in the log-domain, it is highly preferred. The partial response target is $P(z) = 3 + 7z^{-1}$. We shall consider NRZ data $\{-1,1\}$ being filtered through the equivalent ISI channel. White Gaussian noise with variance $\sigma^2 = 0.04$ is added to the received samples during read back.

(a) If the first five received samples
    are $\mathbf{r} = \{3.1452 \quad 3.8823 \quad -3.5634 \quad 9.9727 \quad 4.0228 \}$, obtain the log-likelihood ratios and the hard decisions on the corresponding bits using the BCJR algorithm. Set up the trellis carefully to start and end in the all zero state.
(b) Decode the bits using exhaustive search in the maximum-likelihood sense (brute force search). What are the hard decisions? How does your answer compare with part (a)?
(c) Evaluate the computational complexity of the algorithm used in (a) in terms of the number of multiplications and additions if the length of the received data is 'N' and the ISI memory is 'k'. How does this compare to (b)? (Hint: For (a), you need to compute the computational complexity per trellis stage and scale it by the total number of trellis stages)

NOTE: Software must be well documented with comments for readability. Your report should reflect clarity and understanding on the topic and free of obvious typos (spell check options must help you for this purpose). Well-written work carries 20% of the grade. Use M.S Word or Latex (my personal choice) for this purpose.