Spring 2025 ECE 6521 Error Control Coding Course Project

Assign date: 3/31/2025 Due date: 4/18/2025

In this course project, you will apply the turbo encoder/decoder programs that you have written and the provided 5G LDPC program to implement joint iterative multiple-input multiple-output (MIMO) detection and channel decoding. The MIMO detector you will implement is the optimal maximum a posterior (MAP) detector, and the turbo code is the rate 1/2 (7,5) turbo code. The 5G LDPC code has parameters (2560, 1280). You need to generate simulation curves similar to that of the curve for the QPSK, 2x2 channel as shown in Fig. 6 of the paper "Achieving near-capacity on a multiple-antenna channel" by B. Hochwald and S. Brink. Refer to this paper for the detailed simulation setup except that the length of the information bit sequence is set to be 1280. For each transmitted block (codeword), four (outer) iterations are performed over the MIMO detection loop, and eight (inner) iterations are performed within the turbo decoder. For the LDPC code, set 100 inner iterations per outer iteration of MIMO detection. Please note that since you are using a shorter turbo/LDPC code than that of Hochwald's paper, your bit-error-rate (BER) curve is expected to shift to the right compared to that of Fig. 6. In your simulation figure, please show the BER curves of the turbo code and LDPC code side by side for comparisons. Note that the definition of $E_b/N_0$ follows equation (31) of the paper, given by

$$\frac{E_b}{N_0}(\text{dB}) = \frac{E_s}{N_0}(\text{dB}) + 10\log_{10}\frac{N}{RMM_c}.$$