EE 121: Introduction to Digital Communication Systems

Problem Set for Review Discussion Section

Thu 5/15/2008

1. *Passband Communications*

Let $x_b(t)$ be the complex baseband representation of $x(t)$. Assume $x_b(t)$ is bandlimited to $(-W/2, W/2)$. The signal $s(t)$ is transmitted through an LTI channel with impulse response $h(t)$.

(a) Draw and label a system diagram illustrating the upconversion from inphase and quadrature transmitted signals, $x_I(t)$ and $x_Q(t)$, to $x(t)$, the passing of $x(t)$ through the channel $h(t)$, and the subsequent downconversion of the received signal $y(t)$ back to into inphase and quadrature received signals, $y_I(t)$ and $y_Q(t)$.

(b) Compute an expression for the FT $X(f)$ of $x(t)$ in terms of $X_b(f)$.

(c) Compute an expression for $y_I(t)$ and $y_Q(t)$ in terms of $x_I(t)$ and $x_Q(t)$.

2. *Maximum Likelihood Sequence Detection (MLSD) for Convolution Codes*

Consider the following error correction code. An information sequence $\{b[n]\}$ consisting of i.i.d. equiprobable binary symbols 0 and 1, is transformed into a binary coded sequence $\{x[n]\}$ as follows

$$x[2n] = b[n] \oplus b[n-2] \quad (1)$$
$$x[2n+1] = b[n] \oplus b[n-1] \quad (2)$$

for $n = 0, 1, \ldots,$ where $\oplus$ is addition mod 2. The coded sequence is mapped onto the channel such that the real received sequence is

$$y[n] = \sqrt{E}(2x[n] - 1) + w[n]$$

where $w[n]$ are i.i.d Gaussian random variables with zero mean and variance σ^2.

(a) An example: for $\{b[n]\} = \{0, 1, 1, 0, 0\}$, what is $\{x[n]\}$? What is the length of the coded sequence?

(b) What is the rate of the code?

(c) What is the state vector? How many states are there? Draw a corresponding trellis diagram.

(d) Suppose $E = 1$. Use MLSD to decode $b[0], \ldots, b[4]$ when the received sequence is $\{y[n]\} = \{0.5, -0.5, 1.0, 1.5, 0.5, -1, 1.5, 1, 0.5, 0\}$.