Name: _____ College Number: _____

EE501: An Introduction to the Theory of Statistical Communications

Tuesday, 27 November 2018

Fifth Quiz (optional)

This is a *take home* question. A binary source generates at random one of two messages $\{0, 1\}$ every 1 ms with *a priori* probabilities:

$$\begin{aligned} P(0) &= 0.3 \\ P(1) &= 0.7 \end{aligned}$$

The messages are all statistically independent of each other. The source utilizes a waveform communication system to transmit the messages. The system uses the two orthogonal signals[1]

$$s_0(t) = \begin{cases} 4213\ \sin(2\pi(3\text{ kHz})t) & ;\ 0 \le t \le 1\text{ ms} \\ 0 & ;\ \text{elsewhere} \end{cases}$$

$$s_1(t) = \begin{cases} 4213\ \sin(2\pi(4\text{ kHz})t) & ;\ 0 \le t \le 1\text{ ms} \\ 0 & ;\ \text{elsewhere} \end{cases}$$

over an additive Gaussian noise $n(t)$ waveform channel with mean and power spectral density respectively given by:

$$m_n(t) = 0$$

$$S_n(f) = \begin{cases} 887.4 & ;\ -22.05\text{ kHz} < f < 22.05\text{ kHz} \\ 0 & ;\ \text{elsewhere} \end{cases}$$

The Gaussian noise $n(t)$ is considered *white* over the bandwidth of interest, i.e. from -22.05 kHz to 22.05 kHz. It is assumed that successive uses of the waveform communication system are all statistically independent of each other. The received waveform forms an audio stream that is sampled at 44.1 kHz, PCM encoded with 16 bits and stored in the left track of a 1.1 s audio signal in WAV format. A 500 Hz clock is stored in the right channel for timing.

1. Design an optimal receiver as detailed in §4.4 of the notes (work to be submitted). **Suggestion:** Use a correlation receiver that corresponds to the matched filter receiver of figure 4.21 in Wozencraft & Jacobs.

2. Implement the optimal receiver in a programming language of your choice.

3. Use the optimal receiver to recover the estimates of the 1100 source messages from the audio signal and store them in an ASCII file (to be submitted electronically).

[1] This is known as binary orthogonal frequency shift keying signalling.