iSpy: Detection of Signals in Noise
(EECE4688)
Spring 2019

Homework 4
(Assigned Jan. 30, 2019; due Feb. 6, 2019 in class.)

Objective: The objective of this exercise is to experiment with multiple hypothesis testing.

Task: The Matlab file `hwk4.mat` contains a message. Your task is to decipher it.

The message contains some text embedded into a signal that has been transmitted over a noisy wireless channel. The text, written in English alphabet, was first encoded into a binary 0/1 string, then modulated using 8-level phase shift keying (8-PSK). The vector $\mathbf{y}$, stored in the Matlab file, contains the noisy version of the 8-PSK symbols that represent the text. The noise is zero-mean, Gaussian.

The encoding process is specified by mapping each letter into a 5-bit codeword:
a $\rightarrow$ 00001 (binary 1)
b $\rightarrow$ 00010 (binary 2)
c $\rightarrow$ 00011 (binary 3)
$\vdots$
z $\rightarrow$ 111010 (binary 26)
Codeword '00000' signifies space (blank between words of text).
For example, the words "go on" are encoded into 001110111100000011110111O.

The modulation process is specified by mapping each three bits into one 8-PSK symbol. The eight symbols differ in phase by $\Delta\varphi = \frac{2\pi}{8}$:
000 $\rightarrow e^{j0\Delta\varphi}$
001 $\rightarrow e^{j\Delta\varphi}$
010 $\rightarrow e^{j2\Delta\varphi}$
011 $\rightarrow e^{j3\Delta\varphi}$
100 $\rightarrow e^{j4\Delta\varphi}$
101 $\rightarrow e^{j5\Delta\varphi}$
110 $\rightarrow e^{j6\Delta\varphi}$
111 $\rightarrow e^{j7\Delta\varphi}$
In our example of "go on," the 8-PSK symbols are $e^{j\Delta\varphi}, e^{j6\Delta\varphi}, e^{j7\Delta\varphi}$, and so on.

To decipher the message, you will first have to make a decision on each of the elements of $\mathbf{y}$: which of the eight symbols does it carry? Once you have made the symbol decisions, you will have to map them back into the logical 0/1 bits. Finally, you will have to map the bits into the letters of English alphabet.

Reporting: Your report should be typed, and not exceed two single-sided pages. It should be written in a professional manner. Figures and mathematical expressions should be used whenever meaningful. Figures should always have axes labeled in appropriate units (e.g. time [s], time [ms], frequency [Hz], frequency [kHz], SNR or SNR [dB], etc.). Include any Matlab code as an appendix. Please put your name on top of the report.