Signal Processing for Underwater Acoustics :
4003-19

November 25, 2018

Home Assignment Number 1: Adaptive Estimators

Answer the below questions and implementation problems. In your response, make sure you provide the full derivations and source codes.

Analysis

1. Explain the theorem of underwater sound propagation. In your explanation, describe at least two ways to simulate the underwater acoustic channel.

2. Consider a sound source of 182 dB Re 1uPa @1m emitting chirp signals between 10kHz and 20kHz of duration 1 sec. Calculate bounds for the expected signal-to-noise ratio in terms of power and in terms of energy. Consider sea level 1 and sea level 2, propagation for a range of 1.5 km, depth of 100 m, sea temperature of 22 degrees Celsius, and water salinity of 35 ppt.

3. Consider a sequence of i.i.d Poisson distribution random variables, x, whose power density function is:
$$p(x) = \Lambda^x \cdot \frac{e^{-\Lambda}}{x!} \ . \tag{1}$$
Analyze the mean and variance of the random process.

Implementation. Choose one of the following:

1. Simulate the underwater acoustic channel through the Bellhop ray-tracing software. The channel, signal, and setup are for your choice as system parameters. Provide a plot of the the channel impulse response for the case where the transmitter and receiver are 500 m apart and 550 m apart. Explain what are the observable changes between the two channels.

2. Generate a white Gaussian signal, and a pink Gaussian signal (power spectral decrease by f^{-2}). Pass the signals through a channel impulse response with four taps (parameters of your choice). Plot the power spectral density, and explain the difference between the two signal responses.

Delivery date: Dec. 16th, 2018

Roee Diamant