EE 340 Communication LAB 25/08/2012

Mini-project

Professor: S.N. Merchant

1 Introduction

Mini-project consists of two problems related to communication and signal processing. Students should make use of Scilab for the implementation of the project. Standard functions in Scilab should not be used for major coding purposes (e.g Do not use built-in functions to implement convolution, correlation etc). Standard functions can be used for generation of random noises.

2 Problem 1

1. Generate a sinusoidal sequence $x(n) = cos(\alpha\pi n)$, $0 \leq n \leq N$, $0 \leq \alpha \leq 1$. Plot $x(n)$.
2. Generate uniformly distributed random noise $v(n), 0 \leq n \leq N$, with zero mean and variance σ^2. Plot $v(n)$.
3. Obtain $y(n) = x(n) + v(n)$, $0 \leq n \leq N$. Plot $y(n)$.
4. Write a program to obtain the period of $x(n)$ from the noise corrupted sinusoidal sequence $y(n)$.
5. Repeat the the above steps (2-4) for three different values of σ^2.

3 Problem 2

Let $x_a(t)$ be a transmitted signal and $y_a(t)$ be the received signal reflected from a target where

$$y_a(t) = \alpha x_a(t - t_d) + v_a(t) \tag{1}$$

where $v_a(t)$ is additive random noise. The signals $x_a(t)$ and $y_a(t)$ are sampled in the receiver according to the sampling theorem, then processed digitally to determine the time delay and hence the distance of the target. The resulting discrete time signals are

$$\begin{aligned} x(n) &= x_a(nT) \\ y(n) &= y_a(nT) \\ &= \alpha x_a(nT - DT) + v_a(nT) \\ &\triangleq \alpha x(n - D) + v(n) \end{aligned} \tag{2}$$

We can measure the delay D by computing the cross-correlation

$$\begin{aligned} r_{xy}(m) &\triangleq \sum_{n=-\infty}^{\infty} x(n)y(n-m), m = 0, \pm 1, \pm 2, \ldots \\ &\triangleq \sum_{n=-\infty}^{\infty} x(n+m)y(n), m = 0, \pm 1, \pm 2, \ldots \end{aligned} \tag{3}$$

1. Let x(n) be the 13-point Barker sequence $x(n) = \{+1, +1, +1, +1, +1, -1, -1, +1, +1, -1, +1, -1, +1\}$. Determine the auto-correlation of the above sequence.

2. Let $v(n)$ be a Gaussian random sequence with zero mean and variance σ^2. Write a program that generates the sequence $y(n)$, $0 \leq n \leq 299$, for $\alpha = 0.9$ and $D = 20$. Plot the signals $x(n)$, $y(n)$, $0 \leq n \leq 199$.

3. Compute and plot the cross-correlation $r_{xy}(m)$, $0 \leq m \leq 99$. Use the plot to estimate the value of the delay D.

4. Repeat parts 2 and 3 for three different values of σ^2.