EE640 STOCHASTIC SYSTEMS

Spring, 2006

COMPUTER PROJECT 1

PART A: SYNTHESIS (March 21, 2006)

Let $N = 512$:

1. Uniform pseudo-random numbers. Generate 6 random vectors, each with a different seed. The vectors are all $N^2 \times 1$ where each element is uniformly distributed between 0 and 1. Each element is independent from the others. Mathematically refer to the vectors as:
$$\underline{u}_1, \underline{u}_2, \underline{u}_3, \underline{u}_4, \underline{u}_5, \underline{u}_6, \quad (1)$$

2. Prove the parametric transformation equations for converting from a uniform distribution to a gaussian distribution are correct.
$$\underline{g}_i[2i+1] = \sqrt{-2\ln \underline{u}_i[2n+1]}\cos 2\pi \underline{u}_i[2n+2] \quad (2)$$
$$\underline{g}_i[2i+2] = \sqrt{-2\ln \underline{u}_i[2n+1]}\sin 2\pi \underline{u}_i[2n+2] \quad (3)$$
where $n = 0, 1, 2 \ldots (N^2/2 - 1)$

3. Generate six $N^2 \times 1$ gaussian random vectors from the associated vectors in part (1). Use the transformation developed in (2). Generate them with a 0 mean and unity variance and store as you did in (1). Refer to them as
$$\underline{g}_1, \underline{g}_2, \underline{g}_3, \underline{g}_4, \underline{g}_5, \underline{g}_6, \quad (4)$$

4. Linear combinations of r.v.s. Generate five $N^2 \times 1$ vectors such that
$$\begin{aligned} \underline{s}_1 &= \underline{u}_1 + \underline{u}_2 \\ \underline{s}_2 &= \underline{u}_1 + \underline{u}_2 + \underline{u}_3 \\ \underline{s}_3 &= \underline{u}_1 + \underline{u}_2 + \underline{u}_3 + \underline{u}_4 \\ \underline{s}_4 &= \underline{u}_1 + \underline{u}_2 + \underline{u}_3 + \underline{u}_4 + \underline{u}_5 \\ \underline{s}_5 &= \underline{u}_1 + \underline{u}_2 + \underline{u}_3 + \underline{u}_4 + \underline{u}_5 + \underline{u}_6 \end{aligned} \quad (5)$$

5. Change g_i from lexicographical form to 2D matrix G_i . Put the first N elements in g_i to the first row of G_i, the $N - 2N$ elements in g_i to the second row of G_i and so on. The size of g_i is $N^2 \times 1$ and the size of G_i is $N \times N$.

6. Letting $N = 128$: Use the 12 training images from Project 1-S: Supplemental "SYNTHESIS OF DETERMINISTIC SYSTEM" and add zero mean white Gaussian Noise to them such that the Signal to Noise Ratio is 0 dB. You can use randn() to generate the noise for the 6 target and 6 clutter images. Add them to the images and subplot 12 noisy images.

7. Generate two more 1-D vectors, a pseudo-random binary (i.e., bipolar) sequence and pseudo-random intensity sequence such that:

$$\underline{b}_{binary}[n] = \begin{cases} 1 & \text{for} \quad \underline{u}_1[n] \geq 0.5, \\ -1 & \text{for} \quad \underline{u}_1[n] < 0.5. \end{cases} \tag{6}$$

and

$$\underline{s}_{intensity}[n] = \left(\underline{g}_1[n]\right)^2 \tag{7}$$

where $n = 1, 2, \ldots N^2$. We will use these to conduct some signal processing experiments.