Topic 2: The Communications Channel

Academic Year 2013 - 2014

P1.- A stochastic process X ~ $N(2,3)$, stationary and with independent samples, is introduced into a communications channel that can be modeled as an LTI system with impulse response:

$$h(t) = \delta(t) + 0{,}5\delta(t-1) + 0{,}1\delta(t-2)$$

Obtain:

a) The PDF of the stochastic process to the channel output.
b) The autocorrelation of the stochastic process to the channel output.
c) The power of the stochastic process to the channel output.

P2.- Consider the discrete system shown in the Figure 1:

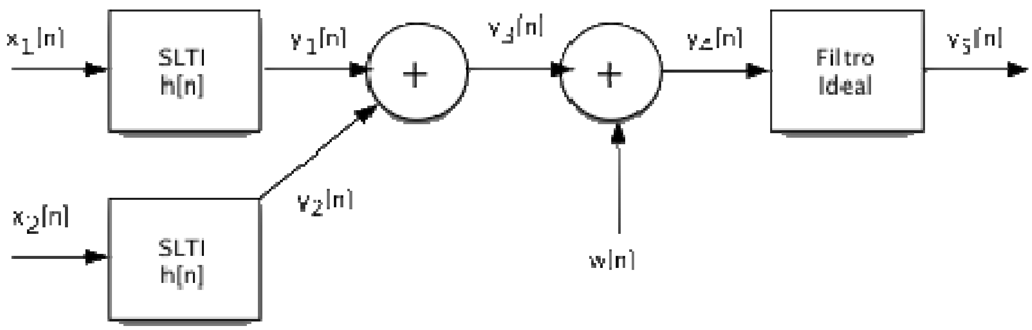

Figure 1.- Communication system.

The discrete stochastic processes $x_1[n]$ and $x_2[n]$ are i.i.d. Both distributions are Gaussian processes: $X_1 \sim N(0,2)$ and $X_2 \sim N(1,3)$. These processes are the signals transmitted by two different users to a base station. Both are transmitted by a channel modeled by an LTI system, represented in the Figure 1 by $h_1[n]$ and $h_2[n]$, respectively, with impulse responses:

$$h_1[n] = 2\delta[n] - \delta[n-1]$$
$$h_2[n] = \delta[n] - 0{,}5\delta[n-1] + 0{,}1\delta[n-2]$$

As shown in the Figure 1, the received signal is added to a noise w[n] (Gaussian, white and discrete, with zero mean and power spectral density $N_0/2$. Obtain:

a) The PDF of $y_3[n]$.
b) The power of $y_3[n]$.
c) The autocorrelation of $y_1[n]$.

Assume that the base station wants to receive only to the user 1, so that the signal received from the user 2 is considered Gaussian noise (in addition to w[n]).

d) Obtain the SNR of $y_4[n]$.

Consider now that the signal $y_1[n]$ is centered around a frequency f_1, with bandwidth 2B; and $y_2[n]$ is centered around a frequency f_2, with bandwidth 2B. f_1 and f_2 are far apart, so that the signals do not overlap in frequency. Assume further that the ideal filter located at the end of the scheme has a bandwidth of 2B, and is centered at f_1.

e) Obtain the SNR of $y_5[n]$.

P3.- Suppose you have a passive attenuator (L = 6dB) and an amplifier (G = 15dB; F_{amp} = 9dB). Obtain the noise factor of a system consisting of:

a) The attenuator followed by the amplifier.
b) The amplifier followed by the attenuator.

P4.- Consider a nonlinear amplifier having a noise temperature at the input of 17°C and these data:

- Signal power at the input = $2 \cdot 10^{-10}$W
- Noise power at the input = $2 \cdot 10^{-18}$W
- Power gain = 10^6
- Internal noise power = $6 \cdot 10^{-12}$W

Obtain:

a) The SNR at the input (in dB).
b) The SNR at the output (in dB).
c) The noise factor (in dB).

P5.- Obtain the total noise factor of a cascade of three amplification stages. Every amplifier with noise factor = 3dB and power gain = 10dB.

P6.- Obtain the noise temperature of a device whose noise figure is 6dB.