Birla Institute of Technology & Science, Pilani, Rajasthan
First Semester 2021-2022
Lab-5 (Python): Noise

Course: EEE F311 Communication Systems
Instructor-in-Charge: S M Zafaruddin

21-09-2021 TUESDAY (P2, P4:): Python

Instructions

- Create a folder named Lab in your shared folder.
- Create a Lab5 Sub-folder in the Lab folder. This folder will be your working directory.
- Develop .py file corresponding to each task.
- You can start the tasks in any order.
- Once all tasks are done, paste your codes and plots/results/observations/conclusions in a word doc and upload through a Dropbox file request link. The link will be shared through Slack.
- Best of Luck

Objectives

In this task, the objective is to study real time transmissions of signals over a channel with additive noise. Information signals are generally random which can be observed over time. Information signals are not transmitted as a whole but in smaller parts. Transmission rate is usually measured how many waveform (i.e., symbols) in a unit time are transmitted over channel. Thus, we use the rate of transmission in symbols/sec. For example, an audio file of 3 minutes duration is not transmitted in one go but transmitted over a time such that each time a smaller part of signal (i.e., of a certain duration) is transmitted. Transmission stops once whole information is transmitted. Time has come to visualize signals in real time.

Python Task 1

Gaussian, Uniform, Rayleigh, and exponential are important distribution functions to model random communication process. Gaussian distribution is used for additive noise, uniform distribution is used for data selection, Rayleigh distribution is used to model wireless channel, and exponential distribution for

voice call traffic. Verify the PDF of each random variable using built-in function quad. Use the package: from scipy.integrate import quad

Python Task 2

Generate random samples of Gaussian random variable $n(t) \sim \mathcal{N}(\mu, \sigma^2)$, where μ is the sum of the last two digits and σ^2 is the sum of the last three digits of your BITS ID. Use "np.random.randn" Find the following:

- Verify the generate samples using histogram. Use hist.
- Use for loop to find $P(n(t) > \sigma)$. Verify $P(n(t) > \sigma)$ with the Q-function. The Q-function and erf are related. Use package from scipy import special, and special.erf.
- Plot the autocorrelation function of the random process $n(t)$ wrt lags τ. Use acorr.
- Find the PSD of $n(t)$ using the ACF.

Python Task 3 (Real Time)

Generate a time domain signal $m(t) = 2Nsinc(2\pi Nt)$, pass the signal to the channel $h(t) = a\delta(t)$, where $a < 1$ is the attenuation due to the channel, and add noise $n(t) \sim (0, \sigma^2)$ to get received signal $y(t) = m(t) * h(t) + n(t)$. Transmit the signal after each second and visualize in real-time for 30 seconds. Observe the effect of various σ^2 on the received signal $y(t)$.

Python Task 4 ((Real Time))

Download an audio song (around 30 sec) and read its data and name $m(t)$, pass the signal to the channel $h(t) = 2Bsinc(2\pi Bt)$, and add noise $n(t) \sim (0, \sigma^2)$ to get received signal $y(t) = m(t) * h(t) + n(t)$. Transmit the signal after each second and visualize in real-time for 30 seconds. Observe the effect of various B and σ^2 on the received signal $y(t)$.

Project Task

We have started individual tasks with a bigger picture: to design an end-to-end simulator for a digital communication system. In this task, we have transmitted signal over band-limited channel with additive noise in real time.