Signal Processing

Tutorial 5 – Sampling, Windowing

Pôle

Numérique

Author	: Guillaume GIBERT
Version	: 1 R 0
Promotion	: 2025
Program	: EENG3
Date	: March 4th 2024

1. Git

- Create a remote git repository (e.g. SignalProcessing_samplingwindowing) on gitarero.ecam.fr
- Update the repository description
- Create a commit
- Move to the develop branch

2. Exercise 1

- Create a Matlab/Octave script entitled sampling.m
- Generate a cosine function $x(t) = \cos(2\pi f t + \varphi)\, with \begin{cases} f = 10\ Hz \\ \varphi = 0 \end{cases}$ for a duration of 1 s

Q. What is the condition for the sampling frequency?

Q. What is the name of the theorem?

- Use the provided frequencySpectrum.m function to plot the power spectrum of the signal

Q. What is the difference between the second and third plot?

- Generate the same cosine function with a sampling frequency that is not correct
- Plot the power spectrum of this signal

Q. What do you observe? Please explain

- Generate the sum of two cosine functions as follow:

$$x(t) = \cos(2\pi f_1 t + \varphi_1) + \cos(2\pi f_2 t + \varphi_2) + with \begin{cases} f_1 = 10\ Hz, f_2 = 20\ Hz \\ \varphi_1 = \varphi_2 = 0 \end{cases}$$

- Choose a sampling rate that respects the "condition"
- Plot the power spectrum of this signal
- Repeat the same procedure with a sampling frequency that does not respect the "condition"

Q. What do you observe? Please explain

- Modify the phase of the signals

Q. What do you observe on the power spectrum? Please explain

- Create a commit and merge it to the main branch

3. Exercise 2

- Create a Matlab/Octave script entitled windowing.m
- Generate a cosine function $x(t) = \cos(2\pi ft + \varphi)\, with \begin{cases} f = 10\ Hz \\ \varphi = 0 \end{cases}$ for a duration of 12 s and a sampling frequency $F_s = 50\ Hz$
- Apply the following time windows to this signal:
    - Rectangular
    - Hanning
    - Hamming
    - Blackman
- Display the different weighted signals on the same plot with different colours
- Compute the power spectrum of the different weighted signals

Q. What do you observe on the power spectrum (main lobe, side lobes...)? Please explain

Q. Why did we choose a cosine function? Please explain

- Create a commit and merge it to the main branch

4. Exercise 3

4.1.

- Create a Matlab/Octave script entitled signalSeparation.m
- Generate the sum of two cosine functions as follow:

$$x(t) = \cos(2\pi f_1 t + \varphi_1) + \cos(2\pi f_2 t + \varphi_2) + with \begin{cases} f_1 = 70\ Hz, f_2 = 100\ Hz \\ \varphi_1 = \varphi_2 = 0 \end{cases}$$

- Choose the sampling frequency and the duration adequately
- Apply the following time windows to this signal:
  - Rectangular
  - Hanning
  - Hamming
  - Blackman
- Compute the power spectrum of the different weighted signals

Q. What do you observe on the power spectrum? Please explain

Q. Can you separate the spectral representation of the two cosine functions? Please explain

4.2.

- Modify the value $f_1 = 98\ Hz$
- Regenerate the weighted signals
- Compute the power spectrum of the different weighted signals

Q. What do you observe on the power spectrum? Please explain

Q. Can you separate the spectral representation of the two cosine functions? Please explain

Q. How could you solve this issue?

4.3.

- Change the amplitude of the second cosine function by multiplying it by a factor 0.1
- Regenerate the weighted signals
- Compute the power spectrum of the different weighted signals

Q. What do you observe on the power spectrum? Please explain

Q. Can you separate the spectral representation of the two cosine functions? Please explain

Q. How could you solve this issue?

- Create a commit and merge it to the main branch