Lecture "Digital Signal Processing"

Prof. Dr. D. Klakow, summer term 2019

Tutorial 8

Submission deadline: 01.07.2019, 10:15

Submission Instructions:
You have one week to solve the tutorials.
The code should be well structured and documented. Do not use any Matlab-Toolbox or Python external libraries if not mentioned that you could use it.

- You are allowed to hand in your practical solutions in groups of two students.
- The theoretical part should be submitted before the lecture.
- For the practical tasks please submit files via the email address
  (Mon)Tutorial 1: dsp.tutorial1@gmail.com.
  (Thus)Tutorial 2: dsp.tutorial2@gmail.com.
- The subject of the letter should be [**DSP TUTORIAL 8**].
- Rename and pack the main directory:
  Ex08_matriculationnumber1_matriculationnumber2.zip.

The directory that you pack and submit should contain the following files:

- code files (contain *main.m* for matlab);
- file "answers.pdf" which contains answers to the questions appearing in the exercise sheet;
- file "README" that contains an information on all team members:
  name
  matriculation number
  email address.

1 MFCC

In this exercise, you will implement a simple feature extraction.

1.1 (2P) Reading

Read the reference and summarize it.

1.2 (1P) Pre-emphasis

You have already heard about Pre-emphasis in the lecture. Now you should implement this filter and apply it to the audiostream point8.au [1]. Use the following definition:

$$f'_n = f_n - \alpha \cdot f_{n-1} \text{ with } \alpha = 0.95 \tag{1}$$

Which kind of filter is it? Is it a low- or high-pass filter?

1.3 (1P) Windowing

Implement the function:

```
function M = windowing(s, shift, width)
```

which applies a Hamming[2] window to signal segments (called frames) of width w. How many frames f_n can be produced from a signal of length k assuming a shift of sh samples and a frame width of w. M will be a Matrix $\in \mathbb{R}^{f_n \times w}$.

1.4 (1P) Mel-filterbank

You will find the function *mel* on our course website. Plot the filterbank with the following parameters:

$$fl = 133.33334Hz \tag{2}$$
$$fh = 6855.4976Hz \tag{3}$$
$$fft\_size = 1024 \tag{4}$$
$$fs = 16kHz \tag{5}$$
$$L = 24 \tag{6}$$
$$fmel = 1125Hz \tag{7}$$

1.5 (3P) MFCC

Use the audiostream of subtask 1.2, the windowing of subtask 1.3 and the mel-filterbank of subtask 1.4 to compute a MFCC-stream[3]. Show the original audiostream and the MFCC-stream[4].

Hint1: for each frame, keep only DCT coefficients 2-24.
Hint2: you don't need to calculate the Dynamic Features.

2 PCA

In this exercise, you will do PCA in a simple 2-D case.

[1] You can use the function *filter()*.
[2] You can use the function *hamming*.
[3] You can use the function *DCT*.
[4] You can use *imagesc* in Matlab or *imshow* in Python to show your spectogram-matrix.

2.1 (2P) Calculation

Calculate the principal components(1-D) of the following points:
(1,1), (1,3), (2,3), (4,4), (2,4).

Hint: write down each step of your calculation.