Speech Signal Processing (EC5.408)

Assignment 3

February 7th, 2025 - February 20th, 2025

Guidelines

- **Do not copy or plagiarise.** If you're caught for plagiarism, the penalty will range from zero in the assignment to an F grade in the course.
- **Always cite your sources** (be it images, papers, or existing libraries).
- **Mention clearly** if any assumptions are being considered.
- Only **MATLAB or Python** can be used for the coding part.
- For this assignment, you might use *Audacity* or *Wavesurfer* software.

Submission Format

Make a directory using the naming format `SSP_A3_RollNo`. The submission might include:

- **Codes** (`.py/.m`) to answer the coding problems.
- **Reports** (`.pdf`) to answer the theory questions.
- **Notebooks** (`.ipynb`) to answer both coding and theory questions together.

Place the files in their respective folders and zip the main directory using the naming format `SSP_A3_RollNo.zip` and upload this zip file to Moodle.

Example Directory Structure

```
SSP_A3_RollNo
├── Codes
│   ├── 1.py
│   └── 2.m
├── Audio
│   └── 1.wav
├── Report.ipynb
└── Report.pdf
```

Questions:

(a) Briefly explain the following concepts:

- LP Residue
- Spectral Subtraction
- Mel Filter Bank
- Cepstrum

(b) MFCC Extraction and Analysis:

- Record your name as a speech signal.
- Compute the Mel Frequency Cepstral Coefficients (MFCC) at the frame level using any speech processing library.
- Extract the first 13 MFCC coefficients for each frame and plot them.
- Comment on the plots and the variations observed.

(c) Speech Prosody Analysis:

- Define speech prosody and explain its importance.
- Record the following sentence with four different emotions of your choice:

  "I can't believe I won the last slice of pizza!"

- Extract the pitch contour for each recording using `Praat` software and comment on the pitch variation across different emotions.

(d) Pitch Estimation and Analysis:

- Using the given audio file, select a voiced region and create a voiced frame using a Hamming window of length 512.
- Perform the following tasks on the voiced frame:
  (a) Compute and plot the auto-correlation of the frame.
  (b) Compute and plot the magnitude spectrum of the frame.
  (c) Compute and plot the Linear Prediction (LP) spectrum of the frame.
  (d) Estimate the pitch using the above three methods and compare the results. Discuss which method provides a better pitch estimation and why.

—— ***End of Assignment*** ——