EE 321: Digital Signal Processing

Python Assignment: Set - P02

1. The audio file *goodmorning.wav* contains saying "good morning" with an echo noise added to it. Load the audio signal from the file into a numpy array. Use Python to design a digital filter that will eliminate the echo contamination from the audio file. Derive the transfer function, and the difference equation. Plot the magnitude and phase response of the designed filter. Use Python to apply your inverse filter to the sound file and show that it has removed the echo. Plot the original noisy signal and the filtered signal in the same graph to compare their frequency content. (Do not use any DSP Python libraries for filter design. Build your own filter function.)

2. The file *safety.wav* contains the speech signal for the word "safety" uttered by a male speaker, sampled at 8 kHz. The signal has a significant amount of background noise (as it was recorded in a computer laboratory). Load the audio signal from the file into a numpy array. Develop procedures to segment the signal into voiced, unvoiced, and silence (background noise) portions using Python. Plot the magnitude and phase response of the designed filter. Also, plot the original raw audio signal and segmented audio signals. Compute and plot the Power Spectral Density (PSD) for each segment that you obtain and study its characteristics. (Do not use any DSP python libraries. Build your own functions.)

Submission Guidelines:

- Read all the questions carefully. If you have any doubts, discuss with the corresponding TA.
- Write all the codes in a single IPYTHON Notebook only (Jupyter Notebook or Google Colab). Submit the IPYTHON Notebook (.ipynb format) containing all your codes, plots, comments, and explanations for each task. You can create separate sections and subsections within the notebook for different parts of the questions.
- Do not use any DSP Python libraries. Build your own functions from scratch.
- Prepare a detailed assignment report explaining all the questions asked, different steps, derivations and calculations, algorithms, and generated outputs and attach all the necessary plots. Submit the report in PDF format only.