Lab 3: Computation of Energy & Zero Crossing

Objective

Like any other signal (image, video, etc.), speech signals can be characterized by features that can be extracted from the signal itself. Features can be categorized according to the domain in which they were extracted.

- Time Domain Features (Energy, pitch period, zero crossing, AMDF, autocorrelation, etc.)
- Frequency Domain Features. (fourier transform, wavelet transform, etc.)
- Combined Time and Frequency Domain Features. For instance, spectrograms compute the power present in each frequency, and how it changes with time. Hence, spectrograms retain information about both domains.

In this lab, we will extract 2 types of time-domain features: Energy and zero crossing rates. For each frame, a single number will be computed to represent the frames energy, and a single number will represent the frames zero crossing.

The energy is computed as a summation (over the frame length) of each sample squared:

$En(n) = \sum_{m=0}^{N-1} x(m)^2$, where 'n' is the frame number, N is the frame size, and m is the sample counter.

The zero crossing computes how many times the signal crossed the x-axis. It can be computed programmatically either by the equation as mentioned in the lecture, or just through a counter which is incremented whenever the current sample is positive, and its next neighbor is negative or vice versa.

Note:

- Voiced frames should have a high energy value and a low zero crossing rate.
- Unvoiced frames should have a low energy value and a high zero crossing rate.

Program Requirements:

Required is a program that divides any input speech signal into frames and computes for each frame its corresponding energy and zero crossing values.

Inputs:

1. Audio File Path
2. Frame size in seconds
3. Overlap size in seconds
4. Window type to be used

Outputs:

1. Vector containing the energy value for each frame. The vector's length should be equal to the number of frames.
2. Vector containing the zero crossing value for each frame. The vector's length should be equal to the number of frames.
3. A single diagram containing 3 plots:
    a. A plot of the framed signal. You can not plot the frames matrix since matrices are 2D and the plot function is used to plot 1D signals. Hence, to make the plot possible, the frames matrix should be used to fill a new vector which will be plotted. The new vector is constructed by concatenating consecutive frames.
    b. A plot of the energy vector.
    c. A plot of the zero crossing vector