

Speech Processing Lab Assignment-4

Title: To perform frame-wise analysis of a speech signal and study the behaviour of time-domain features for voiced and unvoiced speech.

Instructions:

Dataset:

- Use any speech sample in .wav format. You can record your own voice or download a sample from publicly available datasets (e.g., LJ Speech Dataset).
- Ensure the speech signal has a sampling frequency of 16 kHz.

1. Task-1: Short-time processing of speech

- a) Load and visualize the waveform of the first 20 second of speech sample.
- b) Compute the total number of frames for a given frame length of 25ms and frame shift of 10ms.
- c) Segment the speech signal into overlapping frames using the calculated parameters.
- d) Using Hamming window, extract the following time-domain features frame-wise:
 - Short-Time Energy (STE)
 - Short-Time Magnitude (STM)
 - Zero-Crossing Rate (ZCR)
 - Autocorrelation
 - AMDF
 - AMSDF
- e) Repeat (b) using Rectangular window function.
- f) Plot the frame-wise variation of all six features for both window functions.
- g) Analyse and compare the behaviour of all 6 extracted time-domain features for voiced and unvoiced speech segments. Infer your observation for each feature and summarize the findings.
- h) Comment on the effect of window choice on feature smoothness and discrimination capability.

2. Task-2: Periodicity Analysis: Using Autocorrelation, AMDF, and AMSDF:

- a) Identify frames that exhibit periodic behaviour.
- b) Explain how periodicity is reflected in these functions (peaks in autocorrelation, minima in AMDF/AMSDF).
- c) Distinguish between periodic (voiced) and aperiodic (unvoiced) frames.

3. **Task-3: Pitch Estimation:** For frames identified as periodic,
 - a) Determine the pitch period from the lag corresponding to the first prominent autocorrelation peak (excluding zero lag) or the first minimum of AMDF and AMSDF.
 - b) Compute the pitch frequency and infer about the result.
 4. **Write a discussion on:**
 - a) Compare voiced and unvoiced speech in terms of energy, ZCR, and periodicity.
 - b) Discuss how periodicity-based features help in pitch detection.
 - c) Comment on the reliability of each time-domain feature for pitch detection.
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You need to submit the lab report in teams and upload code in Github (same as before)