MAI532 Speech Processing & Recognition

Department of Computer Science, Christ University Central Campus

Lab Exercise I

Sampling and Reconstruction of Speech Signals

(1) Implement sampling and quantization techniques for the given speech signals.
   (a) Plot the time domain representation of the original speech signal.
   (b) Sample the speech signal at different sampling rates (e.g., 8kHz, 16kHz, and 44.1kHz).
   (c) Plot sampled speech signal for each of these sampling rates.
   (d) Using the sampled signals from the above task, reconstruct the signal using:
      (i) Zero-order hold (nearest-neighbor interpolation)
      (ii) Linear interpolation.
   (e) Calculate the Mean Squared Error (MSE) between the original and the reconstructed signals for both methods.

   Write an inference on how sampling rates affect the quality and accuracy of the reconstructed speech signal.

   Dataset

   - *Use a few public datasets.*
      (a) LibriSpeech
      (b) TIMIT
      (c) CommonVoice

   OR

   - *Create synthetic signals to simulate simple speech sounds.*

(2) Implement the source-filter Model for a given speech signal and analyze the impact of sampling and reconstruction on the quality of the speech signal.
   (a) Generate a synthetic speech signal using the source-filter model.
      (i) Create a source signal (e.g., a glottal pulse train for voiced sounds or white noise for unvoiced sounds).
      (ii) Apply a filter that models the vocal tract, represented by an all-pole filter or an FIR filter with formants (resonances of the vocal tract).
   (b) Plot the generated speech signal and analyze the effect of the filter on the original source.
   (c) Sample the speech signal generated in the above task at different sampling rates (e.g., 8 kHz, 16 kHz, 44.1 kHz).
   (d) Reconstruct the signal using a suitable interpolation method (e.g., zero-order hold, linear interpolation).
   (e) Compute the Mean Squared Error (MSE) between the original and reconstructed speech signals.

   Write an inference on tasks such as creating the source filter model, different sampling rates, and reconstruction of the sampled signals.

Evaluation Rubrics:-

(1) Implementation: 5 marks.
(2) Complexity and Validation: 3 marks.
(3) Documentation & Writing the inference: 2 marks

Submission Guidelines:-

- Generate the single .pdf file for the given questions separately. The file name should be your register number followed by the program number.
- Upload the pdf files in Google Classroom on or before the deadline mentioned.

Materials

- Textbook 1: https://drive.google.com/file/d/1Y_M8njlC4ZzdhbTabs12feZ6mRuMQqcv/view
- Textbook 2: https://drive.google.com/file/d/1KP6qZNGLsDLbNogs7jGiFAONBRbatTbC/view