Voice Recognition

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Overview

- Project Objective
- Background
- Feature Extraction Process
- Feature Matching Process
- Implementation
- Demonstration
- Python

Objective

Develop a real time speaker identification system using Python

Project Status:

MATLAB=working

Python=in progress

Background

Speaker Identification:

-understanding who is speaking

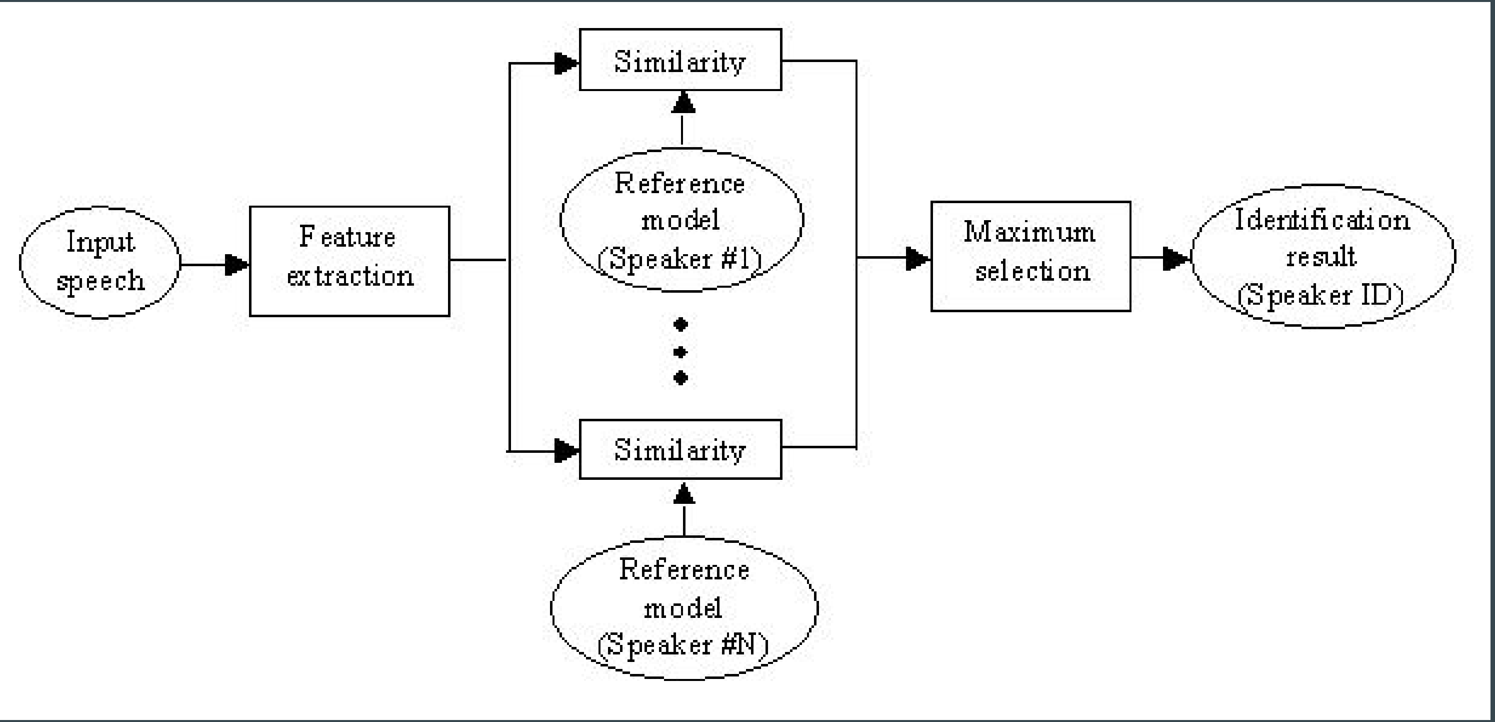
Speaker Verification:

-is the process of accepting or rejecting the identity claim of a speaker

Speech Recognition vs. Speaker Recognition:

-identifying what is said vs. who said it

Overall Process



Feature Extraction

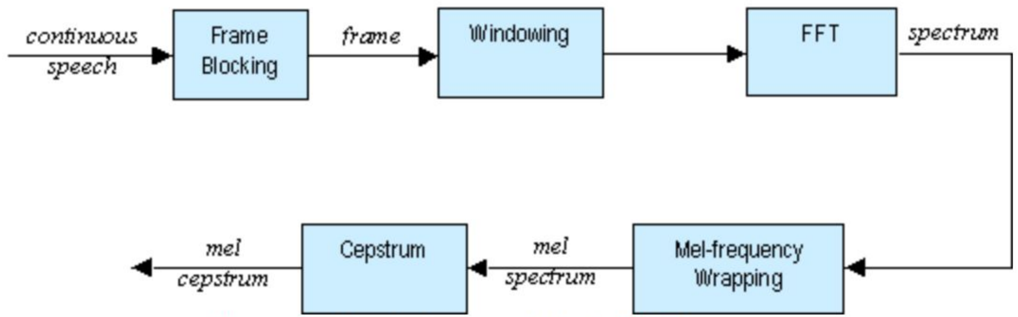


Figure 3. Block diagram of the MFCC processor

Input audio signal sampled at fs=10000Hz

Human voice max frequency is 3000Hz (fs satisfies Nyquist rate)

Frame Blocking

Blocking: Signal is blocked into frames of N samples. With overlap N-M

N=256 M=100

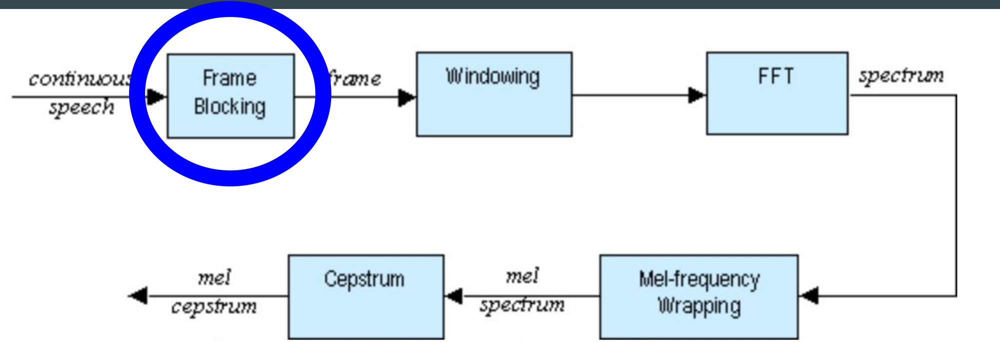


Figure 3. Block diagram of the MFCC processor

Windowing

each frame is windowed to minimize discontinuities at the end points of each frame

Size 0<n<N-1 using Hamming window

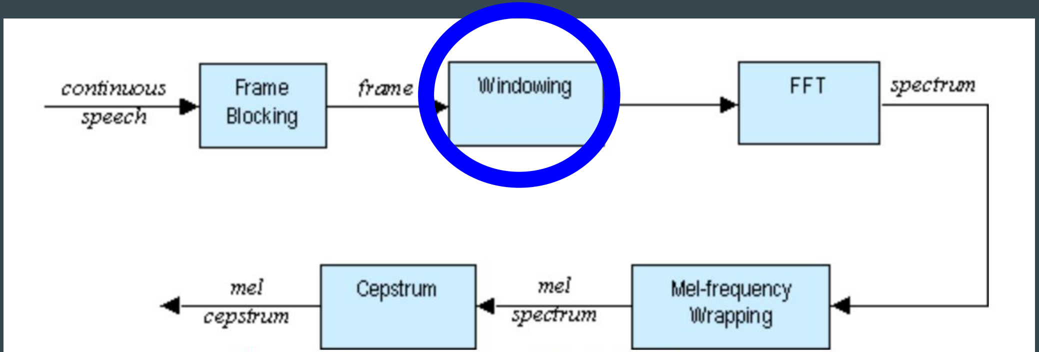


Figure 3. Block diagram of the MFCC processor

FFT

DFT: using FFT function, converts each frame from time domain into the frequency domain

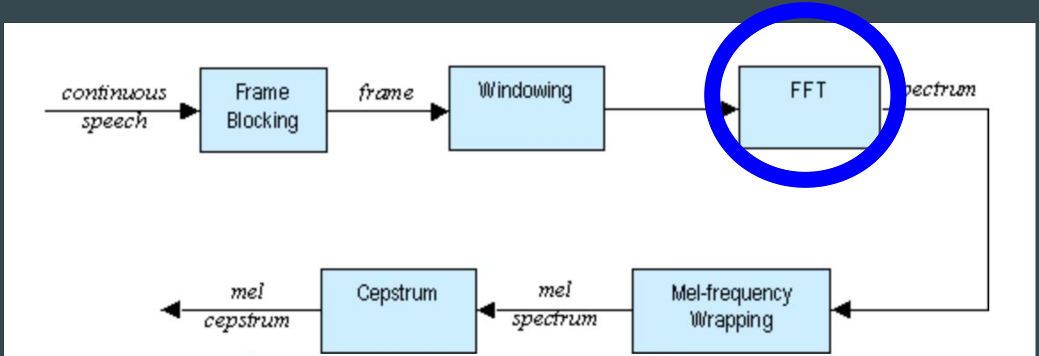


Figure 3. Block diagram of the MFCC processor

Mel-Frequency Wrapping

Filterbank with triangular bandpass frequency response

Linear frequency spacing <1000 Hz<Logarithmic frequency spacing

Human Speech Є BL{300, 3000} Hz

k=number of mel spectrum coefficients=20

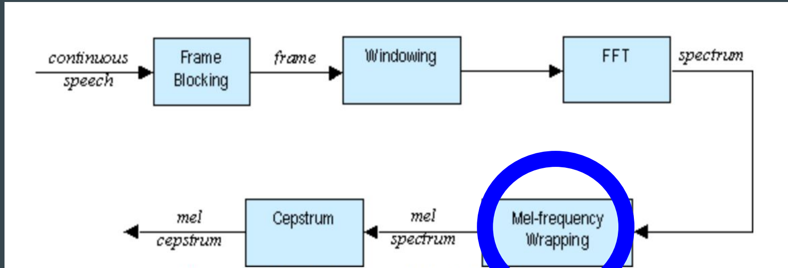
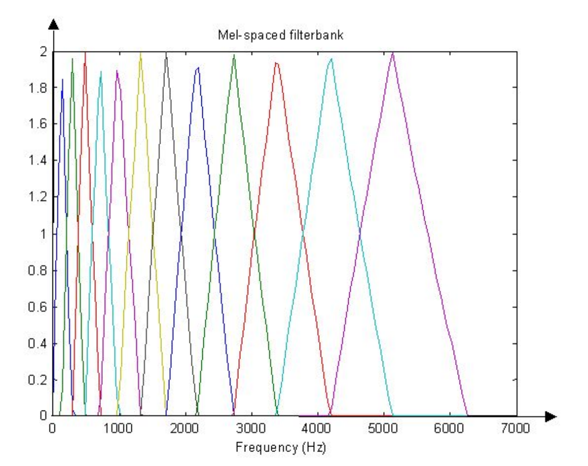


Figure 3. Block diagram of the MFC process



Cepstrum

DCT: converts the mel spectrum coefficients back to time domain

Provides a good representation of the local spectral properties for a given frame

Output is a set of coefficients called an acoustic vector

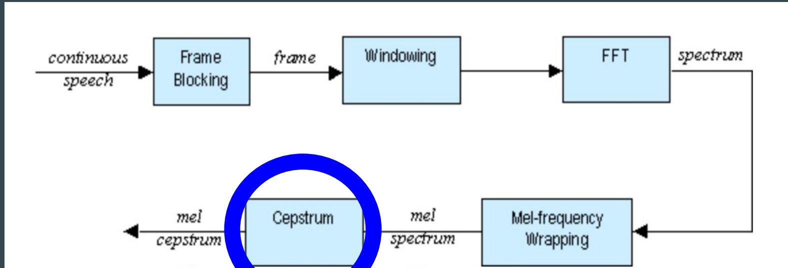


Figure 1: Block diagram of the MFCC processor

Feature Matching

Vector Quantization(VQ): Process of mapping vectors to a finite number of regions in space

↓

Cluster: The region the VQ maps too

↓

Codeword: center of a cluster

↓

Codebook: collection of codewords

Feature Matching

Speaker 1- Acoustic vector(circles)

Speaker 2- Acoustic vector (triangles)

Acoustic vector=clusters of speaker samples

Codewords(black shapes)=center of clusters

Codebook(yellow box)=collection of codewords

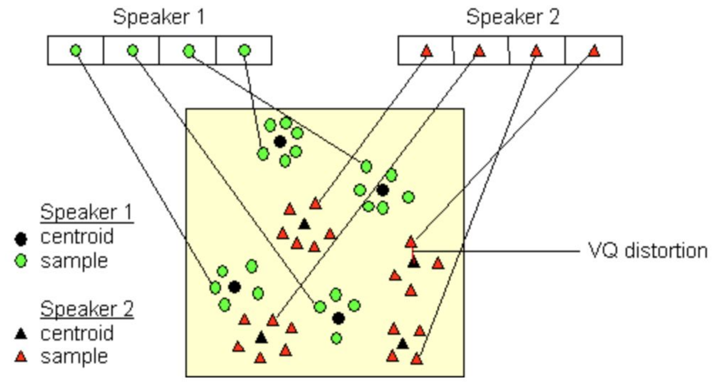


Figure 5. Conceptual diagram illustrating vector quantization codebook formation. One speaker can be discriminated from another based of the location of centroids. (Adapted from Song et al., 1987)

Clustering the Training Vectors

1. Design a 1-vector codebook
2. Split codebook according to rule
3. Search for the Nearest neighbor
4. Update the centroid
5. Iterate 3, 4 until average distance< threshold (ε)
6. Iterate 2,3 and 4 until a codebook size (M) is designed

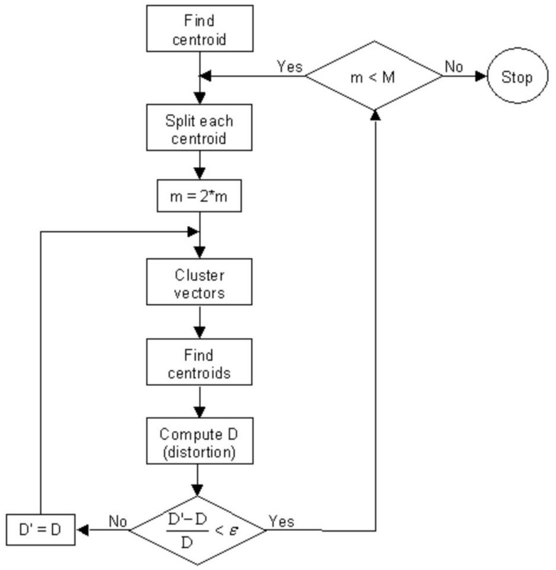


Figure 6. Flow diagram of the LBG algorithm (Adapted from Rabiner and Juang, 1993)

Implementation

Training Phase

- Input: signal used as reference for verification
- Output: vector quantized codebook

Process

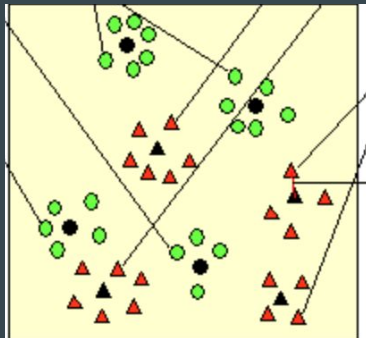
1. Read audio signal
2. Block into frames of 256 samples
3. Hamming filter blocks
4. Compute DFT of blocks
5. Compute power spectrum & Mel filter
6. Take DCT to produce Mel frequency cepstral coefficients
7. Assemble code book through VQLBG algorithm

Testing Phase

Input: new signal & reference codebook
Output: The reference signal that matches

Process

1. Steps 1-6 again
2. Find minimum distance to codeword
3. Identify speaker from cluster

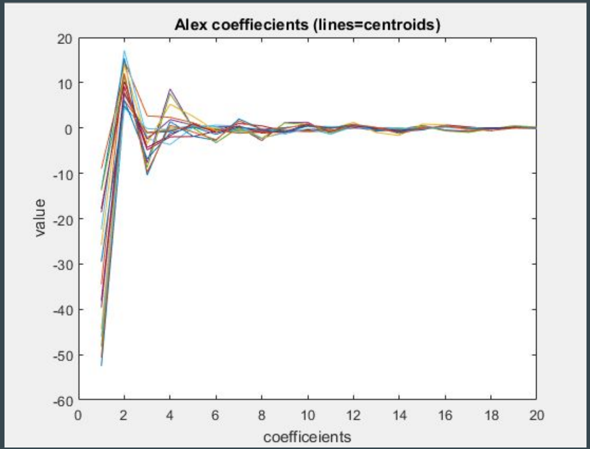


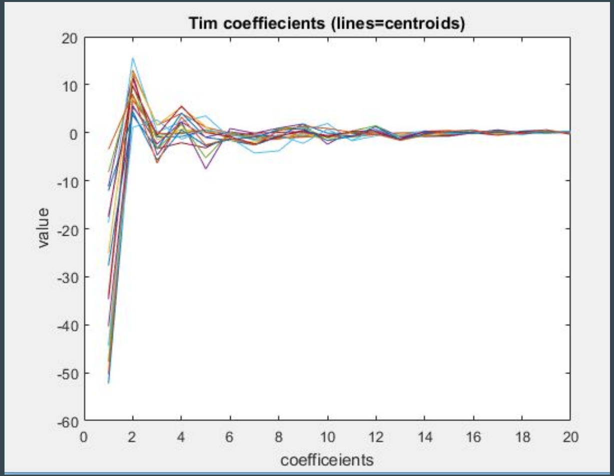
Demonstration

```
code=train('traindir2\',2);

test('testdir2\', 2, code);

test('testdir1\', 4, code);
```

Trained with 44 english sounds

- short -a- in and, as, after
- short -e- in pen, hen, lend
- short -i- in it, in
- short -o- in top, hop
- short -u- in under, cup





Python Code

Found libraries that use MATLAB commands

Manually rewriting scripts

So far

- Record audio from mic, automatically split when silence occurs
- Progress making melfb and mfcc functions

Sources

http://www.ifp.illinois.edu/~minhdo/teaching/speaker_recognition/

http://practicalcryptography.com/miscellaneous/machine-learning/guide-mel-frequency-cepstral-coefficients-mfccs

https://en.wikipedia.org/wiki/Vector_quantization