MATLAB Functionality for Digital Speech Processing

- MATLAB Speech Processing Code
- MATLAB GUI Implementations

Basic Functionality

- read a speech file (i.e., open a .wav speech file and read the speech sample into a MATLAB array)
- write a speech file (i.e., write a MATLAB array of speech samples into a .wav speech file)
- play a MATLAB array of speech samples as an audio file
- play a sequence of MATLAB arrays of speech samples as a sequence of audio files
- record a speech file into a MATLAB array
- plot a speech file (MATLAB array) as a waveform using a strips plot format
- plot a speech file (MATLAB array) as one or more 4-line plot(s)
- convert the sampling rate associated with a speech file (MATLAB array) to a different sampling rate
- highpass filter a speech file (MATLAB array) to eliminate hum and low frequency noise
- plot a frame of speech and its associated spectral log magnitude
- plot a spectrogram of a speech file (MATLAB array)
- plot multiple spectrograms of one or more speech files (MATLAB arrays)

Read a Speech File into a MATLAB Array

- [xin, fs, nbits] = wavread(filename);
- [xin, fs] = loadwav(filename);
  - filename is ascii text for a .wav-encoded file which contains a speech signal encoded using a 16-bit integer format
  - xin is the MATLAB array in which the speech samples are stored (in double precision format)
  - fs is the sampling rate of the input speech signal
  - nbits is the number of bits in which each speech sample is encoded (16 in most cases)
  - program wavread scales the speech array, xin, to range $-1 \le xin \le 1$, whereas loadwav preserves sample values of the speech file and hence array xin is scaled to range $-32767 \le xin \le 32767$
- [xin1, fs, nbits] = wavread('s5.wav');
- [xin2, fs] = loadwav('s5.wav');

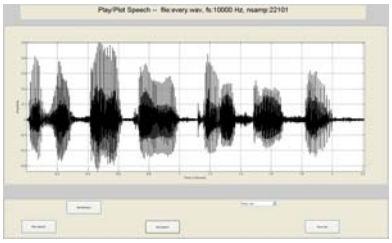
Read a Speech File into a MATLAB Array

```
% test_wavread.m
% test waveread function
%
% read speech samples from file 'test_16k.wav' into array x1 using wavread
% routine
   filein='test_16k.wav';
   [x1,fs1,nbits]=wavread(filein);

% print out values of fs1, nbits, wavmin1, wavmax1
   wavmin1=min(x1);
   wavmax1=max(x1);
   fprintf('file: %s, wavmin/wavmax: %6.2f %6.2f, fs1: %d, nbits: %d \n',...
      filein,wavmin1,wavmax1,fs1,nbits);

% read speech samples from same file into array x2 using loadwav routine
   [x2,fs2]=loadwav(filein);

% print out values of fs2, nbits, wavmin2, wavmax2
   wavmin2=min(x2);
   wavmax2=max(x2);
   fprintf('file: %s, wavmin/wavmax: %d %d, fs2: %d \n',...
      filein,wavmin2,wavmax2,fs2);
```

Terminal Display:
file: test_16k.wav, wavmin/wavmax: -1.00 1.00, fs1: 16000, nbits: 16
file: test_16k.wav, wavmin/wavmax: -32768 32767, fs2: 16000

Play/Plot Existing Speech File

- Play_Plot_Speech_GUI.m
  - MATLAB GUI for basic operations of reading in a file, playing the speech array, and plotting the speech waveform



Write a Speech Array into a Speech File

- wavwrite(xout, fs, nbits, filename);
- savewav(xout, filename, fs);
  - xout is the MATLAB array in which the speech samples are stored
  - fs is the sampling rate of the output speech signal
  - nbits is the number of bits in which each speech sample is encoded
  - filename is the ascii text for the .wav-encoded file in which the MATLAB signal array is to be stored
  - for wavwrite the MATLAB array xout needs to be scaled to the range $-1 \le xin \le 1$ whereas for savewav the MATLAB array xout needs to be scaled to the range $-32767 \le xout \le 32767$
- wavwrite(xin1, fs, 's5out.1.wav');
- savewav(xin2, 's5out.2.wav', fs);

Write a Speech Array into a Speech File

- % write out array x1 into speech file using wavwrite routine
- wavwrite(x1,fs1,nbits,'file1out.wav');
- % write out array x2 into speech file using savewav routine
- savewav(x2,'file2out.wav',fs2);

file1out.wav

file2out.wav

Play a Speech File

- sound(x, fs);
- soundsc(x, fs);
  - for sound the speech array, x, must be scaled to the range $-1 \le x \le 1$
  - for soundsc any scaling of the speech array can be used
  - fs is the sampling rate f the speech signal
- [xin, fs] = loadwav('s5.wav'); % load speech from s5.wav;
- xinn = xin/abs(max(xin)); % normalize to range of – 1 to 1;
- sound(xinn, fs); % play out normalized speech file;
- soundsc(xin, fs); % play out unnormalized speech file;

Play Multiple Speech Files

- play_multiple_files.m;
  - sequence of filenames read in via filelist, keyboard or file search
- Example of usage to play out 3 speech files in sequence:
  - kbe=filename entry via filelist(2), keyboard(1), or file search(0):1; % keyboard chosen
  - N=number of files to be played in a group:3; % play out 3 files
  - i=1; filename: s1.wav;
  - i=2; filename: s2.wav;
  - i=3; filename: s3.wav

Play Multiple Speech Files

- test_play_files.m
  - play the following sequence of files:

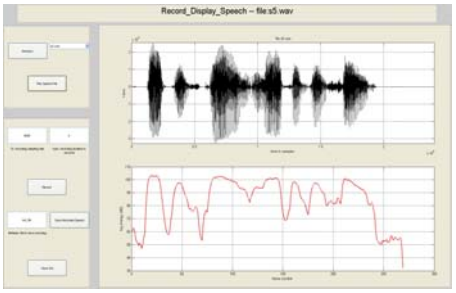
    Maple_short.wav
    s1.wav
    beep.wav
    test_16k.wav
    beep.wav
    s2.wav

Record Speech into MATLAB Array

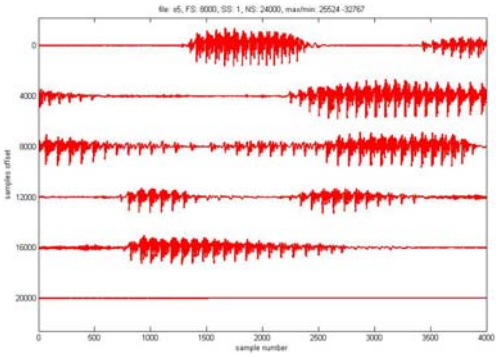
- record_speech.m (calls MATLAB function wavrecord.m)
- function y=record_speech(fs, nsec);
  - fs: sampling frequency
  - nsec: number of seconds of recording
  - y: speech samples array normalized to peak of 32767

Record Speech into MATLAB Array

- record_display_speech_GUI.m

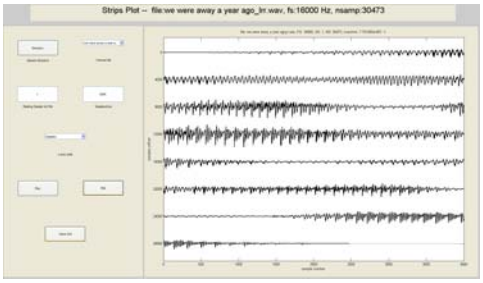


Plot Speech Using Strips Plot

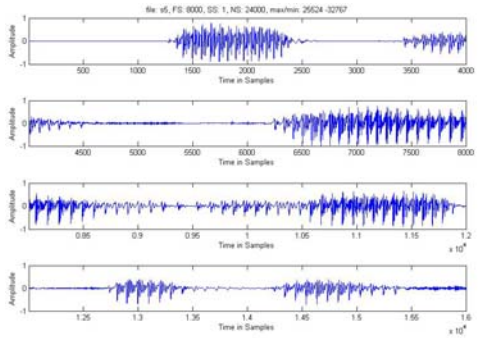


Plot Speech Using Strips Plot

- strips_plot_GUI.m



Plot Speech Using 4-Line Plot

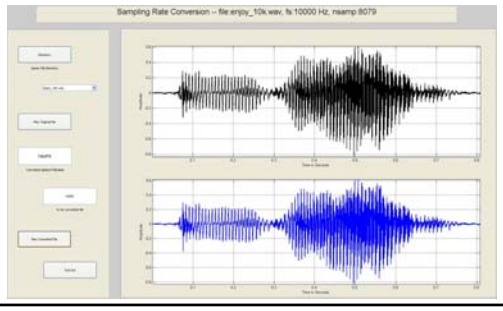


Sample Rate Conversion

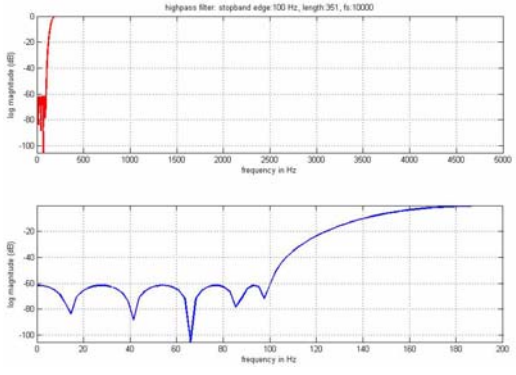
- y = srconv(x, fsin, fsout);
  - x: input speech array;
  - fsin: input speech sampling rate;
  - fsout: desired speech sampling rate;
- Example:
  - [xin, fsin] = loadwav('s5.wav'); % fsin=8000;
  - fsout = 10000; % desired sampling rate;
  - y = srconv(xin, fsin, fsout);

Sample Rate Conversion

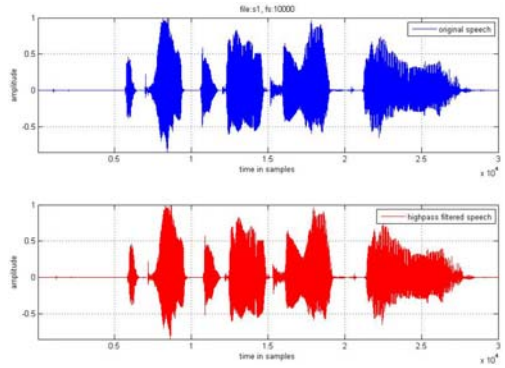
- SRC_GUI.m



Highpass Filter Speech Waveform

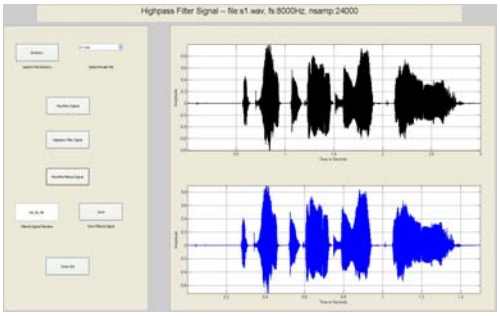


Highpass Filter Speech Waveform

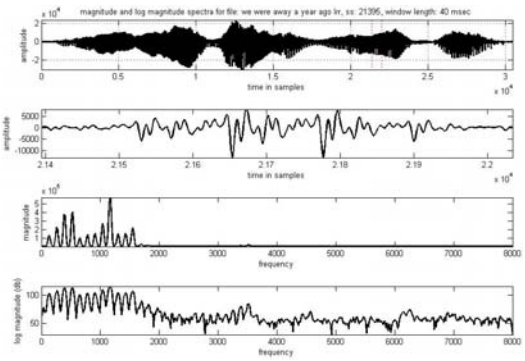


Highpass Filter Speech Waveform

- highpass_filter_GUI.m

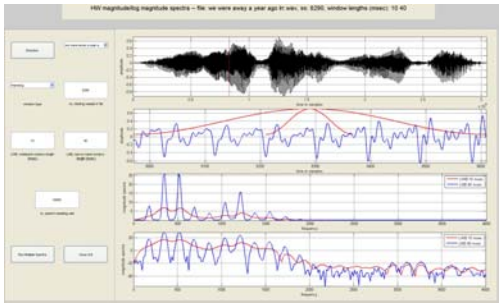


Plot Signal and STFT Log Magnitude

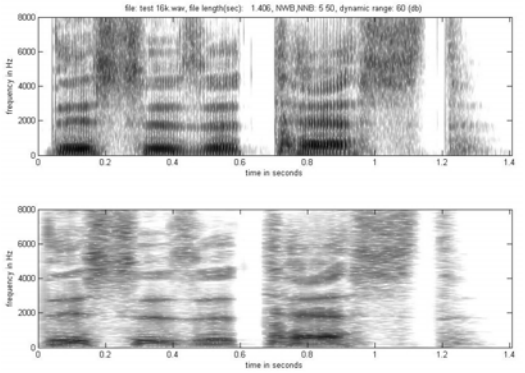


Multiple Spectra GUI

- multiple_spectra_GUI.m

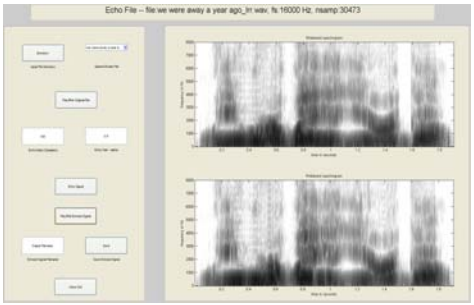


Plot Spectrogram



Plot Spectrogram

- spectrogram_GUI.m



Plot Multiple Spectrograms