University of Texas at Arlington

EE 2347 Fall 2013

Lab Project-1 (Group of two students)

Due date: 09/30/2013

PRINT YOUR NAME in CAPITAL LETTERS. **ID # : XXXX-XX-_____ & XXXX-XX-_____**
1) Last NAME: _____ First NAME: _____ **2) Last NAME: _____ First NAME: _____**

INSTRUCTIONS:

Print this document and attach this page as a cover of your Project Report.

Submit the PRINTED REPORT in class
&
Submit the MATLAB CODE online (email)

Prob. #	Max Points	Points Earned
Code	50	
Report	50	
Total	100	

1. Title:

Signal Analyzer and Synthesizer

2. Objective:

This project has two major components: a signal analyzer and a synthesizer.

2.1 Signal Analyzer:

Given an audio signal (chirp.wav), which is stored as a WAV file, the signal analyzer will

(1) Play the audio signal,
(2) Analyze/estimate the frequency content (magnitude and phase spectra),
(3) Plot both the magnitude and phase spectra, and
(4) Store the analyzed value (magnitude, phase and frequency) as ASCII files.

The sampling frequency has to be **8192 Hz**.

2.2 Signal Synthesizer

Using results from the signal analyzer, i.e. the estimated magnitude and phase spectra, the signal synthesizer will

(1) Read the analyzed value (magnitude, phase and frequency) from ASCII files
(2) Generate/synthesis an equivalent audio signal by combining sinusoidal signals with the estimated amplitude and phase spectra,
(3) Play the synthesized signal,
(4) Store the synthesized audio signal in a WAV file (name it chirp_synthesized.wav).
(5) Finally, make a comparison plot of the original signal and the synthesized one.

Develop and implement the algorithm in MATLAB to analyze and synthesize audio signals. The signal analyzer part of your program shall read/load the audio signal, play the sound, plot part of the audio signal, show its frequency content (i.e. its magnitude and phase spectra), and store the spectra as ASCII files. For the synthesizer part, your program shall load/read the magnitude and phase spectra from the corresponding spectra file, generate/synthesize the equivalent audio signal, play the sound, plot part of the synthesized signal, and store the synthesized signal as an wav file.

3. Mathematical and Computational tools

- Mathematical background: Trigonometric functions, complex exponential, Fourier analysis and Fourier Transform, magnitude and phase spectra.

- Some relevant MATLAB functions: fft(), fftshift(), input(), subplot(), wavread(), wavwrite(), wavplay(), save(), load(), linspace()

- Frequency axis for the signal spectrum after N-point FFT: Let fs be the sampling rate in number-of-samples per second, and N be the number of data points (i.e. number of elements in the data array). The output of fft function in MATLAB is an array of size N

representing the spectrum of the signal. The frequency axis of the spectrum is determined as follows:

Let i =1, 2,...,n be the indices of the spectrum array, -The first element (i.e. i = 1) is the DC component (i.e. f = 0 Hz) -The last element (i.e. i = N) has a frequency (i.e. f = fs Hz) Since frequencies for the first and last elements are known, the frequency axis can be generated using the following formula

$$f_i = \frac{i-1}{n-1} * f_s \text{ for i } = 1, 2, \ldots, \text{N}$$

Note that after the FFT, we are only interested in the first half of the output array.

4. Tasks

1) Develop a high level algorithm (sketch the flowchart) for this project; identify major functions for the entire program. Submit the Flowchart with your report.

2) Building on your Project, develop and validate a computer method and codes to generate/synthesize audio signal with the given magnitude and phase spectra. The use of MATLABs fft function is recommended.

3) Submit a project report (in MS Word) with at least the following sections (i.e. follow the IEEE format): -

    a) Abstract of this study –
    b) Theory section which includes
        i. Brief description of Fourier analysis,
        ii. Brief description of method to estimate the frequency content of a signal,
        iii. Brief description of your synthesizer design -Validation and result analysis section which include test results using the sample user input and show/plot the results. -
    c) Results and Analysis with plots and data.
    d) Flowchart
    e) Summary/Conclusions of this project

4) Submit the project report (printed copy) in class. email the GTA the electronic file for the report along with the complete MATLAB program (*.m extension).

5) **YOUR EMAIL MUST CONTAIN THE SUBJECT**: "EE 2347: Project #1". e-mail it to the GTA: mohammad.hasan@mavs.uta.edu, tanmoy.bhowmik@mavs.uta.edu

NOTE:
This should be a fun and interesting project. Start working on the project as early as possible. If you have any question (or difficulty) please contact the GTA.