Namal University, Mianwali

Department of Electrical Engineering

EE 345 (L) – Digital Signal Processing (Lab)

Lab – 9

Audio Signal Processing using MATLAB

Student Name	Student ID

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Lab Engineer: Faizan Ahmad

Version 1.0 – Muhammad Usman – 15/04/2021
Version 1.1 – Zulaikha Kiran – 05/04/2022
Version 1.2 – Husnain, Saiqa Dilawaiz – 06/04/2023
Version 1.3 – Faizan Ahmad – 26/02/2024

Introduction

The purpose of this lab is to enable the students to study audio signal synthesis and analysis using MATLAB.

Course Learning Outcomes

CLO1: Develop algorithms to perform signal processing techniques on digital signals using MATLAB and DSP Kit DSK6713

CLO3: Deliver a report/lab notes/presentation/viva, effectively communicating the design and analysis of the given problem

Equipment

- Software
  - MATLAB

Instructions

1. This is an individual lab. You will perform the tasks individually and submit a report.
2. Some of these tasks are for practice purposes only while others (marked as 'Exercise') have to be answered in the report.
3. When asked to display an image/ graph in the exercise, either save it as jpeg or take a screenshot, in order to insert it in the report.
4. The report should be submitted on the given template, including:
   a. Code (copy and pasted, NOT a screenshot)
   b. Output values (from command window, can be a screenshot)
   c. Output figure/graph (as instructed in 3)
   d. Explanation where required
5. The report should be properly formatted, with easy to read code and easy to see figures.
6. Plagiarism or any hint thereof will be dealt with strictly. Any incident where plagiarism is caught, both (or all) students involved will be given zero marks, regardless of who copied whom. Multiple such incidents will result in disciplinary action being taken.

Background

Audio signal processing involves the manipulation, analysis, and enhancement of sound waves using digital techniques. Initially, analog audio signals are converted into digital format through analog-to-digital converters (ADCs). Once digitized, various processing techniques can be applied, including filtering, equalization, compression, and reverberation, among others. Filtering can remove unwanted frequencies or enhance specific ones, while equalization adjusts the frequency balance of the signal. Compression reduces the dynamic range of the signal, making it more uniform in volume, often used in music production and broadcasting. Reverberation adds simulated acoustic reflections to create a sense of space or ambiance. These techniques can be implemented using algorithms in software or hardware, providing flexibility and control over audio content in applications ranging from music production and mixing to telecommunications and entertainment. Additionally, advancements in machine learning and artificial intelligence have further expanded the capabilities of audio signal processing, enabling tasks such as noise reduction, source separation, and automatic audio tagging.

Exercise:

Task 1:

1. Using this information create a few different notes in MatLab as follows:

```
f = sin(2*pi*174.61*t);
g = sin(2*pi*195.99*t);
a = sin(2*pi*220*t);
b = sin(2*pi*246.94*t);
```

2. Now to create a line of music use the following command:
   Put the notes in the order you want them to play.
   line1 = [a,b,g,f,f,b,b];
   line2 = [a,b,b,f,f,g,g];
3. To create a music file use:
   music = [line1, line2];
4. To play the file use 'sound(music)'

Task 2:

Add noise in the above music signal using 2*randn(size(t)) command, and take Fs=8000.

Task 3:

To remove noise, design a low-pass filter using commands below, and the cutoff frequency of filter should be 175Hz.

```
cutoff = f/(fs/2);
order = 50;
d = designfilt('lowpassfir','CutoffFrequency',cutoff,'FilterOrder',order);
output= filter(d,music);
```

Task 4:

Design a high-pass filer having cutoff frequency 200Hz.

Task 5:

Design a band-pass filer which passes the range of frequency 200-300Hz.

Task 6:

Record your own voice and observe the frequency spectrum?

```
myVoice = audiorecorder;
disp('Start speaking.')
recordblocking(myVoice, 5)
disp('End of recording. Playing back ...')
play(myVoice)
```

Evaluation Rubric

- **Method of Evaluation**: In-lab marking by instructors, Report submitted by students
- **Measured Learning Outcomes**:

CLO1: Develop algorithms to perform signal processing techniques on digital signals using MATLAB and DSP Kit DSK6713
CLO3: Deliver a report/lab notes/presentation/viva, effectively communicating the design and analysis of the given problem

	Excellent 10	Good 9-7	Satisfactory 6-4	Unsatisfactory 3-1	Poor 0	Marks Obtained
Tasks (CLO1)	All tasks completed correctly. Correct code with proper comments.	Most tasks completed correctly.	Some tasks completed correctly.	Most tasks incomplete or incorrect.	All tasks incomplete or incorrect.	
Output (CLO1)	Output correctly shown with all Figures/Plots displayed as required and properly labelled	Most Output/Figures/Plots displayed with proper labels	Some Output/Figures/Plots displayed with proper labels OR Most Output/Figures/Plots displayed but without proper labels	Most of the required Output/Figures/Plots not displayed	Output/Figures/Plots not displayed	
Answers (CLO1)	Meaningful answers to all questions. Answers show the understanding of the student.	Meaningful answers to most questions.	Some correct/ meaningful answers with some irrelevant ones	Answers not understandable/ not relevant to questions	Not Written any Answer	
Report (CLO3)	Report submitted with proper grammar and punctuation with proper conclusions drawn and good formatting	Report submitted with proper conclusions drawn with good formatting but some grammar mistakes OR proper grammar but not very good formatting	Some correct/ meaningful conclusions. Some parts of the document not properly formatted or some grammar mistakes	Conclusions not based on results. Bad formatting with no proper grammar/punctuation	Report not submitted	
Total						