EEE321 Lab Work 3

(Clearly justify all answers.)

(Due 4 November 2022)

In this lab work you will apply the concepts of impulse, impulse response, and related filtering to a real-life problem.

The task is to record an approximate impulse response of a music auditorium. And then pass music recorded in an anechoic environment through the linear time invariant system (the filter) to simulate the music that would be actually heard by a person sitting at a certain position while that music is performed on stage.

You must find a partner first; the experiment will be conducted by a team of two students. You should then download a piece of anechoic music from

https://research.cs.aalto.fi/acoustics/virtual-acoustics/research/acoustic-measurement-and-analysis/85-anechoic-recordings.html

Read all the explanations in that site, and make sure that you comply with all the required intellectual property rules.

Store that music in a local directory in your computer system. Make sure that it is stored in a file that can be opened by MATLAB. You do not need a too long music: make sure that it fits to an array whose size can be handled by MATLAB. Note that most of the digitally stored music is *compressed* in a lossy fashion, and therefore, inherently distorted compared to the original; that includes mp3 files. However, most of the commonly used compression algorithms are quite good and the distortion might not be noticed by most humans.

Get a few balloons (you may get them from department office) and go to Odeon with your partner. While one of you goes to the stage with the full blown balloon and a needle, the other student should choose a seat (preferably at the back seats) and sit there with a cellular phone ready for sound recording. When the recording setup is ready (make sure that there is no other noise around; that includes wind and rain noise, too), the balloon should be exploded using the needle, and the sound of that explosion must be recorded. The exploding balloon approximates (and it is a quite good approximation) an acoustic impulse function. The recording is, therefore, the impulse response of the system that includes the entire acoustic structure between the point where the balloon is exploded (input) and the point where the recording is conducted (output). Store the recording using a standard sound file structure; again, note that commonly used formats are lossy due to compression algorithms they inherently employ, but the loss may be tolerable. Transfer the recording to your computing environment where you run the MATLAB. Just for the record, take pictures showing the student on stage with the balloon, and the sitting student to give us an idea of the location of the seat.

Now you are ready to perform the filtering. EACH STUDENT MUST PERFORM HIS OWN FILTERING; SUBMMITED REPORTS MUST BE PREPARED BY EACH INDIVIDUAL STUDENT. Note that some of the downloaded music has quite low volume; you may wish to modify that by introducing appropriate level of amplification, by multiplying your input array by a constant > 1 (make sure that no

distortion is introduced by this stage). Using the MATLAB's convolution commands, pass your original (or amplified) music recording through the linear time invariant system represented by the impulse response you recorded. Store the output music as a standard sound file to your directory. This will be the simulation of the music that will be actually heard at that seat of Odeon when the originally recorded music is played on the stage where the balloon was exploded.

For the face-to-face lab session:

1- Be ready to run your original music, output music and your impulse response using players that can handle your stored files. 2- Plot your impulse response as a graph in your report. 3- Plot a short segment of both the original music sound and the resultant output music sound.

Prepare a report, clearly explaining the entire procedure in such a detail that anybody reading the report can identically repeat the entire process. Include the graphs mentioned above in your report. Also include the pictures mentioned above in your report. Upload your report to MOODLE, together with three sound files: your impulse response, a segment of the original music, the segment of the output music corresponding to the uploaded input segment (file sizes should comply with th MOODLE constraints).

Comment on the results: that should include your opinions, after conducting this experiment, related to i- the quality of impulse, ii- the nature about the impulse response, iii- validity of the linear time invariant system assumption of the acoustic environment, iv- distortions and their reasons, v- noise during the recording and its effects. Also comment on the effect of acoustical structure of the listening environment to the listening quality experienced by the audience. In your opinion, which music is more pleasant the original or the one listened in that particular acoustic environment?