Empirical and numerical estimation of room acoustic properties

Due Date: 2024-10-17

Document all your work in your post on the course website.

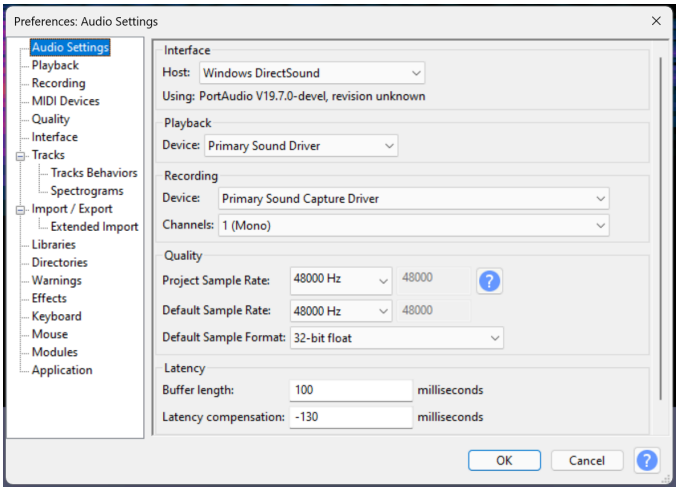
During this exercise, you will become familiar with simple room acoustic estimations and the tools for them. Additionally, you will document the rooms by generating a simple impulse response for each of the three rooms, using free software tools and your notebook/personal device.

Instructions

There is a very wide range of free software available for recording and editing audio.
We will focus on Reaper and Audacity which are available for Windows and Mac OS.

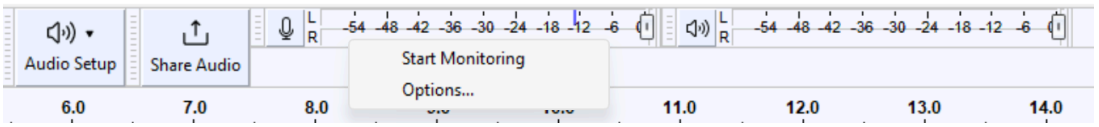
https://www.reaper.fm/download.php
https://www.audacity.de/downloads/

- For this exercise only Audacity is needed. Download and install the software.
- Open Audacity and choose your audio input and output. The configuration can be found in the Edit -> Preferences menu or by clicking on the ‘Audio Setup’ button in the toolbar. Select your system audio device for playback and recording.
- Make sure that your system microphone and loudspeaker are unmuted.



Record a mono audio track

- Right click on the microphone level meter and select ‘Start Monitoring’:



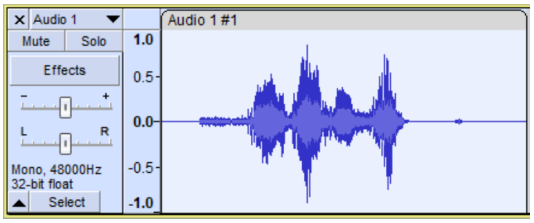
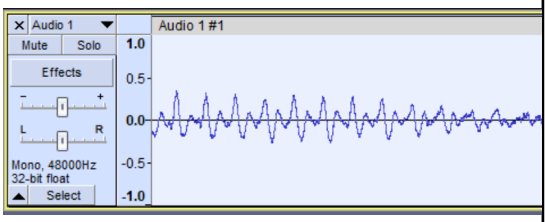
  You should see a green level meter bar that reacts to your voice and ambient sound.

  To get an optimal recording, the loudest parts should reach -12 to -6 dB on the meter. The sensitivity of the microphone can be adjusted with the fader button.

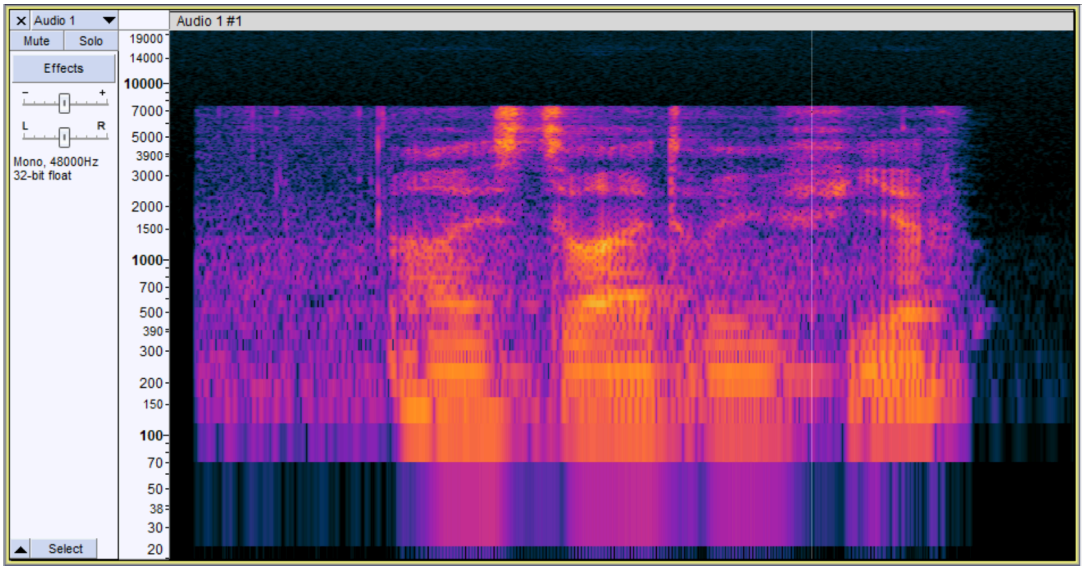
- Click on the ‘Record’ button on the left side of the toolbar:

  To stop the recording press stop.

- You will get a new track with a level envelope plot of the recorded audio. If the overall level was quite low, the recorded sample can be normalized (-> Effect -> Normalize).
- If you zoom in, you will be able to see the recorded wave form, which corresponds to the sound pressure. By selecting the spectrogram option from the Track drop down menu on the left (right click on ‘Audio 1’) a spectrogram of your recording will be shown.

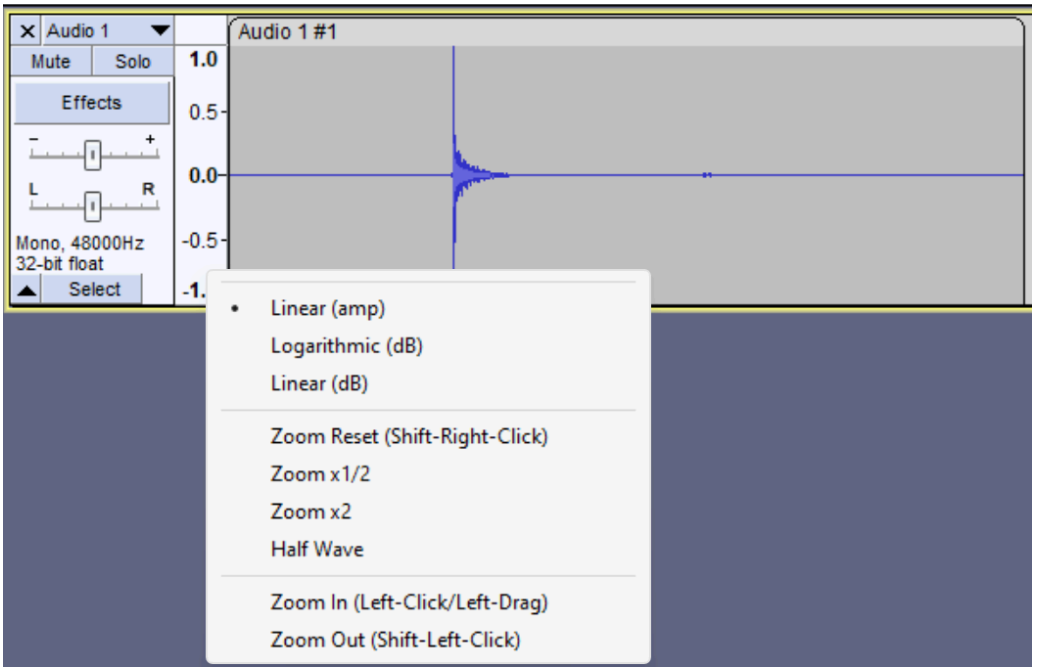
Envelope:	Waveform:
	

Spectrogram:



Task 1:

- Record a few sounds using audacity and play them back again (using a headphone or the speakers of your notebook).
- Record a few clapping sounds in one to two of your three rooms. Make sure that you are in a distance of approx. 1-2 meters to the recording device. Make sure that the individual claps and their reverberation do not overlap (if the reverberation time is very long).
- Configure the visualization of the track by selecting ‘Logarithmic (dB)’ and ‘Half Wave’ from the dropdown menu (hidden under the level ruler, right click):

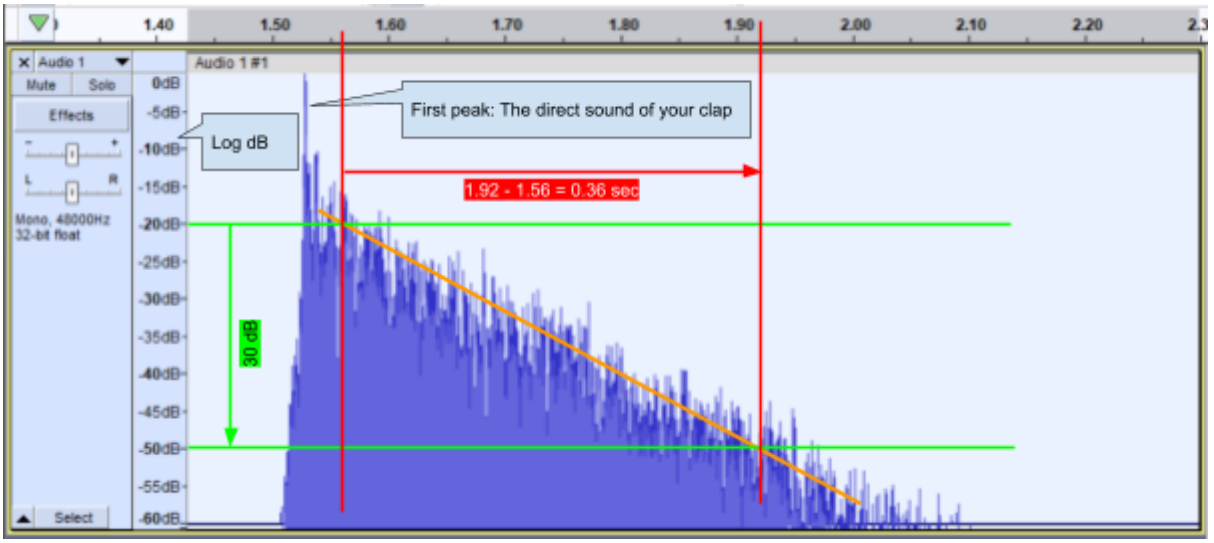


- Normalize (if needed) and filter* (if needed) the recorded audio track.

*) Often it helps to spectrally limit the bandwidth of the recording to a range of 300 Hz to 4000 Hz. This removes the not audible (A-weighting) low frequency sounds and Increases the relevance of the estimation of the reverberation time.

- By zooming in you can easily spot the decays of your claps as linear decays (in the logarithmic scaled envelope plot).
- Try to guess the reverberation time RT60 which you recorded as 'room response' of your claps.

  Reminder: The reverberation time is the time required for a 60 dB decay. If you can measure a 20 dB or 30 dB decay only (e.g. due to a bad signal to noise ratio), the reverberation time as determined by the linear approximation in the plot needs to be multiplied by a factor of 3 or 2 (respectively).



  In my case: 30 dB decay (see green arrow) in 0.36 seconds.
  This corresponds to a reverberation time of RT_{60} = 0.72 sec

- Post a screenshot of your estimation and the numerical values for one to two of your three rooms in your assignment post.
- Are there echoes visible in the impulse decay (they show up as discreet late peaks)?

Task 2:

- Try to estimate the reverberation time at 500 and 1000 Hz using a simple online calculator, e.g.:

  http://www.mh-audio.nl/Acoustics/ReverberationTime.html
  https://sarooma.com/webapp/

- Document accordingly in your post.