



Laboratory 1 – Smartphone calibration

Objective and preparation

The first lab session of this course deals with sound pressure level measurements and the possible use of a smartphone as a sound level meter together with its calibration procedure. The research questions are the following:

1. Is it feasible to use a smartphone as a sound level meter?
2. How is the calibration procedure designed and carried out?
3. What sound pressure levels have you recorded?
4. How accurate are your measurements?
5. What sources of error are there?
6. How can you estimate them?

Groups of 2-3 students will be formed, while at least one should have a smartphone that can record audio or voice memo. The laboratory task is divided into three parts described below.

Part 1. Measurements of sound and silence

A single tone (unknown frequency yet) and a noise signal will be played (one at a time) by the teacher and all participants will record with their smartphones the same sounds together at the exact same spot. The teacher will also record those sounds with a calibrated sound level meter, the latter (i.e. “real”) results not provided to the students yet. Moreover, silence will also be recorded in the anechoic chamber.

The students should take measurements with a dedicated smartphone application: there is an App from Arbetsmiljöverket called “Buller” that can be downloaded for free, or another one called “OpeNoise”. But you are welcome to find/try different ones. Please save and write down these measurements, since the following steps will aim at “guessing” the values the teacher recorded.

Part 2. Calibration of measurement device

In order to perform the calibration, each group will use a function generator, an amplifier, a loudspeaker, a sound level meter and a computer.

- Hint 1: find a way to establish a relationship between the raw data acquired by the smartphone’s recorder – imported to a computer with a *Matlab* script provided on the course website - and the values given by the sound level meter that will be at your disposal.
- Hint 2: the peak voltage output from the smartphone recording is proportional to the sound pressure.
- Hint 3: a calibration factor can be expressed as: $\beta_i = \frac{\hat{v}_i}{p_i}$

Questions of reliability and validity of the measurement should be addressed at this stage. Is it better to use discrete frequencies (i.e. a tone) or a noise signal to calibrate? If a tone is used, how many different ones should one consider? Is one enough? What about the amplitudes (i.e. volume of the signal)? Should one consider several for each frequency?



Part 3. What was the sound pressure level of the sounds/silence recorded in “Part 1”?

Based on the calibration method designed in “Part 2”, translate the raw data acquired by your smartphone in “Part 1” into sound pressure level (in dB), and see if it coincides with the ones recorded by the sound level meter. Discuss the results.

A smartphone app that can register sound pressure levels should also be employed. Discuss if the acquired value is accurate and how accurate compared to the one you got by applying the calibration process as well as with the “real” one recorded by the sound level meter. What are the possible sources of error? Take a look at the situation where you measured silence; when analyzing the audio file, you will nevertheless notice some noise in the signal. Where does the noise come from? How does it affect your other measurements? How can this “background noise” be corrected?

Results

The results of the laboratory will be presented and discussed on Friday, November 15th at 15:15 during the exercise session. Each group will shortly present the actual recorded values of sound pressure level from their measurements. Make sure that you have the following data (from “Part 1”) at hand:

- The sound pressure level of the single tone
- The Z-weighted (un-weighted) sound pressure level of the noise
- The Z-weighted (un-weighted) sound pressure level of silence

Laboratory report

Generally, the results from a laboratory exercise are presented in a written report. For the first lab just an oral presentation is required.

NB: There are some guidelines on how to write a technical report uploaded in the course website. Please start getting familiar with them for the next labs to come!