This document has been created as a part of the Erasmus+ -project “Developing Digital Physics Laboratory Work for Distance Learning” (DigiPhysLab). More info: www.jyu.fi/digiphyslab

Smartphone thermometer?

Student version

6.2.2023

Co-funded by the Erasmus+ Programme of the European Union

Smartphone thermometer?

Motivation

Smartphones are equipped with plenty of sensors, primarily intended for providing a better user experience or monitoring the state of the system, but these sensors also provide a lot of possibilities for physics experiments. However, there is one sensor that would be nice for physics purposes that smartphones often lack: a thermometer. More accurately put, phones often do have thermometers, but they are used to monitor the temperature of the important insides of the phone such as the battery and the processing unit. To measure the ambient temperature, they are thus of little use. But hey, temperature is always determined indirectly by measuring some effect of temperature, so perhaps it is possible to do so with a smartphone!

In this experimental task we will design an experimental setup and procedure, which will allow us to estimate ambient temperature using data taken with tools available in a smartphone. You can use any additional equipment that you wish barring external temperature sensors plugged into a smartphone (no cheating!) or a temperature app (they might not do such a good job either). Do not go into this task with the expectation of finding a perfect method or collecting extremely precise data. The focus is in recognizing and analyzing the limits of an experiment, and in exploring the question “How plausible is it to measure temperature with the tools available in a smartphone?”.

Equipment list

Smartphone. You can access sensor data for example by using the free smartphone app phyphox (RWTH Aachen University) or Physics Toolbox Sensor Suite (Vieyra Software / Chystian Vieyra). However, feel free to use any other apps or tools available in the smartphone if you like.

Other equipment is chosen by the experimenter.

Experimental skills in focus

Designing an experiment, recognizing and analyzing the limits of an experiment.

Safety

Experiments are performed on one’s own responsibility. Design your experiments in such a way that your smartphone stays safe.

Task Description

Step one: Familiarize yourself with the sensors available in your smartphone by going through the options in your measuring app. Which sensors or tools can measure data that you can link to temperature based on a physical model? If you have trouble coming up with measurable quantities related to temperature, ask your instructor for hints.

Step two: Plan the experimental procedure with which you can estimate the ambient temperature by making measurements with your smartphone sensor of choice. Feel free to use any additional equipment that you see fit, except for an external temperature sensor. Present the plan to your instructor before executing it. Your plan should include the following aspects:

- What equipment is used for the experiment?
- What quantities will be measured and how?
- How is temperature determined based on the measured quantities?
- What experimental uncertainties are expected?

Step three: After your instructor has OK'd your plan, perform the measurements to obtain an estimate of the ambient temperature in your chosen location. Feel free to make changes to your plan if a reason to do so comes up.

Step four: Reflect on your measurement. Is there something to improve in your experimental setup? Try out the changes that you come up with (within the given timeframe for experimentation).

Assessment

Prepare for a discussion with your instructor regarding your experiment. Also have your data in a presentable form (tables, graphs) so you can use them to back up your arguments. The discussion is guided by the following questions:

- What was your experimental setup like, especially if you made changes in your initial plan?
- How did you obtain the ambient temperature from your measured data?
- How accurately and precisely were you able to determine the temperature?
- What choices did you have to make which were not optimal? How does this reflect on your results?
- What shortcomings can you identify in your experiment, and in determining temperature with smartphone sensors in general? What would be required to overcome them?