Smartphone Experiments beyond Newtonian Mechanics

Dominik Dorsel, Sebastian Staacks, Christoph Stampfer

Institute of Physics II, RWTH Aachen University, Templergraben 55, 52062 Aachen

Simon Hütz, Heidrun Heinke

Institute of Physics I, RWTH Aachen University, Templergraben 55, 52062 Aachen

Abstract. While common sensors in smartphones allow for a multitude of smartphone-based experiments in the area of mechanics, other areas of physics and other STEM courses can only profit from few of these low-cost experiments. We have a look at these non-mechanical experiments and demonstrate a new alternative by adding supplementary sensors via Bluetooth to access those quantities which are inaccessible by common smartphone sensors.

1 Introduction

Smartphone-based measurements have become a welcome variation for experimentation in physics education as they can be done at low or even no additional cost and provide novel and accessible data acquisition. However, the most common sensors in modern phones (accelerometer, gyroscope, GPS location, atmospheric pressure sensor and microphone) lead to a strong emphasis on mechanics and acoustics, only countered by few magnetometer-based experiments. We demonstrate a way to overcome these limitations by adding supplementary sensors via Bluetooth in combination with the app phyphox.

2 The app “phyphox”

The app phyphox (for “physical phone experiments”, more info on phyphox.org) from the RWTH Aachen University allows a simple read out of the built-in smartphone sensors for basic experimental applications. Although raw data can be very instructional while analyzing, it often distracts learners from the physics subject to be taught. Therefore, phyphox includes tools for a whole data analysis of the measured data on the phone. The app contains a range of predefined settings for specific experiments, which can be modified with an editor by any user. Through this editor, new experiments can be created, and the data analysis can be customized to the requirements of a specific class. Additionally, phyphox features a simple remote control function, allowing any second device, which is in the same network, to monitor and control the measurement. The second device can be another smartphone, notebook or any other device with a web browser. This gives students a direct feedback of the measured data in those experiments.

3 Experiments beyond Newtonian Mechanics

Typical smartphone experiments mostly fall into the area of Newtonian mechanics due to the selection of the sensors available in most smartphones. There are two options to extend the range of experiments beyond the area of mechanics: a) using specific built-in sensors as the air pressure sensor or the magnetometer, or b) extension of the experimental setup by external sensors. Using external sensors is a new feature in phyphox, offering a lot of new sensor types and possibilities for experiments outside Newtonian mechanics or even outside physics.

The light sensor for example is available in many smartphones and allows to measure the inverse quadratic dependency of illuminance against distance. To do so, a candle is placed at different distances in front of the smartphone's light sensor. The support of external sensors allows to measure the distance with a Bluetooth mouse automatically. If the candle is moved together with the Bluetooth mouse, the illuminance can be plotted against the traveled distance of the Bluetooth mouse and the inverse quadratic relation can be shown directly as seen in figure 1.

Besides this example of readily available Bluetooth hardware, versatile sensor boxes are available at low cost to access new physical quantities like temperature or humidity. Also, self-made extensions, for example based on the Arduino platform, represent even more versatile data sources.

4 Conclusion

While some sensors in smartphones already allow experiments beyond Newtonian mechanics, additional data sources are still required to expand the scope of cheap and accessible data acquisition. With the new support of external Bluetooth Low Energy sensors, a whole range of new experiments becomes available for various areas within physics and other fields in STEM education.

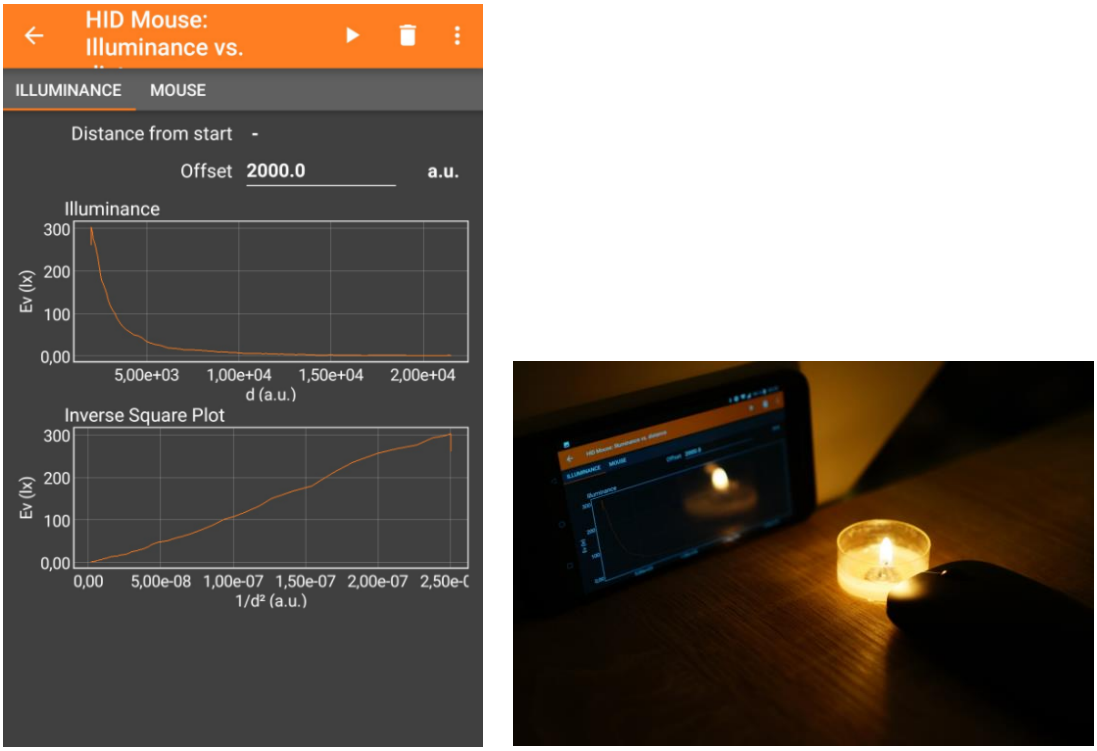

Fig. 1: Illuminance of a candle at different distances to measure the quadratic correlation.