ππgraf: A device to read charts for the visually impaired

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Pupils in the joint school for visually impaired in Bratislava learn physics in practical exercises. In particular, they are using the Pro'sKit MT1820 multimeter with a temperature probe to make hands-on experiments with heat exchange. As part of these experiments they record data and visualize them in tables and charts. Following up on a previous cooperation [1], students at the Faculty of Mathematics, Physics and Informatics cooperate with the physics teacher from the joint school through their project on Information Systems Development course [2]. Their task is to develop a program that communicates with the multimeter, collects the data and shows them on PC display so that they are easily visible for those that can see and accessible for a screen reader for the others. However, the screen reader is not capable of reading line charts.

We have developed a device that detects the movements of the slider potentiometer and sends its position to the PC. The software on the PC allows drawing charts. It reads the position of the potentiometer as the x-coordinate in the chart. It uses the sound output to signalize the position of the line chart on the y-axis. In this way, the visually impaired or blind student can "listen" to the chart curve.

Apart from using in the heat exchange experiments with recording a line chart of temperature, this device has a broader potential. Pupils in usual schools are using wonderful tools, such as [5] to learn mathematics. The purpose of ππgraf is to improve the experience of visually impaired pupils while studying mathematics and physics. The ππgraf device was designed and built by participant of a robot club at age 13 at a different elementary school. It contains the four potentiometers: two linear ones for each axis, and two circular for additional applications, see Figure 1.

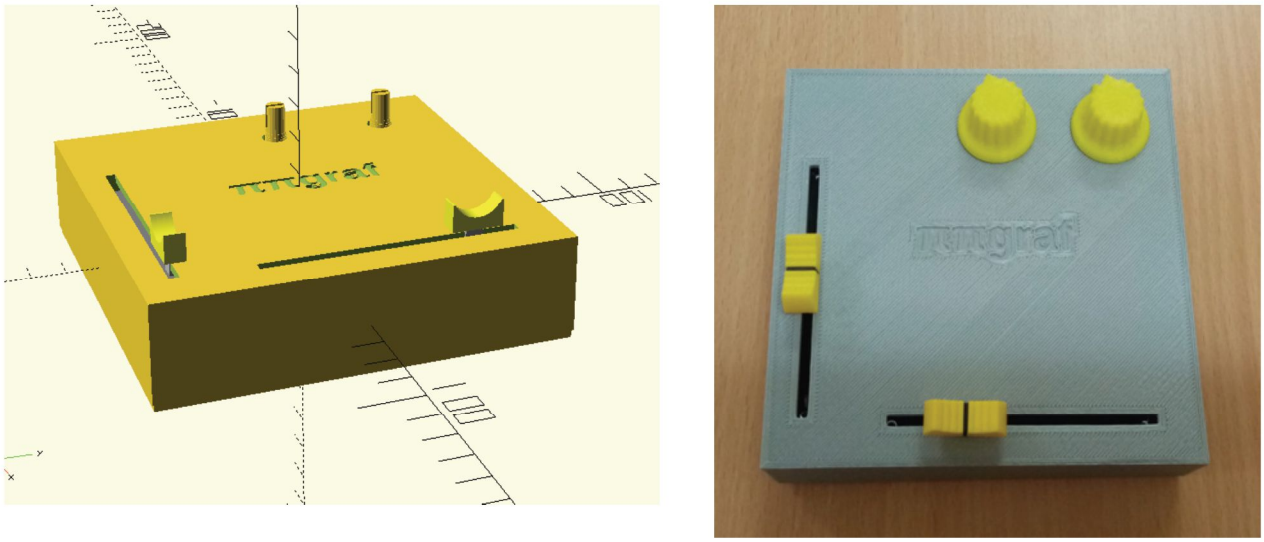

Figure 1. ππgraf as designed in OpenSCAD and produced on a 3D printer.

The prototype software to test the capabilities has been written in Imagine Logo [3], currently it allows reading (or playing loud) only line charts. In the case of line chart, after starting the operation, the PC is producing a musical note with the pitch that is proportional to the y-coordinate at the currently selected x-coordinate. We plan to add additional chart types: 1) bar charts (histograms) will produce the same tone in the same bar, producing a clicking sound when moving to the next bar; 2) xy-scatter plots, where the second linear potentiometer comes to play, for the

selected x-y position in the chart, the PC will produce noise that will be proportional to the density in the position neighbourhood; 3) pie-charts, where the circular potentiometers will find their usage, while the behaviour will be alike the bar charts.

In the first three modes, the circular potentiometers can be used to regulate volume, and possible zoom in or out for a specific region of the chart.

Currently, we have built several prototypes of ππgraf, the students have finalized the software and performed successful tests with the pupils in the early 2020. Ππgraf is open-source and available at its Github page [4]. Ππgraf is very easy to build and very low cost. It has been presented to the public for the first time at Mini Maker Faire in November 2019 in Bratislava.

Recently, we have added an example VBA project for MS Excel that can use ππgraf to play chart shown in Excel using musical notes, also available at [4].

This project is a manifestation of how constructionist approach in after school robot club can be targeted at producing useful devices that help the peers of the robot club participants.

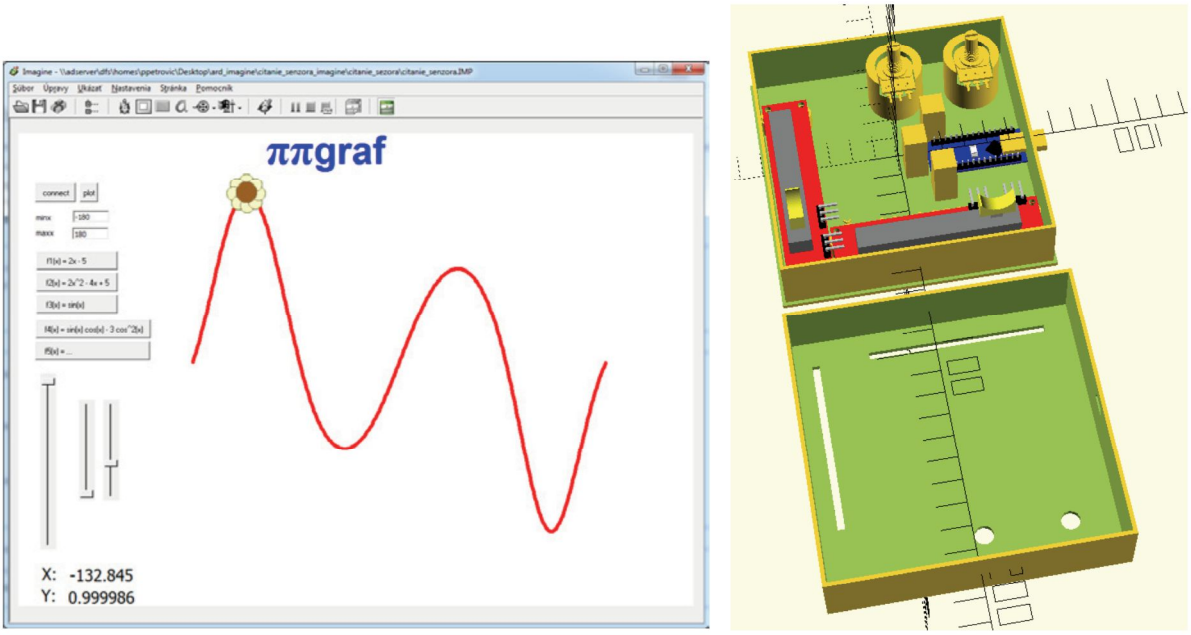

Figure 2. A protype software for ππgraf implemented in Imagine Logo (left) and the design of ππgraf in OpenSCAD as created by Oliver who is 13 years old.

References

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