A new Advanced Learning Platform for Analog Circuits and Automation for hybrid electronic practicals

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Abstract. The COVID-19 lockdowns forced a hybrid form for our electronic lab course. To keep the necessary hands-on experience, we developed the Advanced Learning Platform for Analog Circuits and Automation (ALPACA). This ALPACA platform works either with Arduino or the Raspberry Pi Pico, the latter controlled within our desired language Python. The ALPACA was successfully used for at-home practicals; student evaluations were overall more positive than previous years. As student' motivation improved whilst the grades remained comparable, we continue the use of the ALPACA in the non-COVID era.

1 Introduction to Electron Instrumentation

Nanobiologists study biology at nanoscale using physicists' equipment. As part of their education, nanobiology students get acquainted with sophisticated equipment and simultaneously learn the underlying principles, such that they understand how instrumentation influences their measurement results. This understanding is the key ingredient of our Electronic Instrumentation lab course which runs for 16 weeks, with 2 hours theory and 4 hours practicum per week (hybrid: alternatingly on campus and at home). These 16 weeks were divided over 5 weeks at-home electronics, 3 weeks simulations, 2 weeks Python and 6 weeks on-campus electronics. On one hand students learn the basics of electronic circuits and programming, and on the other hand learn how this electronics influences one's measurement outcome. We present the Advanced Learning Platform for Analog Circuits and Automation (ALPACA) [1], which was built for our course, and our findings related to teaching electronics with this platform in a hybrid version of this lab course.

2 Advanced Learning Platform for Electronic Instrumentation

For many courses lab time was restricted due to the COVID-19 [2]. To still engage students in hands-on and minds-on activities, we decided to build our own stand-alone platform that would allow for home-experiments with a lot of freedom to design and build custom electronic circuits.

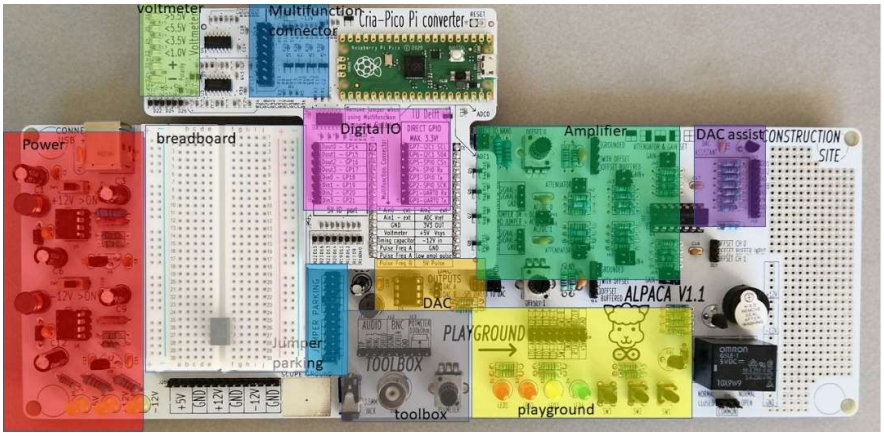

Fig. 1 Advanced Learning Platform allowing electronic experiments in a hybrid era [1]

The first version of the Advanced Learning Platform for Analog Circuits and Automation (ALPACA) used an Arduino Nano, chosen for its good performance, and numerous supported libraries [3]. To allow more advanced at home experiments, many electronic components were included (DAC, amplifiers, power controls), see figure 1. In our renewed design the Arduino is replaced by a Raspberry Pi Pico [4], which allows direct control of the microcontroller from our desired Python and therefore complements the on-campus experiments, with the more sophisticated instruments available, better.

The total system provides the students with the means to measure and control circuits, if needed combined with basic and more advanced test equipment and gives them the freedom to design and experiment with circuits on their own.

3 Results

The results presented here stem from students' evaluation and teacher's observations.

With some adjustments of the tasks and assignments, students were able to conduct the intended experiments at home using the ALPACA platform. An advantage for the students was the extended possibility to prepare and continue outside regular practicum hours. This was particularly useful for our final assignment, where students home-build a colorimeter. They thus attained the learning goals as if they were allowed full lab time. This finding is confirmed by the fact that the average exam grade was not affected.

Students highly appreciated our efforts to continue offline experiments, but most importantly they reported positive experiences: "Arduino was a fun way to build circuits at home", "The SCR and at-home practicals were useful. The ALPACA board was great, really inventive. I learned a lot", "The content of the distance-education was very good; the arduinos and such". These results are augmented with students' evaluations, where ~67% of 24 overlapping criteria were never as highly evaluated as with the ALPACA. The criterion 'I learned a lot from this course' even gained 0.6 point of a 5 point scale.

Despite the positive effects of this hybrid form using the ALPACA, students stated that it was: "difficult to ask questions about a physical circuit online".

4 Conclusion

The ALPACA platform allowed us to introduce students to (advanced) electronics, where students used the equipment at home for experiments, which were previously only performed on campus. Now that we are allowed to go back to campus, we further diminish the negative side of at-home experiments, and further exploit the plus sides of our platform. It thus seems a suitable educational tool that contributes to run lab course in a hybrid educational format.

References

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