




Hardware-Control: Instrument control and automation package

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Summary

Conducting experimental research often relies on the control of laboratory instruments to, for example, control power supplies, move stages, and measure data. Task, such as data logging or parameter scans, often needs to be automated. Being able to easily create a user interface to the hardware and to be able to reuse code is highly desirable.

Hardware-Control is a Python package for instrument control and automation. It provides reusable user interfaces and instrument drivers to simplify writing control programs. Hardware-Control uses Qt, a GUI framework (Riverbank Computing Limited, [2020](#)), to create fast and efficient user interfaces compatible with most major operating systems. Hardware-Control is also designed so that new drivers can be easily added for new hardware and used with existing user interfaces. The package also provides means for simplifying data collection with automatic data logging, plotting, and many export formats. Hardware-Control was designed to be a flexible solution for a wide variety of experimental challenges.

Statement of need

Commercial systems, such as LabVIEW, already exist and they often do provide a wide range of instrument drivers. However, we found that the resulting code is often hard to version control (LabVIEW files are binary and code reviews and pull requests on services such as bitbucket and github are therefore difficult). Furthermore, although backend code can be easily shared between projects, complex user interfaces can not easily be reused. The software package presented here solves the main issues that we have encountered in the past. Specifically, it makes reusing frontend code easier, integrates well with git (pure python code), and provides an easy built-in scripting solution (via an optional python REPL that has full access to the GUI and all backends). Especially the control through python during execution make one-off complex parameter scans easy to implement. The software also makes it easy to develop and test the code without any hardware connected to the system.

A similar package with a slightly different approach can be found at [Scopefoundry.org](#) (Barnard et al., [2020](#)). However, our experiments have a slightly different need and we therefore decided to implement the provided solution. This software is actively being used in two different research projects in our group at Lawrence Berkeley National Laboratory. One such project, ROOTS, uses Hardware-Control to run a variety of data acquisition modules and power supplies to measure carbon content in soil via neutron irradiation. Our other project, STS-50, uses Hardware-Control to operate a compact RF particle accelerator. Although our group is using Hardware-Control specifically in particle physics applications, it can be used in almost any field of experimental research because it solves the broadly applicable problem of instrument automation.

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References

- Barnard, E. S., Buckley, A., Borys, N., Ogletree, F., Ursprung, B., Aiello, C., & Wu, H. (2020). A python platform for controlling custom laboratory experiments and visualizing scientific data. <http://www.scopefoundry.org/>.
- Riverbank Computing Limited. (2020). Python bindings for the qt cross platform application toolkit. <https://pypi.org/project/PyQt5/>.