

Open-source through the lens of a microscope

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A low-cost professional microscope based on open-source technologies has been developed by a group of engineers at the University of Cambridge, Department of Engineering.

The project is part of the OpenLabTools initiative, a new cross departmental initiative to develop [open source](#) instruments for education and research that will remain in the public domain. Academics from five departments, across three schools, are involved in the programme. This project is aimed at providing a forum and knowledge centre for the development of low-cost and open-access scientific tools. The idea is to enable research centres all over the world to do work even with a tiny budget. This may be a spur to education and scientific development in countries with limited resources.

The microscope prototype will cost around US\$800, whereas conventional microscopes cost between US\$15,000 and US\$80,000. It will be modular and simple to replicate, improve and adapt to different research purposes, as the instructions will be made available online. The microscope's electronics are controlled by Raspberry Pi, the US\$25 computer launched in 2012 by engineers at the Raspberry Pi Foundation. Originally designed for educational purposes, this computer is the size of a smartphone and has proven to be suitable for a variety of uses, including gaming and research.

"We are not trying to develop a new cutting-edge technology," says Alexandre Kabla, project supervisor at the University of Cambridge.

"We want to use tools already available on the market to design new and flexible products. Our aim is to share results and build a community that will progressively make these instruments better."

The limited market for scientific instruments means that traditional laboratory equipment could be expensive and therefore out of the reach of university teaching laboratories and research institutions, in particular in developing countries. This causes an increasing mismatch between training and research needs, as well as a growing disparity in research capabilities across the world. OpenLabTools aims to develop low cost scientific tools based on current open source hardware and software projects. The audience the team hope to reach includes students involved in higher education (undergraduate and graduate) and also researchers in academia or research and development labs.

The objective is not to deliver new technologies or even to match today's state of the art. Their approach is to progressively develop an online repository of tutorials that addresses the key components of today's instruments (sensing, imaging, logging, actuating, etc.) and combine them to build some of the most ubiquitous lab instruments. Designing this knowledge centre and assembling the instruments provide a fantastic training opportunity for undergraduate students. Undergraduate projects have already heavily contributed to the initiative, in particular thanks to the support of the University of Cambridge's Learning and Teaching Innovation Fund, and the Raspberry Pi foundation who helped start the project by funding five summer internships in 2013. Our first target is the design of an automated microscope, and preliminary blueprints are now available online (www.openlabtools.org), thanks to the work of Chris McNicol, David Purdie, James Ritchie, Thomas Roddick and Marco Selvi.

The image acquisition, analysis and data storage processes of the microscope rely on the low-cost Raspberry Pi computer and its camera

module. The supporting frame is built with the OpenBeam technology. The focusing system uses positioning techniques currently used for hobbyist and consumer 3D printers. All non-standard parts have been 3D printed and the designs made available online so that the whole system could be reproduced without workshop facilities. The Raspberry Pi computer also has full control of the microscope stage and illumination thanks to the open-source Arduino microcontroller. A few lines of code then enable the implementation of rather sophisticated features such as auto-focusing or in plane tracking. In the next few months, a team of 4th year students at the Department of Engineering will further explore the imaging capabilities of the microscope, as well as the design of new components for the development of mechanical testing rigs or flow tracking systems. They plan to roll out some of these instruments in undergraduate teaching labs within a couple of years, and use them to train graduate students in instrument design and automation through hands-on workshops.

Strengthening the culture of open source instrumentation in academia is likely to increase research productivity and innovation by lowering costs and facilitating collaborations on instrument development.

OpenLabTools will eventually make it easier for researchers to deploy in their lab existing open technologies by providing detailed instructions primarily aimed at students and academics and a forum for discussion and sharing knowledge.

More information: www.openlabtools.org/

Provided by University of Cambridge

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