Desktop plant experiment box

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The Idea

Doing experiments in plant biology is a difficult task. Experimental conditions are difficult to control and often the impact of even slight variations of environmental conditions is difficult to predict.

Commercial solutions to control the environment are available but quite expensive and normally are optimized for plant growth but not for running experiments. For example, when running photographic time-lapse recording, often an entire growth chamber needs to be used for a single plant or plate. If multiple time-lapse need to be run in parallel the costs escalate quite rapidly and the setup becomes complicated.

We want to build small independent “experimental boxes” which are optimized for in-vivo recording of single plant/single plate growth under different environmental conditions and subject to different stimuli. The boxes will be small in size (around 50x50x60 cm), cheap (estimate material cost <£1000 each) and flexible in features thanks to a modular design. The boxes will be under PC control and allow multiple experiment to run in parallel and in sync.

Who We Are

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Implementation

The first version of the boxes will allow illumination control (multispectral visible light for growth and day photography, infrared light for night photography), temperature and humidity control, and include two Raspberry PI cameras in an orthogonal arrangement for the study of plant circumnutation in 3D.

In later versions, atmosphere composition monitoring, rotating plant/plate platform and robotic manipulation will be added to the system. The robotic manipulator will be used for close-up (in-vivo microscopy), to administer mechanical stimuli and for accurate positioning of electrophysiology probes. Localized chemical stimulation (hormone treatment) could also be achieved with the same setup. The boxes will be built in a modular way, to allow a simple “plug and play” of different modules allowing different experimental setup.

The project leverages on a series of previous projects: recently (Kabla Lab, University of Cambridge) a environmental box has been used to study mechanical properties of materials under controlled conditions. In our case an extended version of the box will allow modular experimental setups, while a similar extensometric technique will be available to measure mechanical properties of fresh plant samples. We will also integrate one of the previously OpenPlant funded 3D printed portable motorized microscopes as the microscope head in our design, and include the outcome of our current plant electrophysiology project for stimuli administration and recording.

Benefits and outcomes

Cheap and flexible setup for high-throughput study of plant growth in controlled conditions.

Open source design, integrating previously funded projects

Possible implementation in schools, as multidisciplinary project

Budget

Estimated material cost for each box: ~£1000 (first version) x 2, £2000 (second version including motorized microscope head) x 1
We do not have access to additional funding for this project