Report: Open Pi-Image: A low cost-open source plant growth imaging and analysis platform

Summary

We have designed and constructed a near infrared image capture system based on a Raspberry Pi computer and PiNoir camera and custom 3D printed parts. This runs an extensible and modular open source software suite we developed called Open Pi Image that controls automated image capture and spawns image analysis. The Pi software can be accessed on any external system (e.g. a laptop) via a web server running on the Pi and the system can be embedded in inaccessible places. Open Pi Image is designed to incorporate new user provided scripts for analysis and can be easily extended and customised.

Report and Outcomes:

Open Pi Image went very well according to plan. We successfully created open source Python software to allow a novice user to setup and run a Raspberry Pi/PiNoir Infrared Camera time lapse image capture system.

Software

We produced three base packages ‘opimage‘, ‘opimage_interface‘ and ‘opimage_things‘. ‘opimage’ is the central package containing the image analysis and statistical segmentation algorithm code, ‘opimage_things’ is a sub-package that controls external devices e.g the PiNoir camera on the Pi or motors for automating sample movement etc and ‘opimage_interface’ is a second sub-package that defines the web-interfaces through which modules and tools using the first two packages can be run. These are all installable easily through Python’s package manager in single line commands, source code is available at GitHub .
Currently, ‘opimage_interface’ has an interface that allows timelapse jobs to be setup and run through a graphical web interface. ‘opimage_analysis’ has methods that assist the segmentation of images of sideways photographed seedlings grown on vertical agar plates. The package is easy to extend to include new algorithms and methods. ‘opimage_things’ has methods for controlling camera devices on the Pi’s camera connection port and ‘opimage_interfaces’ presents a web interface for defining time-lapse photography regimes, these are also extendable.
We created an installer that allows the whole package to be installed onto the hardware with a single command-line invocation.

Hardware

We created a specification for a standalone Raspberry Pi unit with a PiNoir camera that uses two WiFi dongles, one to connect to the Internet, one to broadcast its own WiFi channel and serve webpages that show the interfaces that run the tools. This allows the Raspberry Pi and camera equipment to be located in difficult to reach places and accessed without a physical connection.
We have produced models for 3D printing of camera stands for the Pi Cameras.

Live tests

Our complete package from download to captured image analysis has been tested from start to end in a production pipeline in the Webb lab by and we are now confident the tools can be released for use by others.

On-line instructions

Full step-by-step instructions on setting up and installing the tools are available at github.

Expenditure:

Follow On Plans

We will finish the project by writing blog posts explaining the science behind using IR images and the advantages it has for plant analysis, and on how to convert and extract IR enriched signal from captured images.