1 Quick start guide for building your own test setup

1.1 Required materials

To build your own test setup for multispectral imaging using the code in the repository `https://github.com/Liveshort/astroplant-camera-module`, you will need the following (for a single LED board, I recommend buying more and using at least two LED boards for your tests):

- A Raspberry Pi NoIR camera.
- A red LED (660-680 nm), about 15 mA rated current. This is a regular small sized LED, but is best bought from a high quality supplier. More detailed examples can be found in the Github repository.
- A near infrared LED (850 nm), about 15 mA rated current. Dito for buying info.
- A white LED (400-700 nm wide spectrum), about 20 mA, cool or warm doesn't really matter. Dito for buying info.
- Some resistors to limit the current through the LEDs, just like the ones used in the simple `https://www.arduino.cc/en/tutorial/blink` tutorials. You'll need to match the resistive value to the current you want to achieve, but this should be fairly straight forward. Once you have measured the voltage drop over the different LEDS, you can calculate what resistor you need to achieve 15 or 20 mA of current.
- A driver or transistor array to allow usage of the high current 5V rail of the Raspberry Pi. I've used a ULN2003 transistor array, but anything similar will also work.
- A piece of hardboard to mount all the electronics on. If you have the resources to do something more fancy, feel free to use those.
- Some jumper wires and breadboards to wire everything together. Some solder and a soldering iron will also come in handy.
- A way of mounting your creation into the kit. I used duct tape and tie wraps, glue or screws could be used to make create something more permanent.
- Diffuse white paper. Be sure to use a decent kind of paper, and not just some random A4's. I bought some photo cardboard (the stuff you can glue pictures on, and serves as background only). Be sure it is *NOT* shiny in any way, this will be bad for measurements.
- Black sanding paper. It is best to cover the bottom of the kit in unreflective material for the best contrast in the pictures. I've found that most black paper is not really black in the infrared spectrum, but black sanding paper is (and it is also really diffuse, which is very good).

1.2 Building the setup

Wire the LEDs and driver board according to the schematic in figure 1. Stick the white diffuse paper to the ceiling of your Astroplant kit, be sure to not cover the growth light, fans, etc. Then mount your newly produced board in the Astroplant kit aimed upwards, to the ceiling of the kit, like in figure 2a. The code assumes more or less uniform lighting, which is best approximated by illuminating a diffuse surface, and using the indirect lighting as the light source. Cut the black sanding paper to size and cover the area around the plant container. Lastly, follow the instructions in the README of the github repo to get some tests up and running.

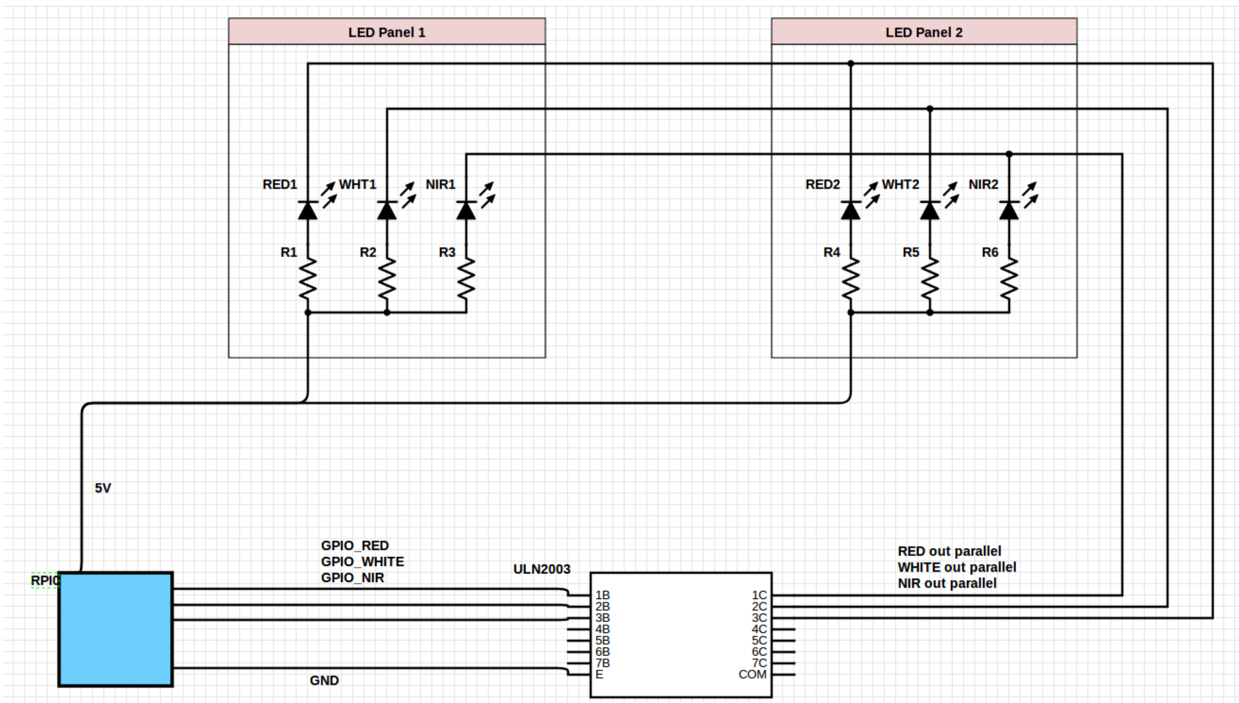
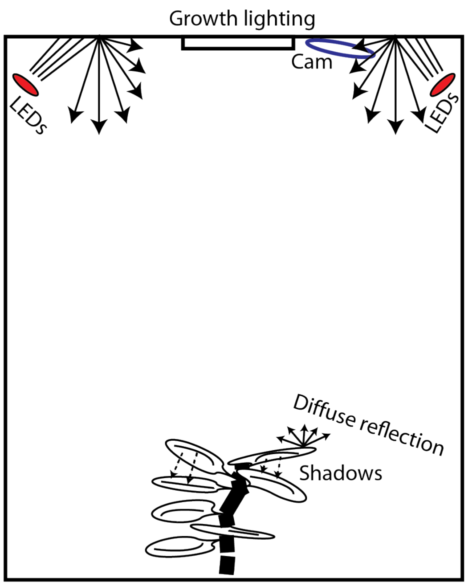
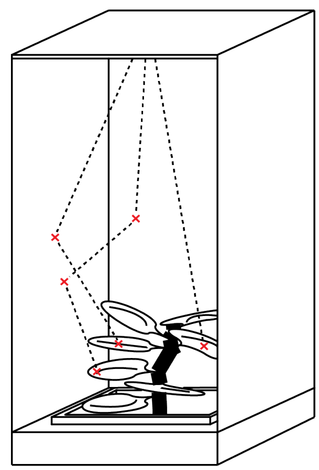


Figure 1: Schematic representation of the test setup used for the following tests. Two boards of three LEDs are present in the kit, mounted in such a way that they radiate upwards on a white diffuse surface. Light from this surface lights the scene with the plant. Resistors in this schematic are chosen to limit the current through the LEDs to 15 mA, and are (for red, nir and white respectively) 150, 200 and 100 Ohm's. A driver circuit is used in order to be able to use the full 5V rail of the Raspberry Pi.



(a) Illustration of the lights pointing upwards and reflecting off of a white diffuse surface, creating diffuse lighting. Light bouncing off of the reflective surfaces on the sides of the kit now plays a significant role in the total amount of light reaching a target surface.



(b) Illustration of the first orders of reflection when diffuse lighting is used. In previous cases the light reflecting off of the walls was relatively minimal, since the beam was pointed directly at the bottom surface, here however, the role of indirect light becomes more serious.

Figure 2: Illustration of the indirect lighting method.

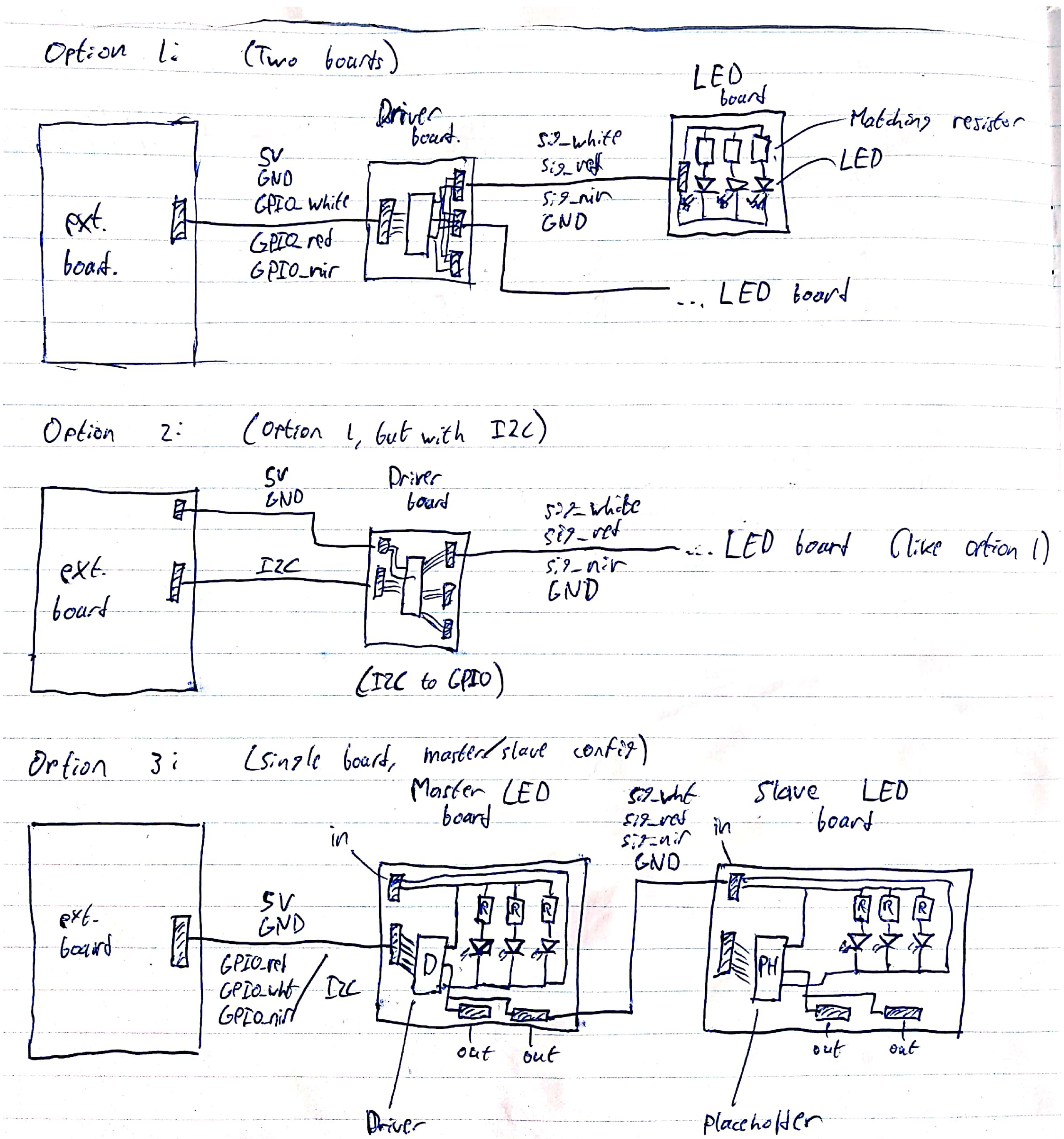


Figure 3: Proposition for the LED board production. The first two options list a driver board and separate LED boards (regular GPIO vs I2C bus), while the last option lists a master/slave configuration where one LED board acts as a master with the driver on board, while the other board(s) act(s) as (a) slave(s).