

# **Low-Cost Multispectral Imagery for UAV-based Vegetation Monitoring**

## **Primary Contact**

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## **Team**

Currently I am the only team member (Jonathan). I'm a PhD student working on image analysis tools, with a Bachelors' in Maths and a Masters' in Systems Biology.

I plan on working on developing the electronics and software to run the imaging device. I am looking at possible collaborations with a few other projects along a similar vein and have researchers both within (at the Scott Polar Research Institute) and around Cambridge who have suggested they would be keen to work within my project. Some of these also want to learn, and some have previous experience of a similar project and are happy to advise. In summary, I'm still looking for more collaborators and hope to gain some early in the project.

## **Summary**

This project is to develop a low-cost multispectral camera. I'd want to combine filtered cameras with identical modules below a light diffuser to measure irradiance. Combining the two streams would then allow mapping reflectance based on the filters used. Within the university we should be able to find a chance to try to calibrate and assess this as an alternative to the currently very expensive cameras. This could be combined with the touch screen to output averaged reflectance indices in the image (I hope) and if we work really hard (though will be difficult) to produce images. This plays in with my UAV work, as I'd love to build and test my own low cost multispectral camera (the one I currently use costs £3,600 and is very far from open source...)

## **Proposal**

### **i) The Problem:**

Multispectral imagery is of great importance in the field of remote sensing and can either be from satellites (such as Landsat) or from airborne imaging. From the data it is possible to compute various indices and measures. One such measure is the normalised difference vegetation index which can be used to assess vegetation cover as well as its health. The cutting edge in vegetation mapping is to use Unmanned Aerial Vehicles (UAVs) for high resolution mapping. These generally either use a more standard RGB camera, or require use of a very expensive commercial camera. With the parallel rise of 'making' I would like to see how possible it might be to develop a low-cost open-source design for a UAV-mountable multispectral camera. This should allow the work I am undertaking in my PhD to develop methods for multispectral UAV data to be accessible at a much more affordable price point

### **ii) The Study System:**

As stated above, the primary study system would be mapping tropical rainforest from UAVs. However, this is not practical in the timeframe for the project. As such the study system can simply be any vegetation, including houseplants. Time permitting I have already got a UAV system and permission in place to fly on some university land and can actually try to get some real field work within the UK with scope to compare

study system can simply be any vegetation, including houseplants. Time permitting I have already got a UAV system and permission in place to fly on some university land and can actually try to get some real field work within the UK with scope to compare to results for a commercial camera.

### iii) The Design Goals:

The design will ideally feature 4 camera sensors. 2 Imaging with different filters, and two to record illumination under the same filters placed underneath a light diffuser. These would be mounted above and below the UAV to produce reflectance maps, though this would require calibration. The design needs to meet three key criteria to be feasible. It must be lightweight to allow it to be flown on a UAV, it needs to be low power so as to not require too large a battery and it needs to be robust so that it can be reliably flown. I believe these three elements should be possible and at a low-cost.

### iiii) The Implementation

The first step will be to get the camera element working with 4 cameras in parallel. From here I would then build rigs to hold each pair of cameras, as well as the light diffuser. I would then look to test the camera under controlled conditions for calibration. Time permitting I would look to build a mount to attach the complete rig to a UAV.

### v) Proposed Outcomes and Benefits:

The outcome would be an open-source design and software to enable an Arduino multispectral camera to be built by anyone. This would add an option for many vegetation (and other) monitoring projects to produce their own low-cost and modifiable sensor. At present sensors are both very expensive, and often limited with proprietary software.

## Estimate of Components and Budget

In addition to the base kit I would be looking to acquire: (TOTAL ~£450)

- 6-8 camera modules (to allow for breakages) such as the [grove camera](#) (~£160)
- 2 [SD card shields](#) (~£40)
- [Grove GPS unit](#) (for UAV tracking) (~£35)
- Some SD cards (~£10 ea)
- Power unit (£~25)
- Consumables (electronics – cables etc.) (~£50)
- Consumables (brackets, materials etc.) (~£100)