NDVI imaging for plants

A manual covering tasks to show plant health through images

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What is the Infragram?

The Infragram is a digital camera that has been modified to be an infrared camera. The typical use of the camera is to take photos of plants to measure their health.

Public Lab, a community that uses inexpensive DIY techniques to investigate environmental concerns, developed the camera hack. The project website lists a couple of variations of the Infragram (http://publiclab.org/wiki/infragram).

This user guide is going to cover the DIY modification of a simple digital camera, and the processing and analysis of the photos it produces.

What you need

1. **Canon PowerShot A490**
   The tutorial covers this one, but a similar camera can be used. It should be new.

2. **Rosco filter #2007**
   This is currently the easiest one to use, but you can also play with the #74.

3. **Flathead and philips screwdriver**
   It's easiest to have two separate ones so you don't have to change tips.

What exactly am I doing?

For the DIY modification of the camera, you will be opening your camera with a screwdriver and replacing the existing filter with the #2007 filter.

Then, you will adjust the white balance. After that, you should be ready to take photos of plants. To get your final results, you will upload them to the Public Lab's website for processing. The result should give you an indication of the plant's health.

Removing and replacing the filter

This is the part where you open your camera with screw-drivers and replace the filter.

1. **Take out batteries and memory card.**

2. **Unscrew the 5 outside screws using a small screw driver.**

Locations of screws:

1 2

Inside cable connection slot

3

Left side

4

Bottom right

5

Inside battery case on left side

3. **Take the back and side off the camera.**

   Use your fingernails or a flathead screw-driver. Do not mess up the electronics.

4. **Unscrew the 3 interior screws.**

   There is one at the top right, bottom right, and bottom middle. 3 total.

! Don't touch the capacitor leeds because you will get shocked.

5 **Take a flathead and pick out a switch on the left side of the camera.**

6 **Carefully take off the blue film and the ribbon cable and gently bend the cable backwards.**

! Don't touch any of the surrounding wiring.

7 **Gently swing metal part over and then let go of the blue film.**

8 **Remove 3 screws on the left half of the camera.**

These are glued in and holding the sensor, so very carefully remove them.

9 **With flat head, carefully lever up the orange piece that the sensor is on.**

! Don't put your fingers on the sensor.

10 **Hold the orange sensor tab back, pull the gasket back, and shake the filter out.**

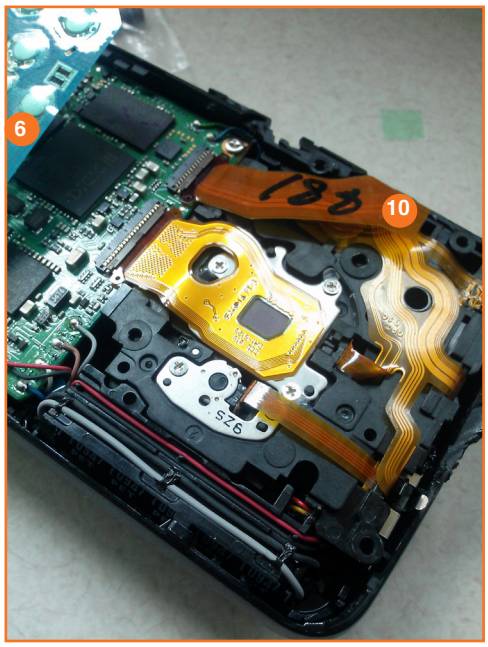
The gasket hold the IR block filter. This is what you are removing, do not remove the back of the sensor.

11 **Put the orange sensor back in.**

12 **Put the pieces back together.**

13 **Before putting final case back on, put batteries back in to make sure the camera works**

13 **Take the Rosco #2007 filter and cut it to fit the lens of the camera. Tape it on with packing tape or something similar.**



Adjusting the white balance

Customizing the white balance on the camera will make it take yellow-orange photos. These photos produce NDVI images that are easy to interpret.

1. **Turn on your camera.**

2. **Click on Mode button.**

   Auto should be selected.

3. **Press the right arrow button to go to Program mode.**

4. **Press FUNC.SET to set the camera in Program mode.**

5. **Press FUNC.SET again.**

6. **Scroll to the second icon on the lefthand menu, MENU: Evaluate Whit Bal**

7. **Scroll all the way to the right to select Custom**

8. **Put a blue object in front of the camera.**

   Make sure the lighting isn't too bright or too dark. I used a cobalt blue gift bag.

8. **Press the Menu button to adjust the balance.**

   You're making the camera think that the blue object is white. Plants and objects should be very orange.

Don't be frustrated if it doesn't work the first time. Experiment with sunlight, artificial light, time of day, shade, slightly different colors of blue, etc.

8 **Check the white balance of your camera. The following colors indicate if it is correct or not.**

Pink The white balance didn't work. This is what the infrablue images look like without any white balancing. Repeat the steps.

Gray Something changed, but it's incorrect. Repeat the steps and try the balancing again.

Orange You did the white balance correctly. If it's a dull orange or too orange, try different shades of blue and different lighting.

Too orange **Not enough orange** **Correct orange**

Chris Fastie from Public Labs explained why the NDVI results will not be perfect, and what type of results you should expect:

"Even the best white balance for a particular camera and particular filter will not produce perfect NDVI results. The goal is three-fold: 1) NDVI values for healthy plants in the range 0.1 to 0.9, ideally near the middle of that range, 2) NDVI results for foliage with a range of values, so differences in plant health can be discerned, and 3) NDVI values below 0.1 for non-foliage surfaces. There will always be non-foliage surfaces that mimic the NIR/VIS ratio of foliage, so there will always be artifacts in NDVI images. This is especially true with very bright or very dark areas of the scene."

Processing “infrablue” images

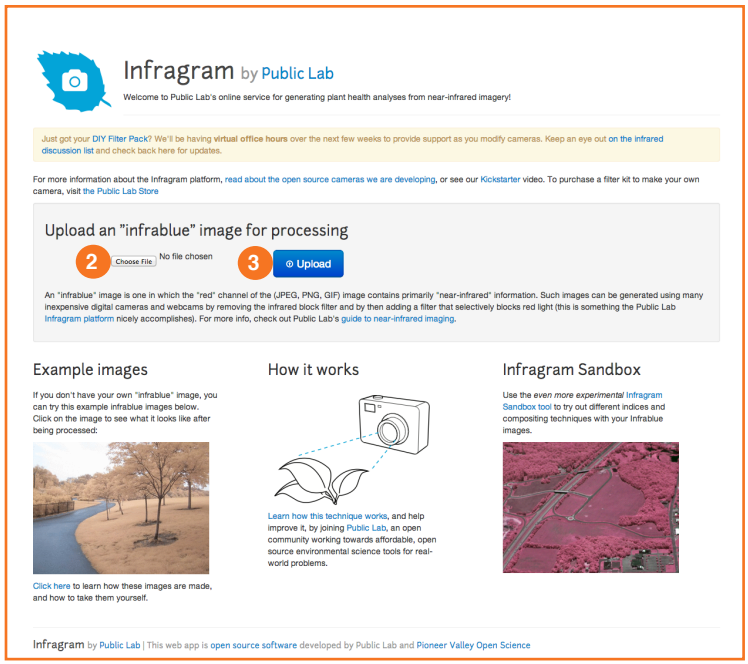
Now that you have your orange images of plants, you need to process them to get readable results. The easiest way is to go to the Infragram website and upload a photo.

! Make sure your files are of reasonable size, or you will get an error.

1 **Go to infragram.org**

2 **Click on “Choose File”**

3 **Click on “Upload”**



4 **View your results**

Currently, the website is designed like the screen-shot on the right.

Explanations for each photo generated, and how to read the NDVI photo, are given.

* **ImageJ has a plugin that is also an option.**

There is a plugin for ImageJ that can be downloaded and used for NDVI processing. It involves a stronger understanding of the process to use it correctly.

Terms and helpful links

The following terms with short explanations are related to the camera hack and NDVI processing.

Near-infrared photography
Used to assess plant health.

NDVI
Normalized Difference Vegetation Index. It works because plants use red light for photosynthesis, but not infrared light.

NDVI = (Near infrared – red) / (near infrared + red)

Infragram
The camera hack created by Public Labs. You can order a starter kit on their website, or follow this tutorial with your own basic camera.

Infrablue
Describes a photo taken with the hacked camera, because the camera now has a blue filter.

Infrared
Scientific definition from Wikipedia: “electromagnetic radiation with longer wavelengths than those of visible light”. The infrared filter in the camera is removed for this hack.

These links go more in-depth about everything covered in this tutorial.

About the project:
http://www.kickstarter.com/projects/publiclab/infragram-the-infrared-photography-project

NDVI detailed explanation:
http://publiclab.org/wiki/ndvi-plots-ir-camera-kit

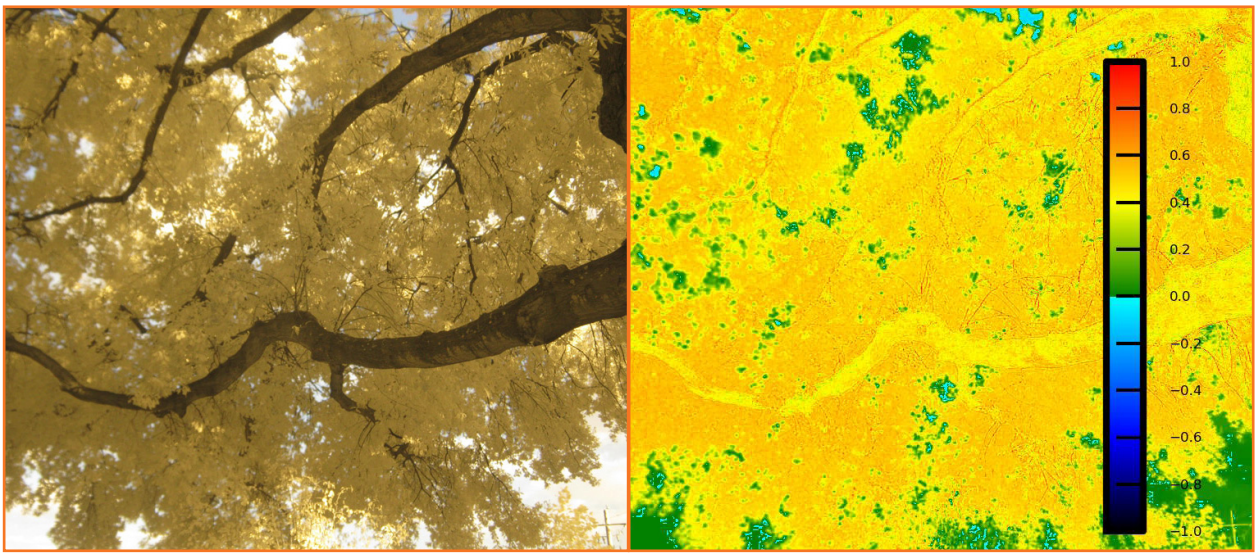
More about white balancing:
http://publiclab.org/notes/warren/08-15-2013/white-balancing-a-canon-camera-for-infragram-photography

http://publiclab.org/wiki/infrablue-white-balance

Video explaining the camera hack:
http://www.youtube.com/watch?v=XFOHWaL7XsM

Infragram and NDVI for fruit

These are some example images with a fig tree and Public Lab's website. The images on the left are straight from the Infragram. They were then uploaded to Public Lab's website, and the results from the web application are on the right.



Underneath a tree.

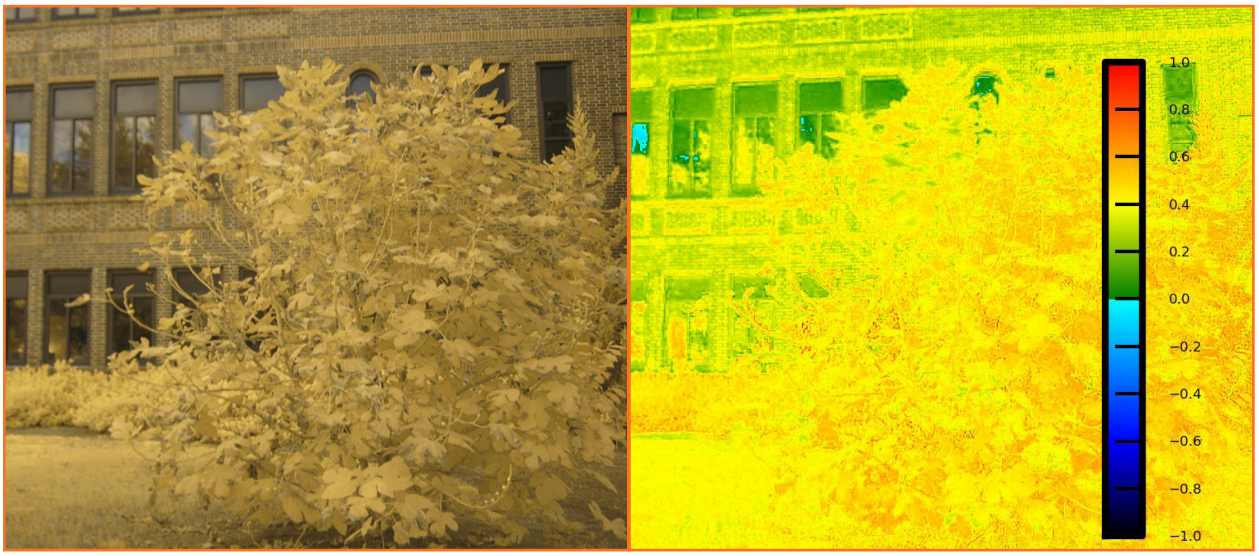
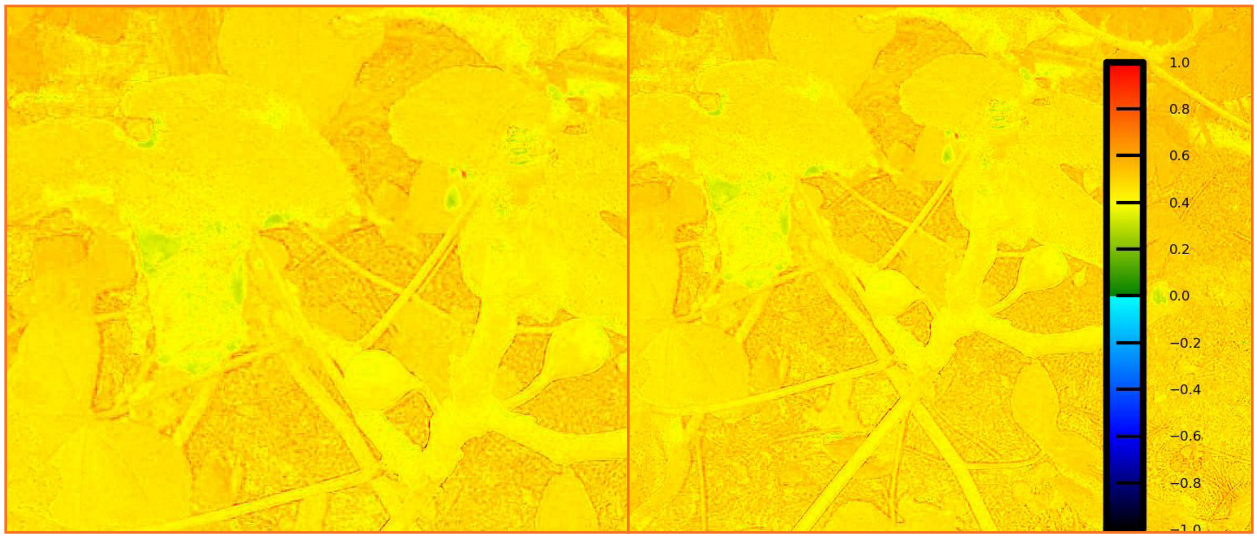
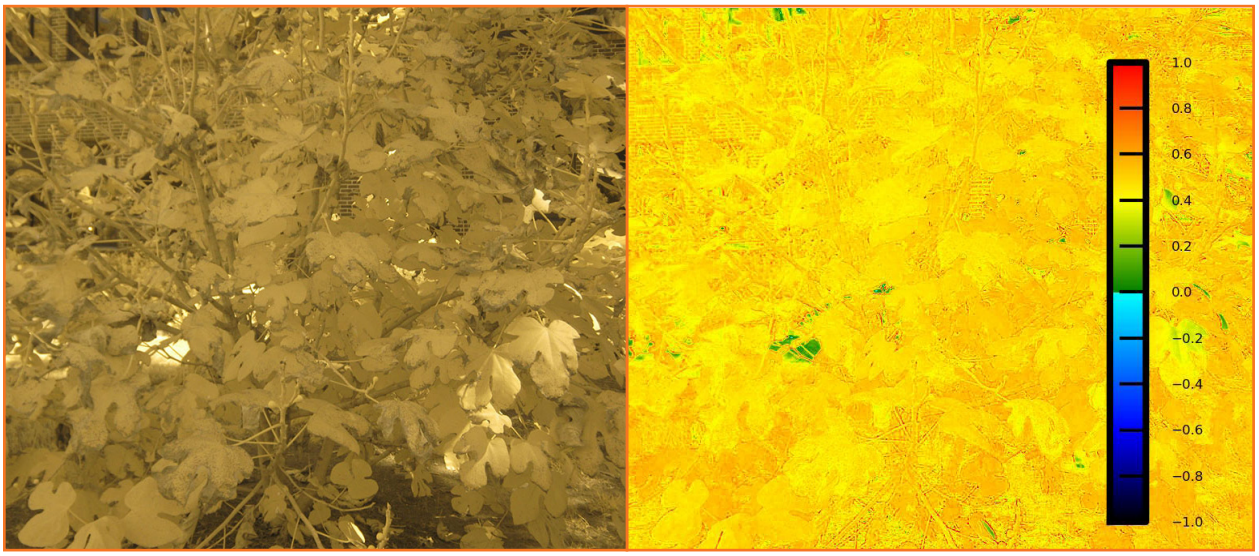


Fig tree in front of a school.



Closeup of figs in the fig tree.



Closeup of the fig tree, but no fruit shown.

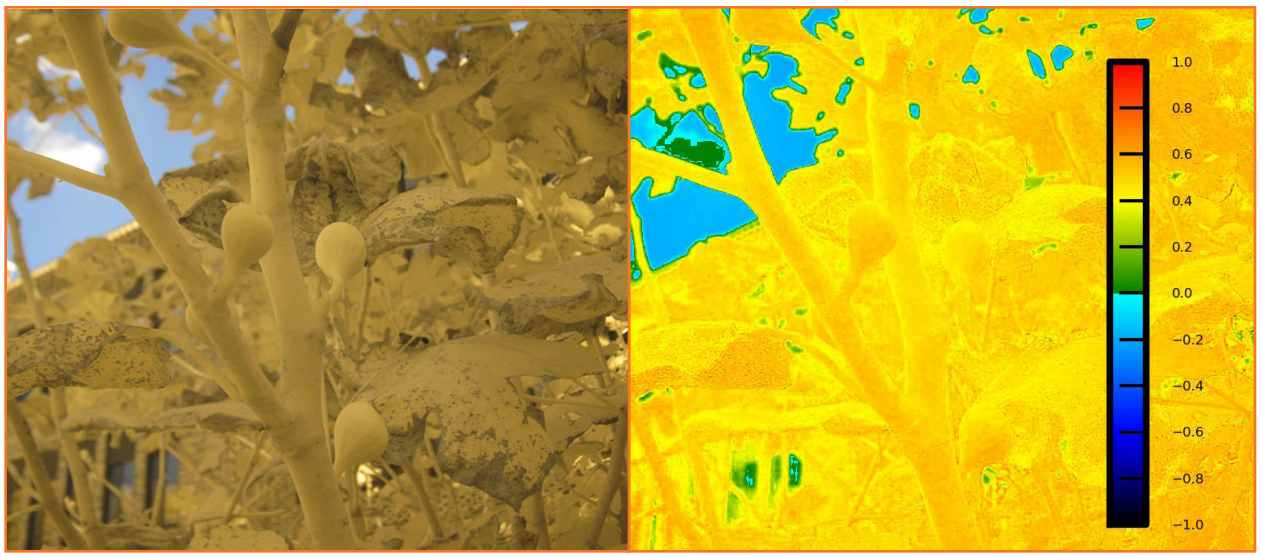


Fig tree with building and sky in background.

Credits

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