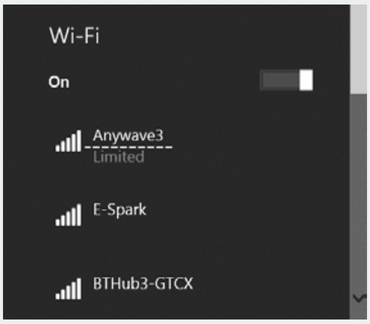
Anywave User Guide

Power & Connectivity

Anywave requires a power supply of 12V to 25V, capable of producing 30W. Its consumption in active state is a steady 10W. We recommend connecting it directly to the battery pack powering your UAV. Most UAVs large enough to lift Anywave have sufficiently capable batteries.

When turned on, Anywave acts as a Wi-Fi access point. When your computer connects it will be assigned an IP address in the 10.0.0.0/24 subnet. Anywave can be accessed at the IP address 10.0.0.1.



Windows 7 and earlier versions will connect instantly, but Windows 8 and later will display “Connecting” for up to a minute. In its infinite wisdom the new OS attempts to access the internet through the multispectral sensor. When it inevitably fails, connection will be displayed as limited. This silly behaviour has no effect and can be ignored.

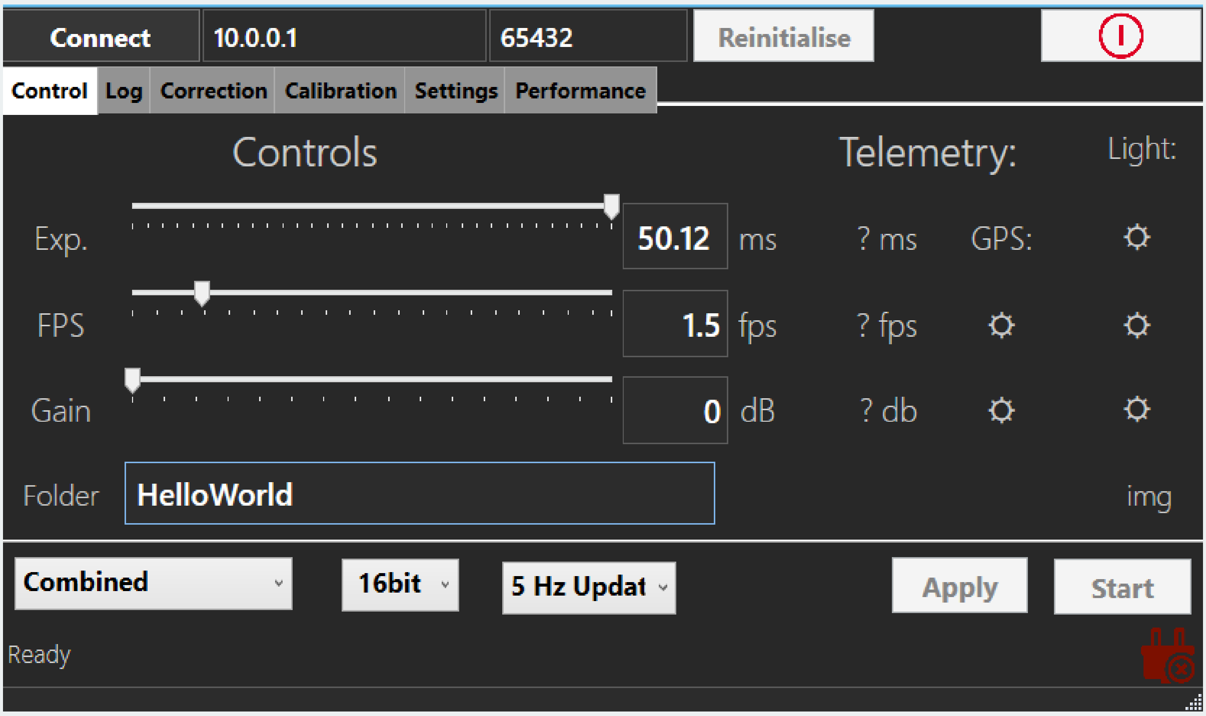
OS periodically searches for new Wi-Fi networks, but on new editions of Windows intervals are very long. If you are impatient, you can force-refresh the list of wireless networks by toggling Wi-Fi on and off.

Spectral Command

Anywave multispectral camera is controlled using a Windows application called ***Spectral Command***. It is bundled with your Anywave purchase. It is designed to be used in the field, the UI is large and high-contrast. The program can be enlarged to full screen and is touch friendly. We will cover the most important functionality.

CONNECT

The first order of business is to connect to Anywave camera. This is done in ***Control*** tab, by clicking the ***Connect*** Button in the top left corner. ***Control*** is the default tab.



CAMERA SETTINGS

Once connected, you will be able to change the ***Folder*** where you are saving images. We recommend giving this folder a meaningful name. Left bottom drop-down list allows you to choose how files are saved.

> ***Combined*** will save all channels in a single file. This is the default setting.
> ***Separate*** will save a monochrome tiff for each channel.

You may also set ***Exposure***, ***Framerate*** and ***Gain***.
Exposure is the most important setting, it controls for how long the camera is taking the image and

how much light it captures. It can be set between 0.03ms and 50ms. Exceeding 5ms will typically result in blurred images. The slider is exponential, dragging the handle by one division will alter exposure by 12%. It can also be controlled by arrow keys.

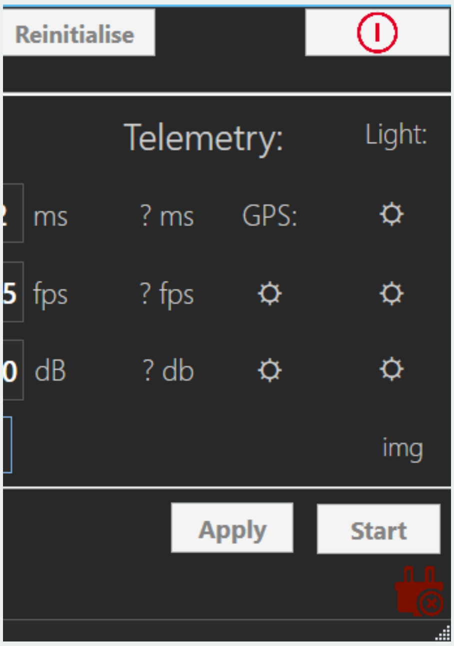
Framerate is the number of images taken per second, and can be set from 0.1 to 10fps. Settings between 0.3 and 2fps are common, depending on the speed and height of the aircraft.

Gain is the equivalent of ISO setting on consumer cameras. Increasing gain will boost brightness of the image, but result in more noise. Gain is set in decibel scale, which is exponential. Anywave cameras are very light sensitive, so you should rarely need this setting.

Once you have changed settings, you must hit ***Apply*** button for your settings to take effect.

TELEMETRY

Right half of the screen displays ***Telemetry***, it contains settings that are currently in effect, readings of the ***GPS*** and ***Light*** sensors if they are connected, and number of images taken in this session.



Spectral Command displays readings of luminosity sensors. You can connect several luminosity sensors to improve accuracy of measurements. A mean average of all luminosity sensors is displayed as the bottommost reading. It is used to automatically set exposure, which is explained in the next section.

GPS coordinates are displayed too, you can confirm that GPS is connected and working. First value is Longitude, and the second is Latitude. It is recommended that you disconnect Wi-Fi before flying to avoid interference.

Image Correction & Calibration

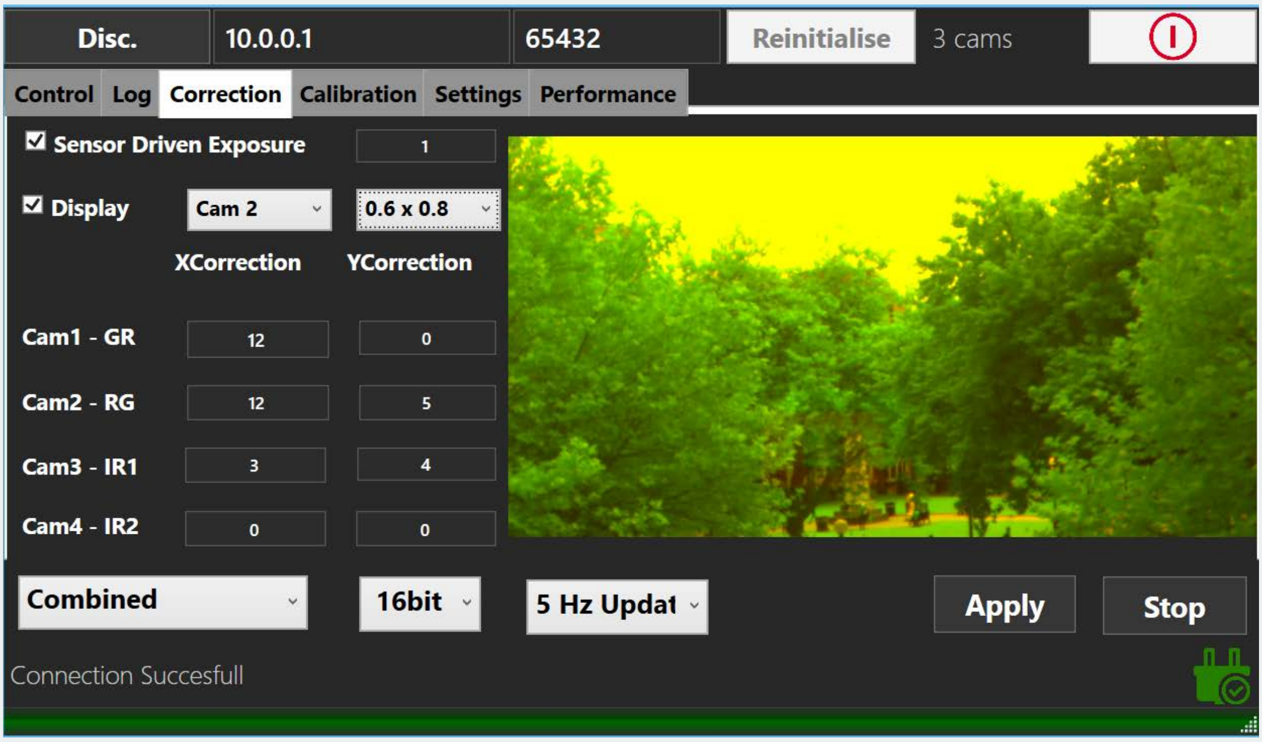
Read Appendix A & B to learn why correction and calibration are required.

CORRECTION

Correction tab allows you to see what the camera sees. The image looks yellow because only two channels are displayed at a time, green and red. You can switch the camera used for green channel, the red channel is fixed to the first camera. The camera are always ordered in ascending order of their respective wavelengths. [Blue, Green, Red, IR, farther IR]

You can zoom into the image and carefully align images. Done once, you shouldn't have to repeat this operation. Alternatively you can align images in post processes with application we designed for that purpose.

You can control ***Sensor Driven Exposure*** in this tab. It uses a luminosity sensor attached to Anywave to continuously measure light levels and set exposure for the sensors. This will produce consistently illuminated images even in intermittent cloud cover. To set correct exposure you must enter a saturation constant, defined as exposure required to saturate the sensors when imaging a scene lit at 1 lux. This depends on lenses and filters used, our default configuration uses a value of 2. You can pick this value by trial and error, larger constant will result in proportionally brighter images, and vice versa.

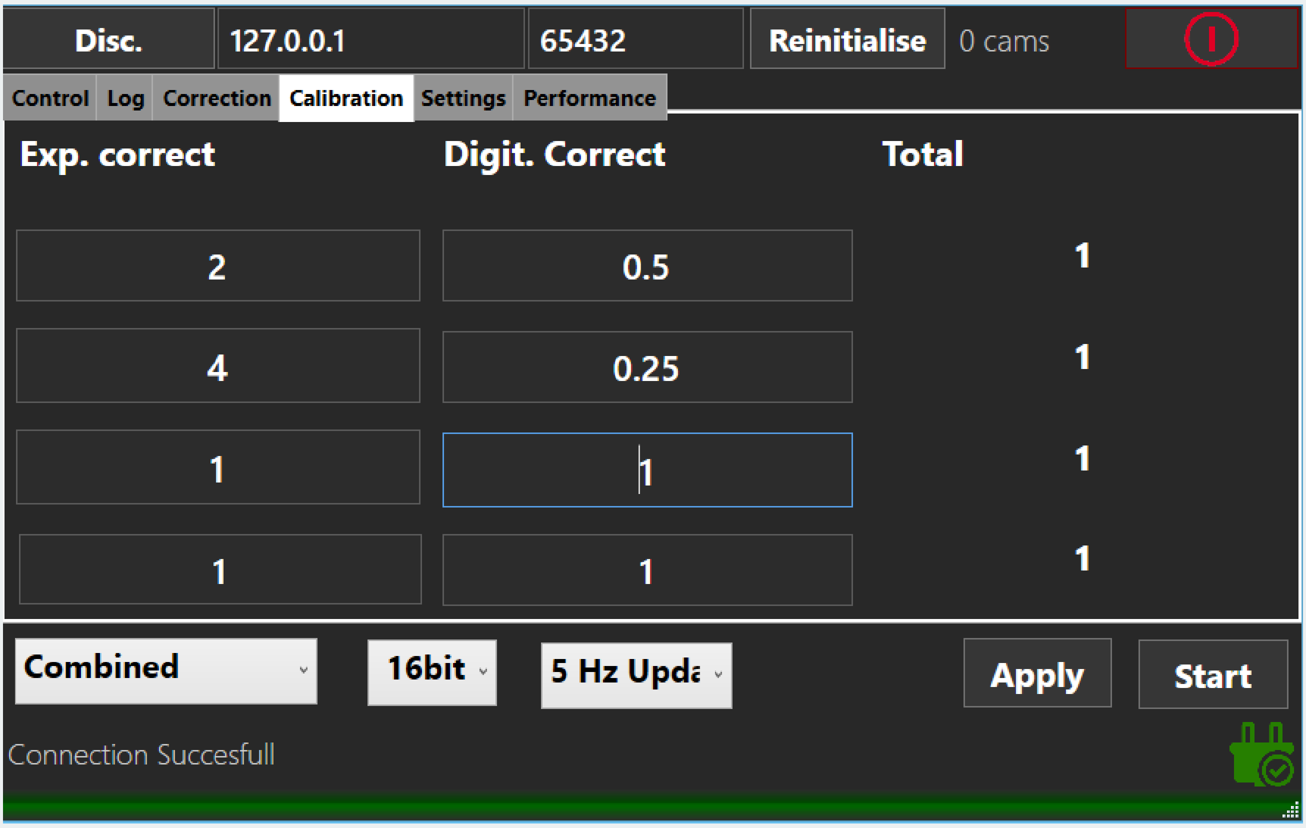


CALIBRATION

To get data-rich images of correct brightness, set ***Exposure Correction*** in Calibration tab. ***Exposure Correction*** is a multiplier, individual for each channel. In the image below, channel one will be exposed twice of normal, and channel two will be exposed four times the normal.

Digital Correction keeps the apparent brightness of the channel without losing information.

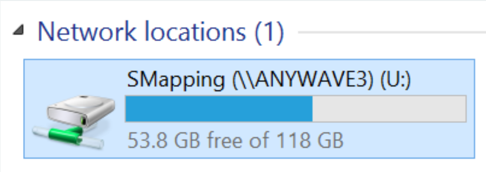
Column ***Total*** demonstrated overall effect on each channel. Numbers used don't have to be multiples of two. If you use filters of different bandwidth you may also use this technique to correct brightness of a channel.



Obtaining images & Postprocessing

SMAPPING

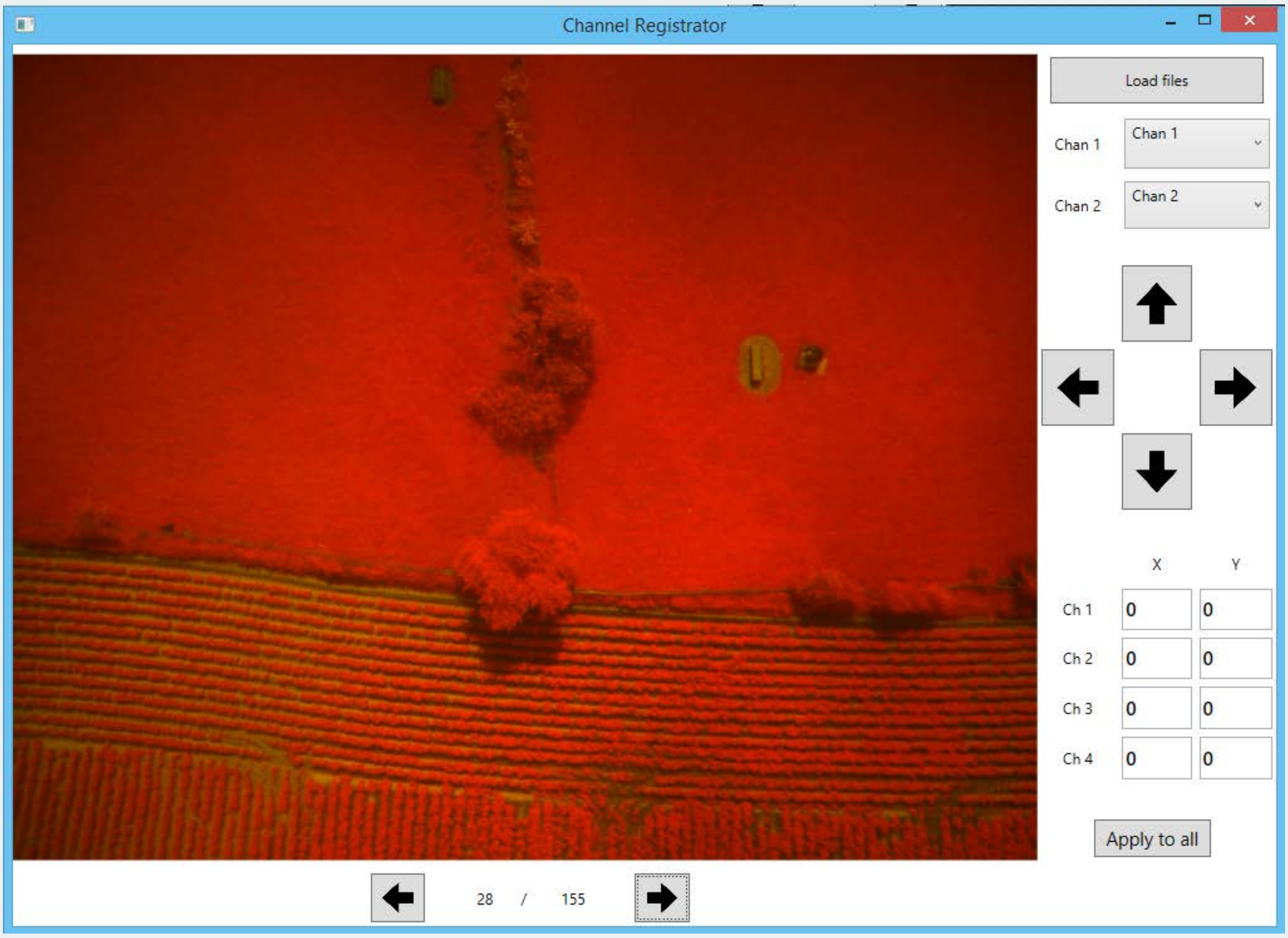
Anywave saves images in local ***SMapping*** directory. Every time you start imaging, the images are placed in a separate folder. The directory is available over SMD (windows file share). It is accessible through Network.



Accessing Anywave will require username and password you received with your package. Add this directory as a network drive for convenience, and copy images like you would any file in windows explorer.

POSTPROCESSING

Registrator is a software we developed in-house to preview and postprocess multi-channel .tiff images. If you did a survey, took images and found out that the channels are not well registered (see appendix A), this tool will let you fix all of your images at once in a batch process.



Load the files that you want to edit. To align your images you will need good visual cues, scroll to an image that has a house, a car or another manmade object with clear boundaries.

Select the channels that you wish to adjust. Arrows will shift the second channel selected, and the matrix below displays total shift amount for all channels. Once you are happy with the result, click ***Apply to all***. A new folder ***Corrected*** will be created in the same directory where your files are located. Edited images will be saved there.

APPENDIX A

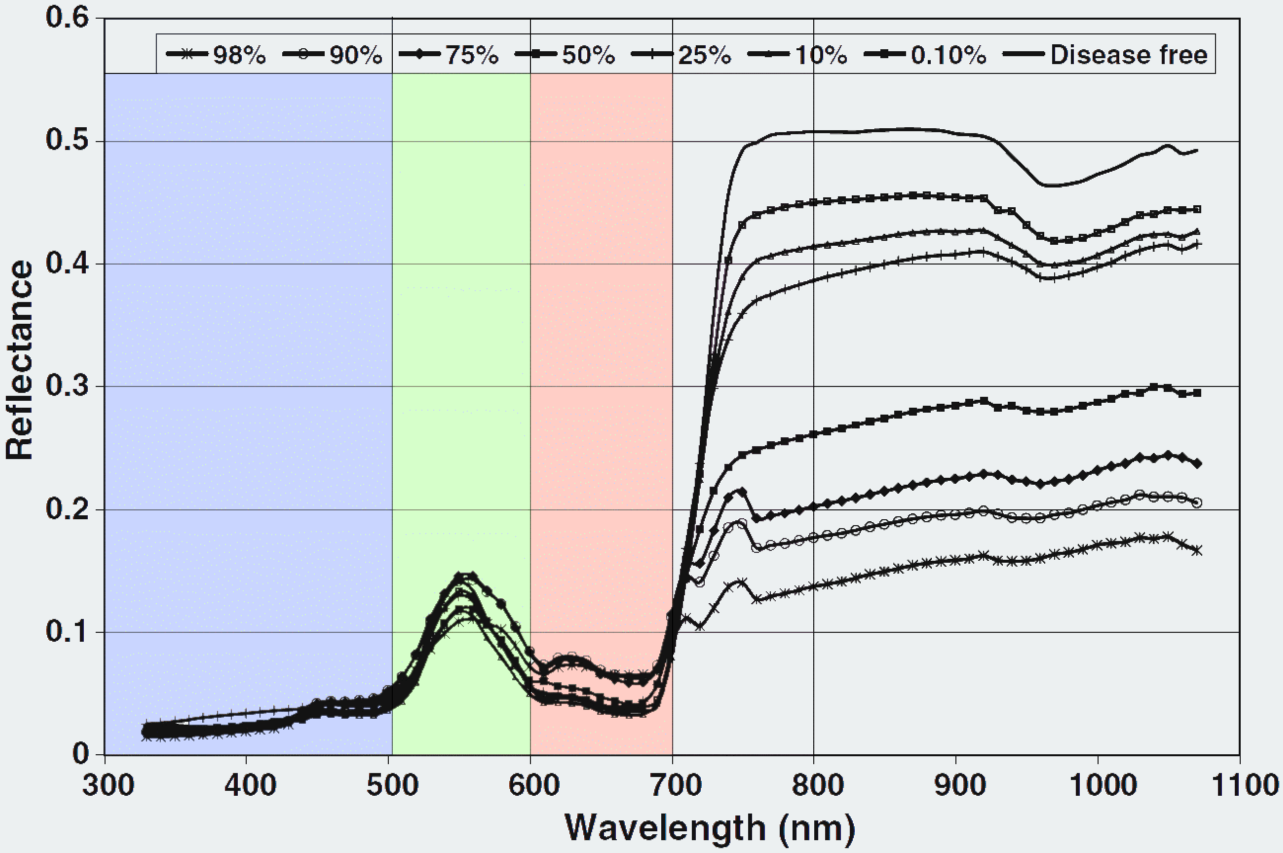
Image Correction

Multi-camera arrays like Anywave produce a separate image for each channel. These images need to be aligned, this process is known as **registering**. This need comes from tiny tolerances in the manufacturing process, which make each camera point in a slightly different direction. For example if the circuit board with the CCD is held by two supports, and the difference in their height is just 0.1mm, it results in 0.2° misalignment. It may not sound like much, but with a 60° lens and 1920p wide image, the image will be out of alignment by 6 pixels! If we leave it uncorrected, the images will look like anaglyph 3D.

APPENDIX B Calibration

For optimal quality you should configure relative exposures of each channel in an image. Healthy plants reflect 5- 10 times more infrared light than they do visible light. Graph below illustrates the effect. Infrared spans 700nm- 1000nm, and the bump at 550nm is what causes the plants to look green.

REFLECTANCE OF HEALTHY AND DISEASED PLANTS



When imaging in infrared and red with equal exposure, we obtain a very bright NIR image and a dim red channels which contains very little information. Obtaining a well-exposed red channel would typically result in over-saturated infrared channel. This reduces the amount of information you can extract from an image, and quality of indices such as NDVI. Below is an illustration of information contained in a pixel, and what happens when an image is dramatically overexposed or underexposed.

'Good' image	Underexposed image	Overexposed image
$\overbrace{X\ X\ X\ X\ X\ X\ X\ X}$	$\underbrace{0\ 0\ 0\ 0\ 0}_{\text{always empty}}\overbrace{X\ X\ X}$	$\underbrace{1\ 1\ 1\ 1\ 1}_{\text{always filled}}\overbrace{X\ X\ X}$

Only bits marked with X contain useful information. Underexposed image contains less information as its higher bits are empty. Oversaturated image loses data too.

To obtain a better image, Anywave allows you to set Exposure correction. It is simple to use, setting exposure correction of Red channel to 4, will result in it being exposed four times the normal amount. But doing just that would increase the values on red channel and result in erroneous values for NDVI and other indices.

$$\overbrace{X\,X\,X\,X\,X\,X\,X\,X\,X\,X}^{\text{Data from cameras}}\underbrace{0\,0\,0\,0\,0\,0}_{\text{Padding}} \qquad \overbrace{0\,0\,0\,0\,0\,0\,0\,0\,X\,X}^{\text{Underexposed image}}\underbrace{0\,0\,0\,0\,0\,0}_{\text{Padding}} \qquad \overbrace{X\,X\,X\,1\,1\,1\,1\,1\,1\,1}^{\text{Overexposed image}}\underbrace{0\,0\,0\,0\,0}_{\text{Padding}}$$

This problem can be solved by taking advantage of the way images are stored. Sensors are capable of producing 8-12 bit of useful information. On Anywave each channel produces 10 bits and this data is saved in a 16-bit image file. In this image each pixel contains 10 bits of data and 6 bit of padding, as illustrated

$$\overbrace{X\,X\,X\,X\,X\,X\,X\,X\,X\,X}^{\text{Bright IR channel}}\underbrace{0\,0\,0\,0\,0\,0}_{\text{Padding}} \qquad \underbrace{0\,0}_{\text{Padding}}\overbrace{X\,X\,X\,X\,X\,X\,X\,X\,X\,X}^{\text{Dimer red channel}}\underbrace{0\,0\,0\,0}_{\text{Padding}}$$

After we obtained an image that was exposed four times the normal amount, we divide it by 4 digitally. This is the same as shifting it by two bits to the right. We call this technique ‘Padding Shift’. As a result you get two images of correct brightness, yet full of data!

Quickbird

www.quickbird.uk