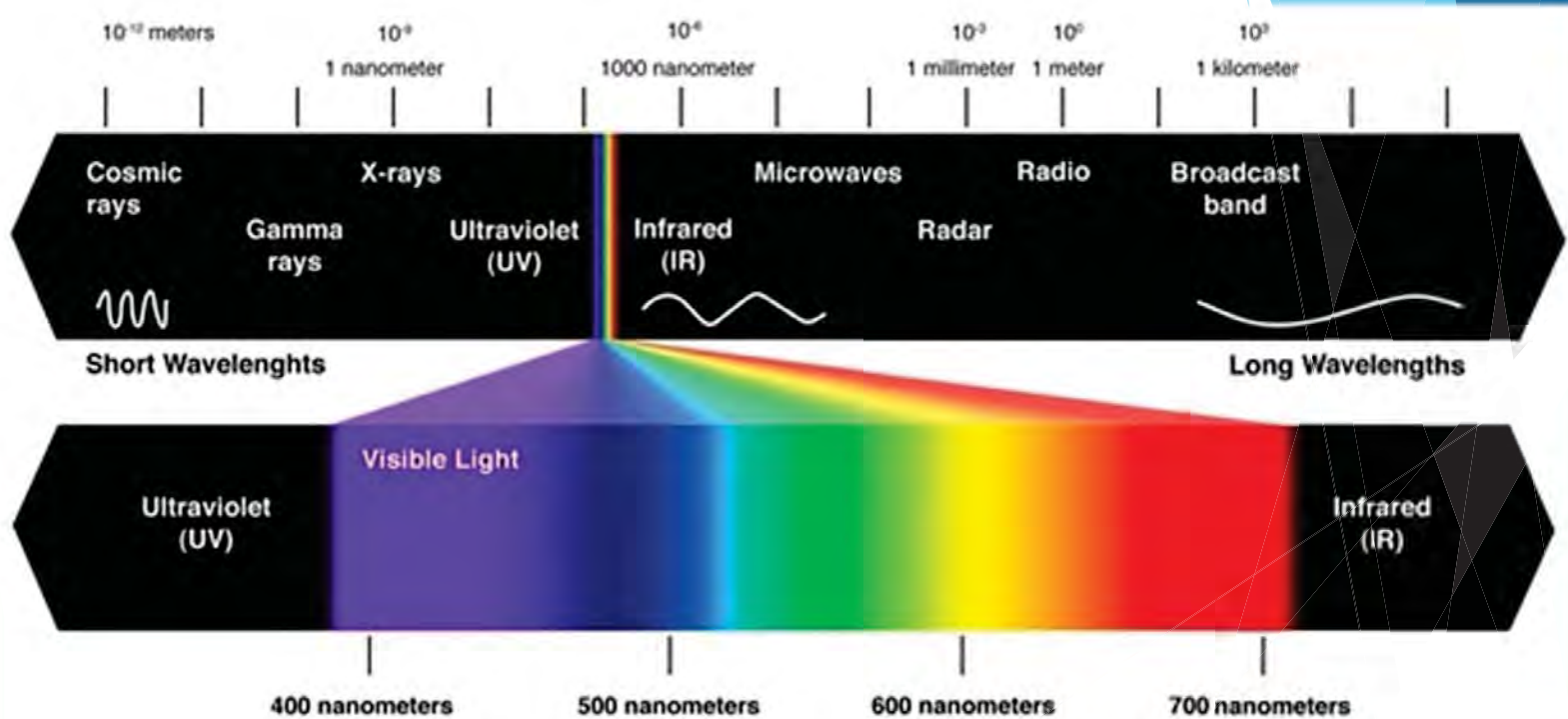# What's in a Pixel?

Digital Imagery and Sensors

Cherie Aukland and Daniel Cross

Let's Look at Light.

What is a Digital Image?

▶ Information of a 2D image stored in binary.

▶ This info is interpreted by software/hardware to be printed or displayed on a screen.

▶ Modern hardware displays images via raster grids.

What is a Pixel?

- Pixel = Picture + Element.
- Smallest, most basic unit of an image on a display.
- Dots or rectangles that each display to a certain color.
- Combined, they create an image.
- Pixels originate as information, either digitally created or recorded by a sensor.
- Pixels can display 1-3 "bands" of information depending on the type.

The Monochrome Pixel.

▶ The most basic pixel is one that displays a single set of data.

▶ This can be a black and white image, reflectance map, or thermal imagery.

▶ This image is a grid of binary numbers ranging from 0 to 255.

▶ The computer is told to interpret it as a black and white picture.

Color Pixels (RGB).

▶ Color pixels are created by the use of very small sub-pixels.

▶ To create a color, the 3 primary colors (red, green, blue) are combined in different intensities.

▶ This means that each pixel requires 3 set of data.

▶ There can be many different configurations of hardware sub-pixels.
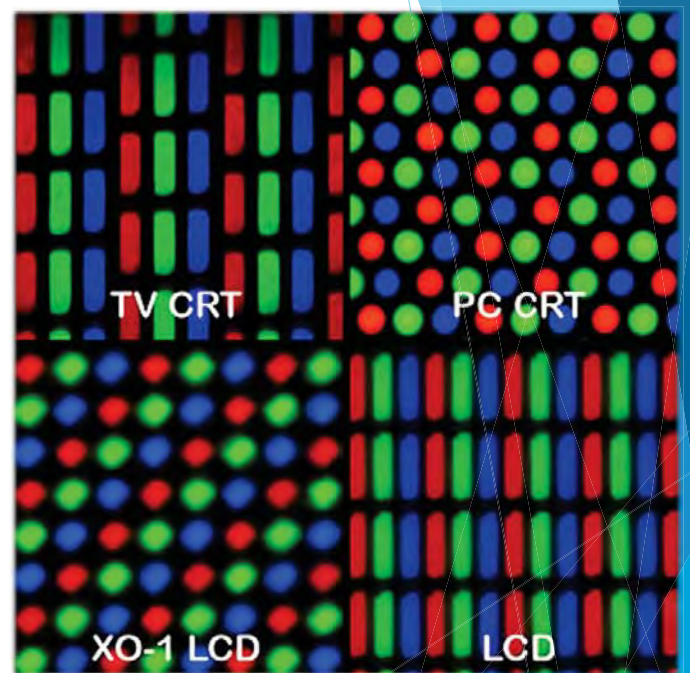
Weird Color Pixels (Multi-Band Images).

▶ The data being displayed for a band (individual color sub-pixel) does not always match that sub-pixel.

▶ This means that you convert non-visible spectra into visible colors.

▶ This false color infrared uses:

  ▶ Red band = Infrared light

  ▶ Green band= blue light

  ▶ Blue band = green light

Resolution

▶ Refers to the number of pixels in an image/display or size of the area covered by a pixel.

▶ Lost of terms get thrown around.

  ▶ Mega-pixel, HD, 4K, etc.

  ▶ 3840 x 2160, 640 x 512, etc.

  ▶ Size of pixel (4in, 1m, 3 arc second, etc.).

▶ The more pixels, the higher the resolution, the "better" the image.

▶ There are also different aspect rations.

 ▶ Most common = 4:3 and 16:9.

Image File Formats

- ► File format is the standardized way the information is encoded for storage and use with a computer.
- ► There are many different file formats.
- ► Different formats are used for different applications.
 - ► Ex. Pix4D uses TIFF and JPEG, DoneDelopy only uses JPEG.

RAW

▶ RAW images are the unaltered/unprocessed data captured by the sensor.

▶ Some software suggest you use RAW images so that all changes made during processing are known and recorded.

▶ They are uncompressed, so they are BIG.

▶ Each camera manufacturer uses their own RAW format.
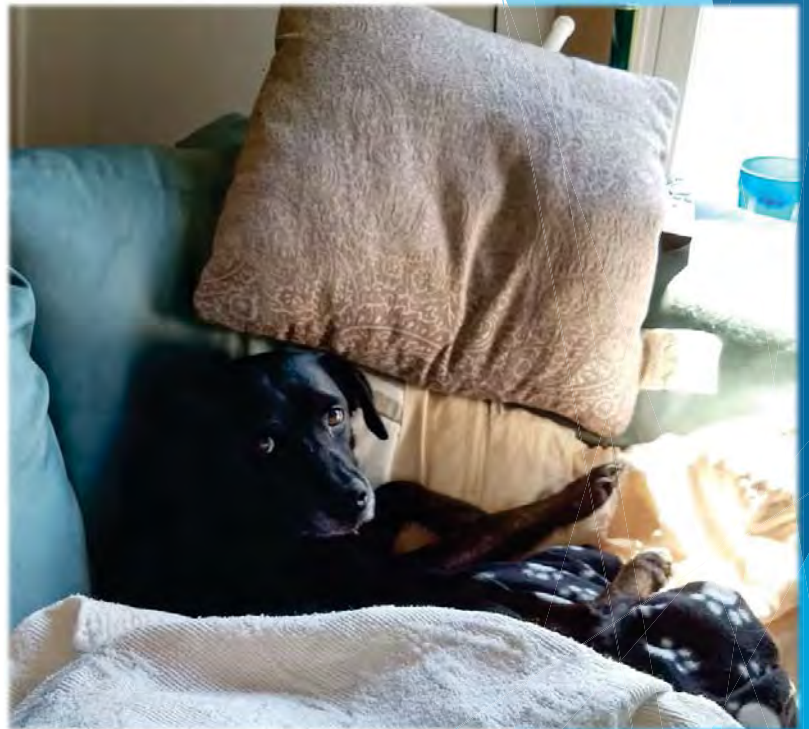
Jpeg

▶ JPEG/JPG = Joint Photographic Experts Group.

▶ Most common format.

▶ Compress images so they are smaller.

▶ Compression can cause artifacts.

▶ No transparency or layering.
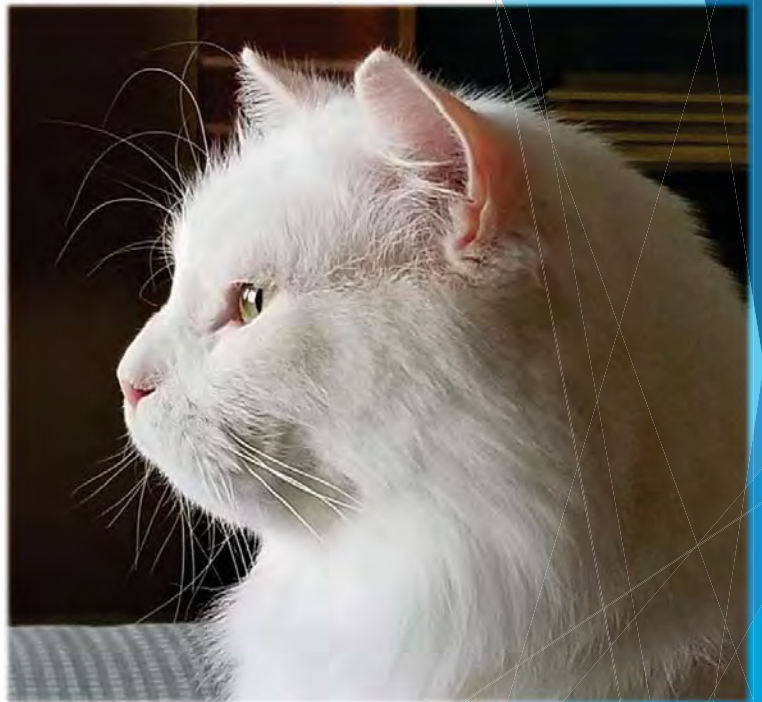
TIFF/GeoTIFF

▶ TIFF/TIF = Tagged Image File Format.

▶ Lossless format create high quality images that are larger in size.

▶ Good for "mapping" imagery and photography.

▶ GeoTIFF format contains geographic information for mapping (georeferenced).

▶ Requires camera with "Fast" memory.

Radiometric JPEG (Thermal)

▶ FLIR format for thermal imagery.

▶ Similar to a JPEG.

▶ Each pixel contains the detected temperature instead of raw data.

  ▶ 32˚ instead of 11174.

▶ Other sensor manufacturers may use different formats.

PNG

- ▶ PNG = Portable Network Graphics.
- ▶ Uncompressed, so high quality but large size.
- ▶ Does allow for transparency.
- ▶ Mostly used for web graphics.
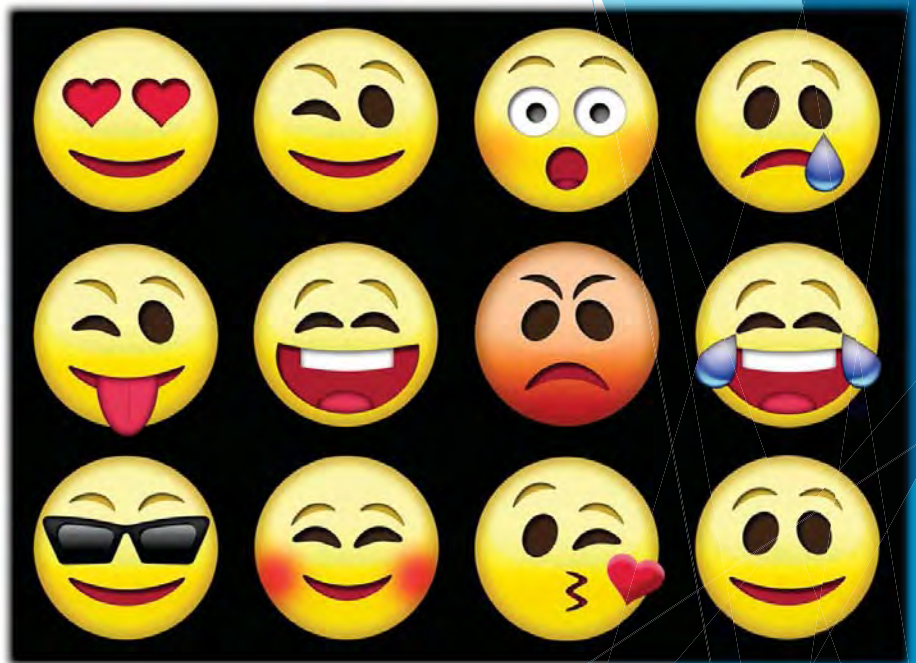
GIF

▶ GIF = Graphics Interchange Format.

▶ Simple animations that quickly flip through a number of still images.

▶ Does allow for transparency.

▶ Limited to 256 colors.

▶ Some sensors record video as GIF.

▶ Can be pronounced "JIFF", or "GIFF" (for those who like to be wrong!).

# Actual Imagery!

- We collect 4 main types of sUAS imagery:
  - True color.
  - Mono/Multispectral.
  - LIDAR.
  - Video.
- Reasons to collect this data:
  - Photography
  - Videography
  - Mapping
  - Research/Monitoring
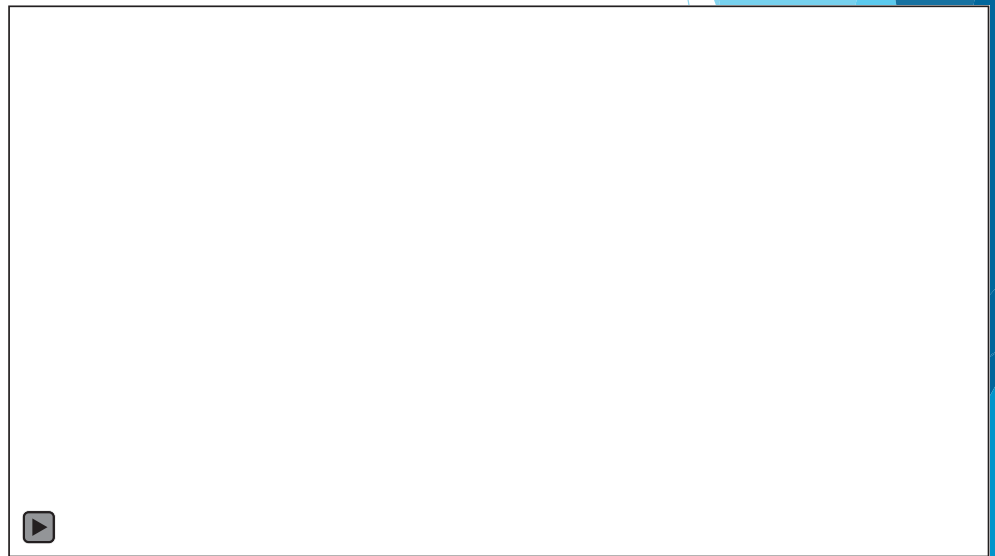
# Red, Green, Blue/True Color

▶ Displays the world as we humans see it.

▶ Great for mapping features, including surface features, such as land cover, and atmospheric features, such as clouds or smoke.

▶ Cannot detect anything beyond the human range of vison.

▶ Easiest to interpret.
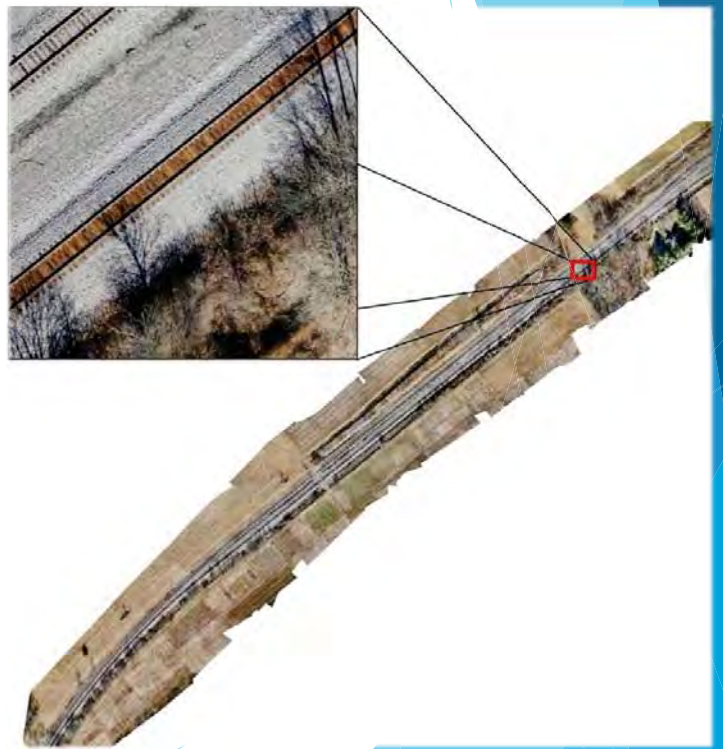
# Multi/Hyperspectral

▶ Sensors detect EM radiation that is not visible to the human eye.

▶ Can include RGB.

▶ Allows for better detection or classification than true color imagery.

▶ Need to know band combinations for the job.

▶ Can be difficult to interpret.
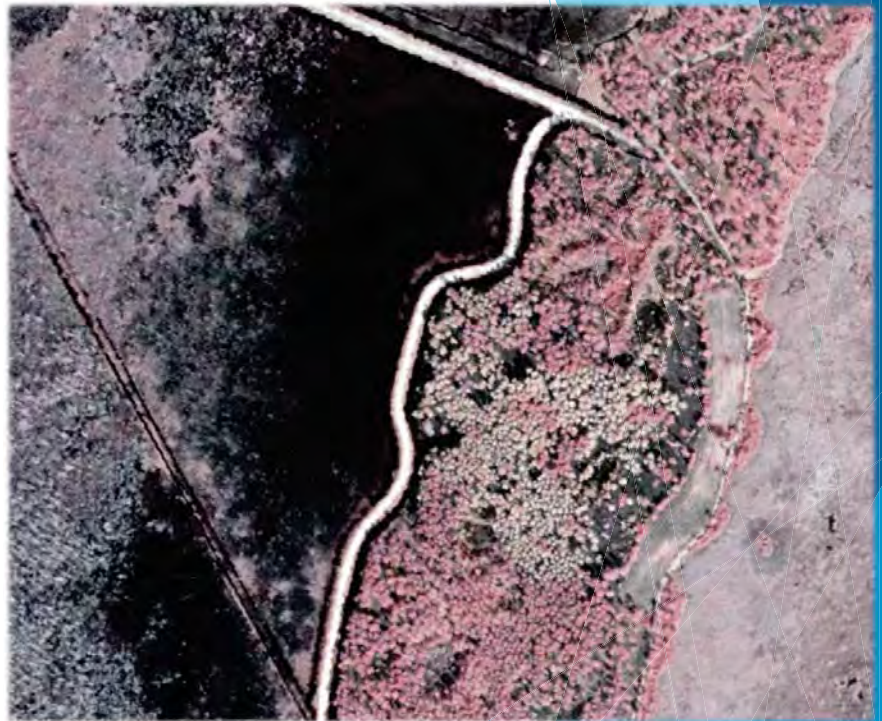
Multispectral Derivatives

▶ NDVI, reflectance maps, other indices.

▶ Bellow, RGB and NDVI of the same field captured at the same time.

▶ NDVI shows crop stress that is not visible in the RGB image.

Legend
NDVI Value
Value
Healthly
Poor
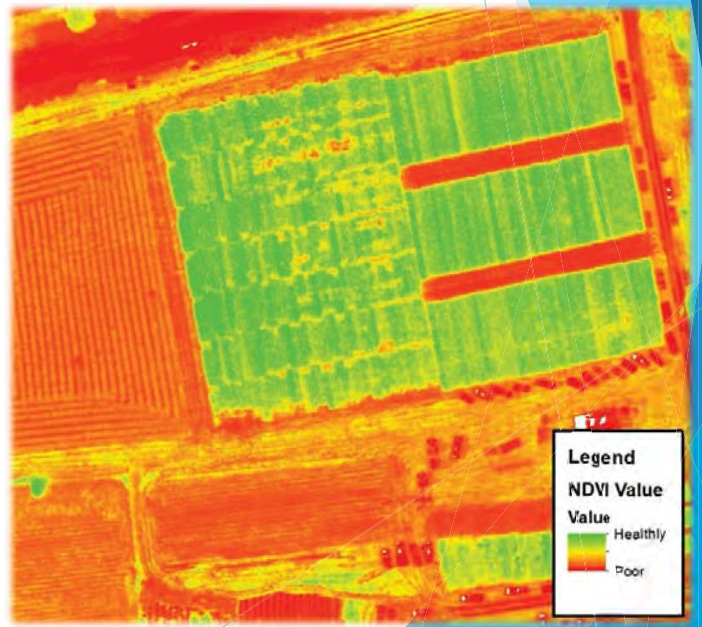
Thermal

▶ Detects emitted and reflected heat.

▶ Can "see" in the dark.

▶ Can be used for wildlife tracking/monitoring, solar monitoring, search and rescue, infrastructure inspection, and security.

▶ Problematic on hot, sunny days.

▶ Low resolution.

▶ Requires VERY high overlap for mapping.
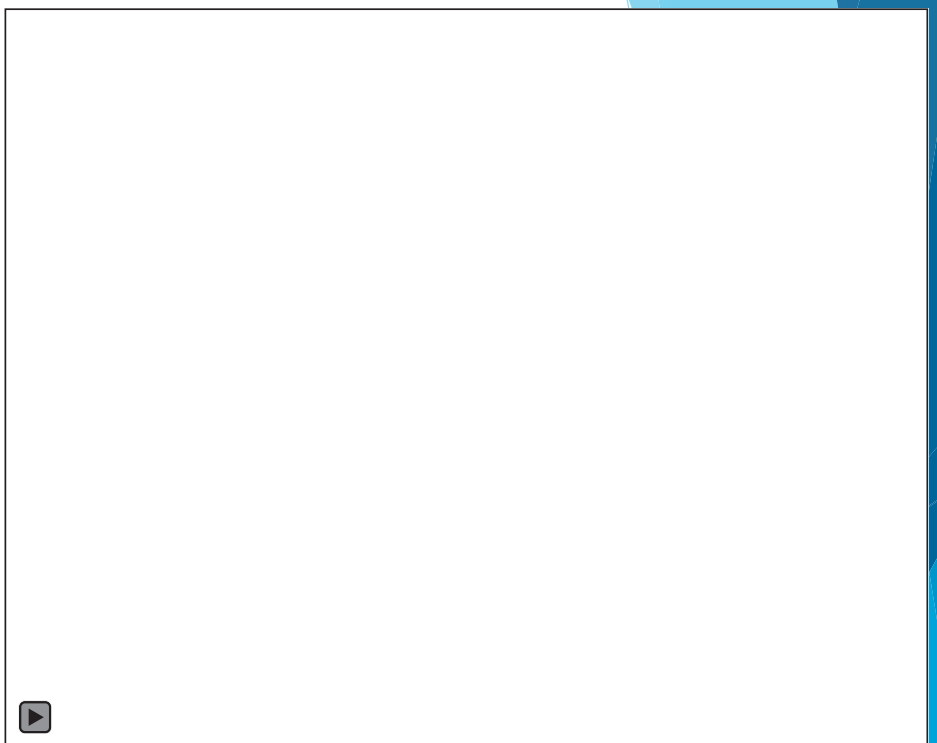
LIDAR

▶ LIDAR uses reflected laser pulses to determine the range to an object.

▶ Can have multiple returns from one pulse, measuring different layers.

  ▶ I.e. Canopy, undergrowth, and ground level.

▶ Creates high accuracy 3D point clouds.

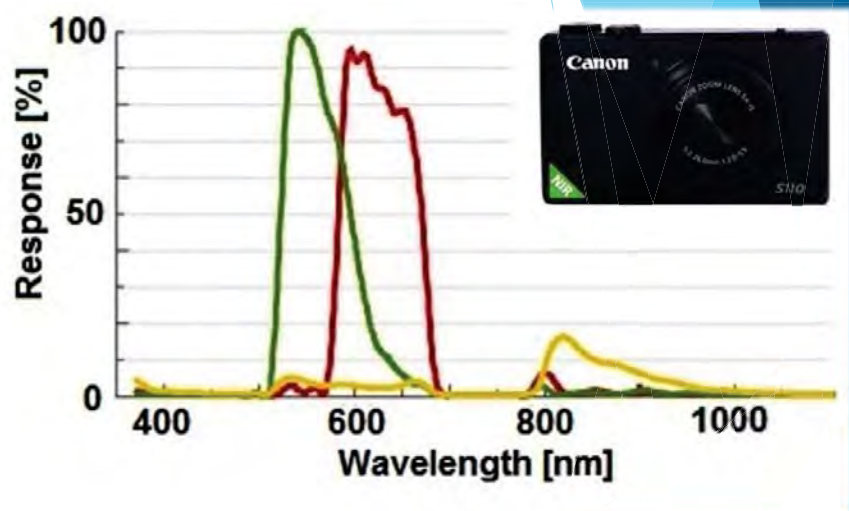▶ Used for elevation models, volumetric measurements, viewsheds, watersheds, etc.
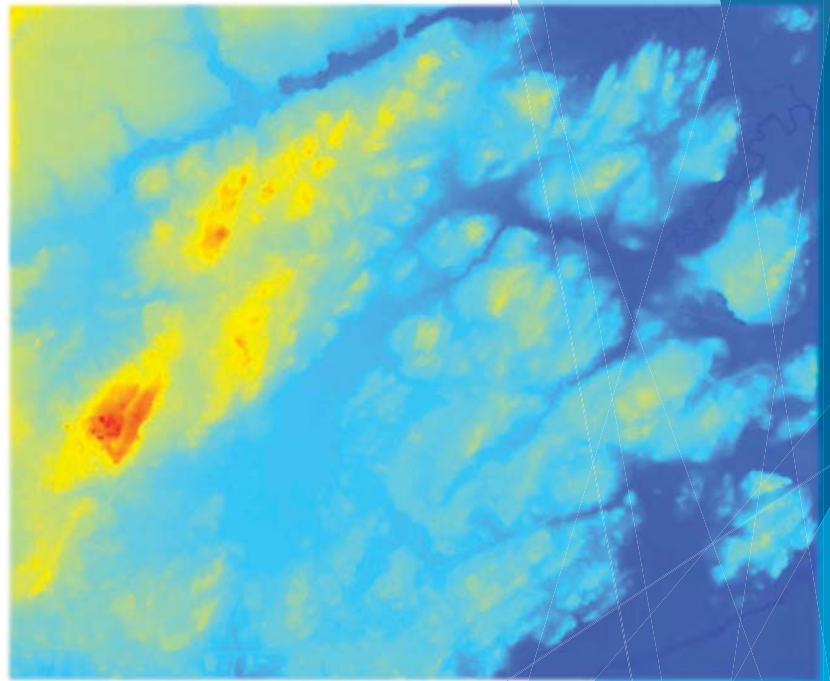
Some Notes on Sensors.

▶ Not all cameras are made equal.

  ▶ sUAS sensor detection may be either too wide or too narrow for your mission.

▶ Know the accuracy of the sensor.

  ▶ Many sUAS sensors are not calibrated for accuracy.

▶ Only use the fastest storage you can get.

  ▶ Use internal storage or class 10 SD.
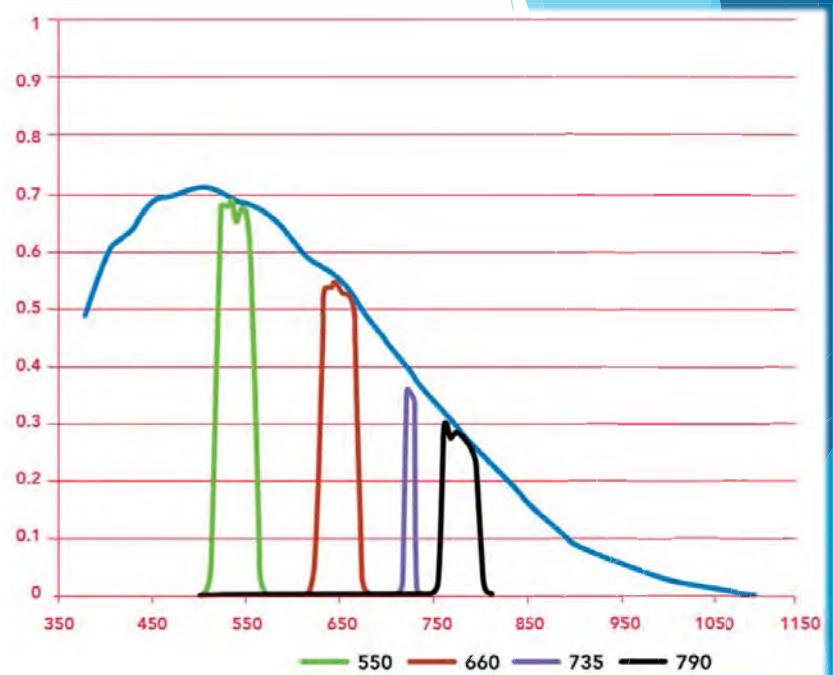
Modified Sensors.

▶ Many sUAS cameras are modified from their original design.

▶ Many Near Infrared (NIR) cameras are normal digital cameras with an IR filter removed.

▶ SenseFly's Cannon NIR (Right) has a lower NIR response than the Sequoia Multispectral.

▶ Often have unorthodox band combinations.

Questions?