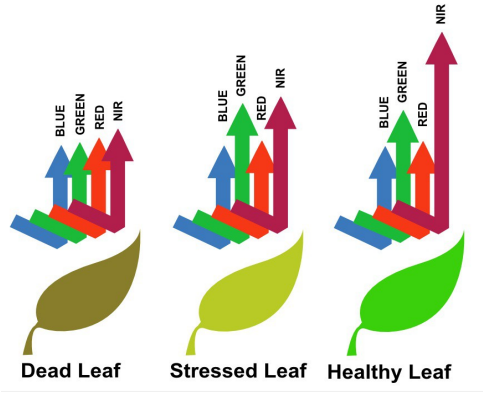
Dinner and Data and Drones, Oh My!

NDVI – Normalized Difference Vegetative Index

UAVs (Unmanned Aerial Vehicles) commonly referred to as drones, are advanced tools that collect images to determine crop health in agriculture. In theory, these NDVI images could be used for everything from prescribing fertilizer to identifying weed patches to estimating yields. So, what is NDVI? NDVI is a ratio of near infrared (NIR) reflectivity minus red reflectivity (VIS) over NIR plus VIS.

$$NDVI = (NIR - VIS) / (NIR + VIS)$$

How does it work? Plants reflect more green light than any other red reflective (VIS) color; however, the amount of any reflected VIS light is actually very small compared to the amount of infrared (NIR) light reflected. Plants reflect strongly in the NIR because of a spongy layer found on the bottom surface of the leaf, but not strongly in the VIS. Soil, on the other hand, reflects both equally. When a plant becomes dehydrated or sickly, the spongy layer collapses and the plant ceases to reflect as much NIR light. Camera filters are crucial to the interpretation of plant health while using UAVs compared to Satellite imagery. Look at the three images below to understand how the use of filters and cloud cover can impact the NDVI image.



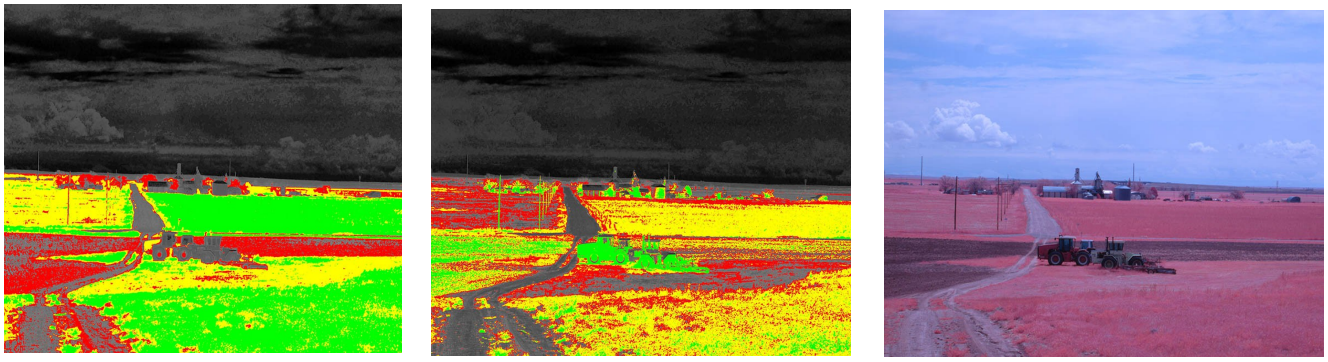


Photo 1: The NIR-VIS index shows a reproducible vegetation map. A false coloring that scales from green (dense vegetation) to yellow to red to grey (no vegetation) has been applied. Note: the tractors, houses, and roads have a low signal, while the fields have a higher signal.

Photo 2: NDVI without any filters. The incident light produced by the cloud cover produced shadows that the UAV demonstrates in the photo making the tractor look like it is the dense vegetation instead of the crops.

Photo 3: The original raw image taken with a blue filter gives a general idea about the scene before the filter layering is complete.

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Now let's look at the following photograph to understand the incident light phenomena more easily.

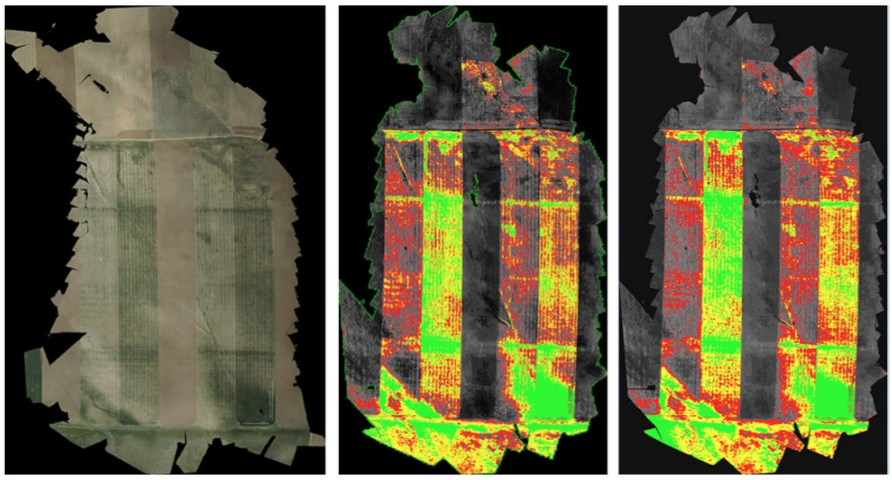


Photo 1: Standard color image

Photo 2: NDVI Image

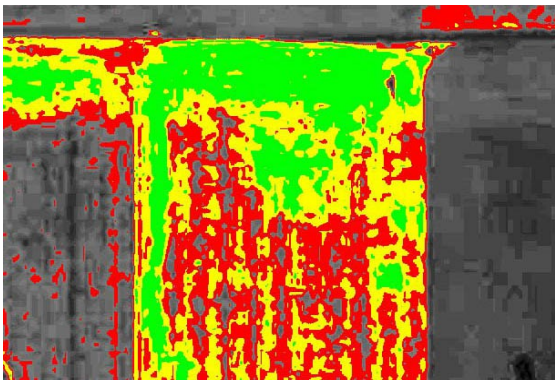
Photo 3: NIR-VIS image

Notice that under normal circumstances, the NIR-VIS looks identical to the NDVI. It's only when signals get low due to shadows or absorbing materials that the NDVI signal yields the strange results you see in the photographs with the tractor.

Reflection:

1. The five wheat fields above have all been planted at the same time. Some fields have been planted immediately following a previous wheat crop and some have been planted following a fallow (no crop) year. Which fields were planted following a wheat crop, a fallow year? What evidence did you use to decide?

2. UAVs can help the farmer better understand his crops by creating a different view than from the roadside. It is hard to interpret the health of your field looking at it from the side versus in the air. Look at the image to the right to interpret how the farmer would see his field from the side of the road (top of the image). Would he interpret his field as healthy with dense vegetation? Why or why not? What is the overall health of the field?



References: http://agribotix.com/blog/2014/06/10/misconceptions-about-uav-collected-ndvi-imagery-and-the-agribotix-experience-in-ground-truthing-these-images-for-agriculture/

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Activity:

1. Above is a NDVI image from a local Ohio Soybean farmer's field. Using colored pencils, please draw a realistic interpretation of the soybean vegetation density in the grid below. Remember to create a key noting which color(s) indicate greater plant density and which color(s) indicate less vegetation.

Key:

2. Which areas of the field are the healthiest? Which areas of the field are not as healthy?

3. What are some possible reasons for less soybean growth inside of the field seen above?

4. Now, look a the same field from the roadside (bottom left of the image above). Do the soybeans look healthy from this image?

5. In this VIS light photograph, what color represent the soil? What color represents the soil in the NDVI image used for questions 1 & 2? Why does the soil reflect that color instead of the reflected reds-yellows of the soybeans?

6. How do you think that this loss of soybean growth will affect the farmer when he harvests the soybeans?