Obtaining NDVI from UAV-based aerial photography

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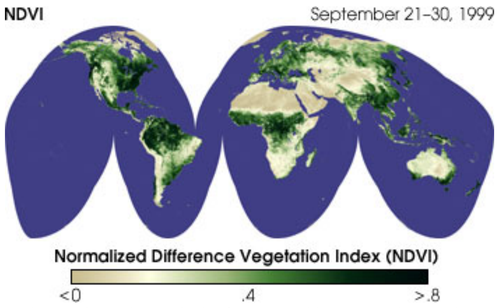
Introduction

Healthy vegetation has a unique spectral signature. The chlorophyll in plants strongly absorbs red wavelengths of light for use in photosynthesis, while the cellular structure of the leaves strongly reflects near-infrared wavelengths. The Normalized Difference Vegetation Index, or NDVI, takes advantage of this difference in reflection to characterize the health of vegetation, or "greenness". NDVI is calculated with red and near-infrared bands as $\mathrm{NDVI} = \frac{(\mathrm{NIR} - \mathrm{RED})}{(\mathrm{NIR} + \mathrm{RED})}$. NDVI produces a range of values from -1 to 1 with healthy green vegetation having values from approximately 0.8 to 1.



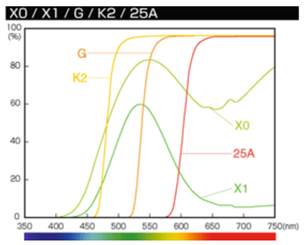
Low values show a lack of, or unhealthy, vegetation, and high values indicate high raters of photosynthesis.
Image source: NASA Earth Observatory

Purpose

The purpose of this project was to establish a method for obtaining NDVI imagery from a single digital sensor affixed to an unmanned aerial vehicle (UAV). The UAV used was a DJI Phantom 2 Vision +, a remotely controlled quadcopter. A private property southwest of Lawrence, Kansas was the study area, chosen for ease of access and the presence of several different land-cover types within the property boundaries.

Methods

In order to obtain multispectral imagery with a single digital camera, a converted Canon EOS M was purchased. The internal no-pass filters had been removed, making the camera a full spectrum digital sensor. In order to obtain the bands necessary to calculate NDVI, a low-pass yellow filter was added in order to block light in the UV and blue wavelengths.

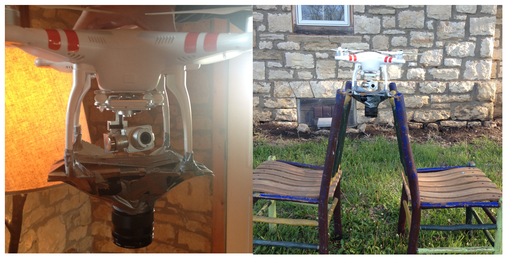


The yellow filter (K2 in the image) blocks light with wavelengths shorter than approximately 500 nm.

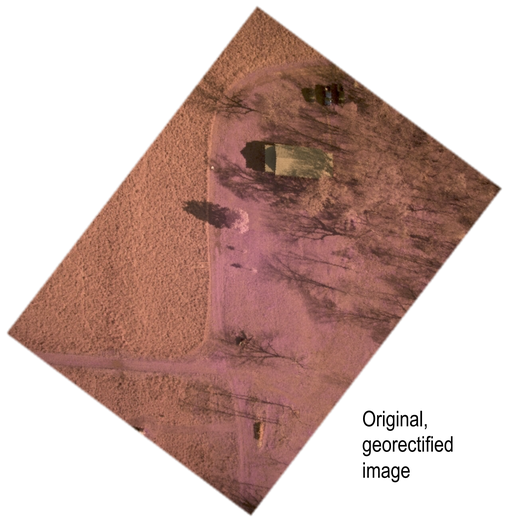
Image source: Hoya Filters

Methods

The modified camera was mounted to the UAV using cardboard and duct tape with the shutter depressed in order to collect continuous imagery. The imagery used in this analysis was obtained from an above ground altitude of approximately 114 meters on 20 April 2015.



Due to technical issues it was not possible to follow the programed flight plan and the UAV was flown manually. Consequently many of the images did not contain the established ground control points. A single image was selected based on recognizable features, and georectified to NAIP imagery using Erdas Imagine.



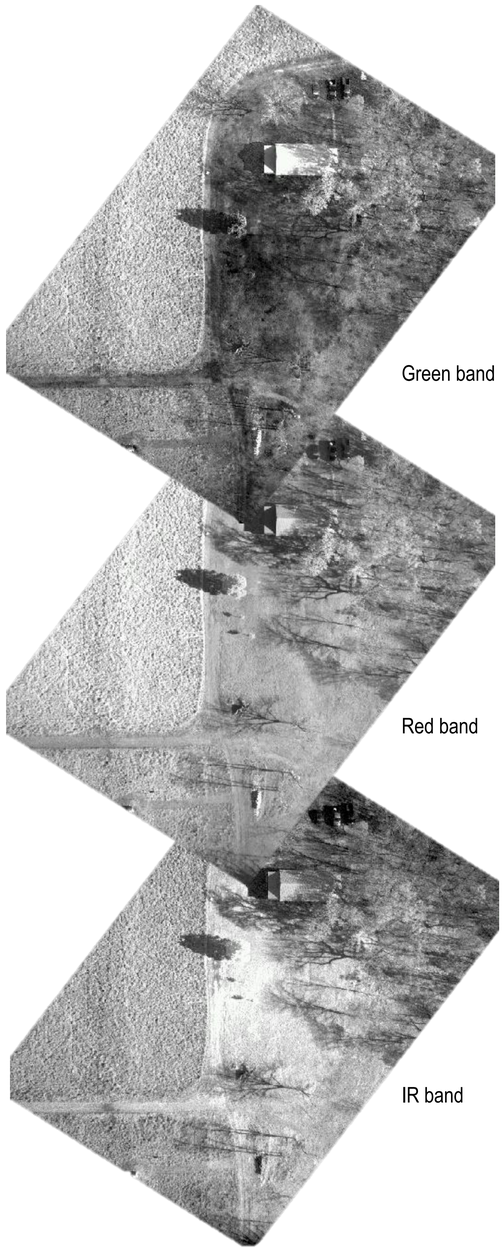
Original, georectified image

The combination of the full-spectrum digital camera and the low-pass filter produced three bands of data:

UV + Blue + IR – (UV + Blue) = **IR**
UV + Green + IR – (UV) = **Green + IR**
UV + Red + IR – (UV) = **Red + IR**

Utilizing raster calculator in ArcMap, the IR band was subtracted from the other two bands, resulting in an IR band, a green band, and a red band. These three bands were then stacked in Erdas Imagine to create a color-infrared composite image.

Methods



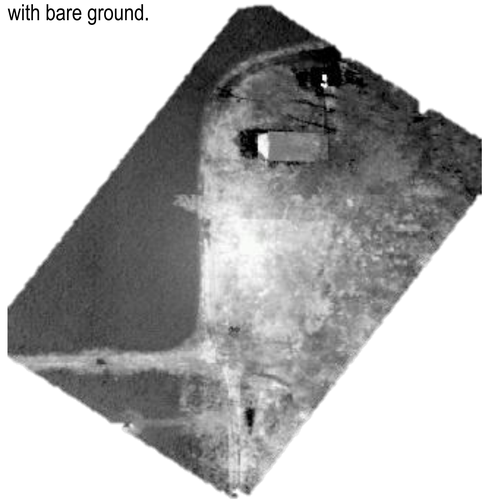
Green band

Red band

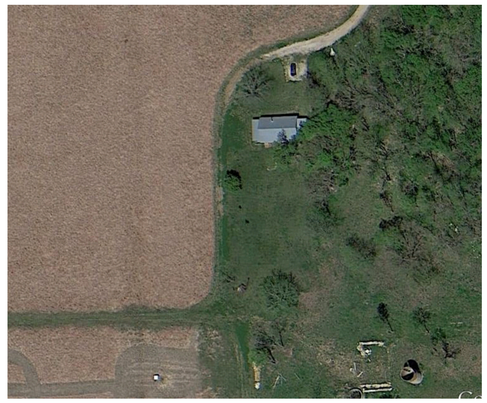
IR band

Results

NDVI was calculated in ERDAS Imagine with the color infrared composite using the red and infrared bands. Areas of high NDVI are shown with light shades and areas of low NDVI are shown with dark shades. The image shows a fallow field and a pattern of emerging grasses interspersed with bare ground.



The NDVI image was visually assessed against a Google Earth image from Digital Globe captured on 3 May 2014. The UAV imagery was obtained prior to tree greenup and so does not show the vegetated biomass in the tree crowns. The NDVI image does distinctly capture the pattern of grass growth in the open areas.



Further validation is necessary to assess the accuracy of the NDVI image. Due to a lack of precise spectral resolution there is inherent uncertainty in the process. Ground-based measurements should be taken using a spectroradiometer and NDVI calculated for a set of sample points. A confusion matrix could then be used to determine the accuracy of the aerial measurements. Based on a visual assessment of the NDVI image, the technique holds great promise for production of high spatial resolution NDVI imagery.

Reference: Rabatel, Gilles, Nathalie Gorretta, and Sylvain Labbé. "Getting NDVI spectral bands from a single standard RGB digital camera: a methodological approach." In *Advances in Artificial Intelligence*, pp. 333-342. Springer Berlin Heidelberg, 2011.