Using a Fixed Wing UAV Remote Sensing System for Monitoring Sorghum Growth and Development

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INTRODUCTION

Unmanned aerial vehicles (UAV) are fast becoming the next generation tools for remote sensing applications in agriculture. The low operational cost, high temporal and spatial resolutions, easy-to-use controlling systems and high flexibility in image acquisition and planning make UAV very popular compared to other remote sensing systems. While numerous remote sensing studies in agriculture have been conducted over the last decades, there had been a few studies that used UAV-based remote sensing for developing and implementing agricultural management strategies and high throughput plant phenotyping.

OBJECTIVES

1. Evaluate the suitability of Anaconda UAV with multispectral sensor system for sorghum growth monitoring
2. Determine the relationship between yield, leaf area index fractional vegetation cover, and NDVI

METHODS

- The study was conducted at Texas A&M Brazos Farm, TX (30°32’ 29.54″ N, 96° 25’ 37.24″ W)
- Soil type: Ships clay with 0-1% slope
- Six sorghum hybrids were planted in three different seeding rates (30,000; 60,000; and 90,000 seeds/acre) with three replications
- Each plot was 15 m long and 3.5 m wide
- LAI was measured using a LAI-2200C plant canopy analyzer (LI-COR, Lincoln, NE)
- Overhead photos were collected using a canon camera for fractional vegetation cover measurements
- Images were collected at an altitude of 120 m above the ground at approximately 11:30 AM - 12:30 PM CST on 24 May, 10 June and 18 June in 2016

Conversion of Digital Counts to Reflectance

- For radiometric calibration of the aerial imagery, three calibration tarsps (3%, 8% and 22%) were used
- Digital count (DC) values corresponding to the calibration tarsps were extracted from the UAV imagery and correlated with the known average tarp reflectance
- Linear calibration equations relating DC values to reflectance in the red and NIR wavebands were developed
- These calibration equations were used to convert the UAV image DC to reflectance
- Red and NIR reflectance values for the pixels from each plot were averaged to calculate the Normalized Difference Vegetation Index (NDVI)

NDVI = (NIR-Red)/(NIR+Red)

UAV used in the study
(A) Anaconda Fixed-wing Aircraft and (B) Flight Plan

Sensor used in the study
Sentek GEMS multispectral camera

UAV Image Processing

- Images were collected with 75% overlap
- Used Pix4D software for pre-processing (image mosaicking) and ENVI for post-processing
- 422 total images each for RGB and NIR and less than 300 were useful
- Mosaicked the NIR and RGB image is 207 megabytes

RESULTS

NDVI images of the study field

In image acquired on 24 May, the lack of sufficient overlap has resulted in gaps in the upper left corner of the study area

Summary

- NDVI images clearly show the difference between different seeding rates
- There is a strong curvilinear correlation between NDVI and LAI
- NDVI saturates when LAI is greater than two
- NDVI is linearly correlated with vegetation cover
- LAI is highly correlated with vegetation cover
- Late season rainfall resulted in some yield loss from the study plots
- NDVI is linearly correlated with sorghum yield
- The results from the study show that UAV remote sensing is a promising technology for agricultural remote sensing applications
- Compared to satellite and aircraft remote sensing, UAV-based remote sensing requires significant pre-processing of data

Funding

This project is supported by Texas A&M AgriLife Research