The Impact of Flying Modalities on UAV Estimations of Agronomic Characteristics of Wheat

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- Image collection with a UAV can be done in one of three ways: taking a single image of the entire field, taking a single image of each replication, or collecting images at several waypoints in a field and then merging into an orthomosaic (Xiang & Tian, 2011).

- Our objective was to examine the three types of data collection with the UAV and determine the most ideal for estimating agronomic characteristics of wheat.

- **Materials & Methods:** Images were collected with an AscTec Falcon 8 UAV (Figure 1) with three cameras.
  - Sony Alpha 6000 digital red-green-blue (RGB) camera
    - Vegetation and color space indices
  - Near-infrared (NIR) ADC Lite Tetracam
    - NDVI
  - FLIR Tau 2 Infrared (IR) camera
    - Canopy Temperature

Waypoint flights were flown as illustrated in figure 2, and after the flights the images were merged with Pix4D (Figures 3 & 4). Single images and images of each replication were also collected. Data from the images was compared with corresponding ground collected data and grain yield.

Figure 1: AscTec Falcon 8 flying and collecting data over wheat plots in Suffolk, VA.

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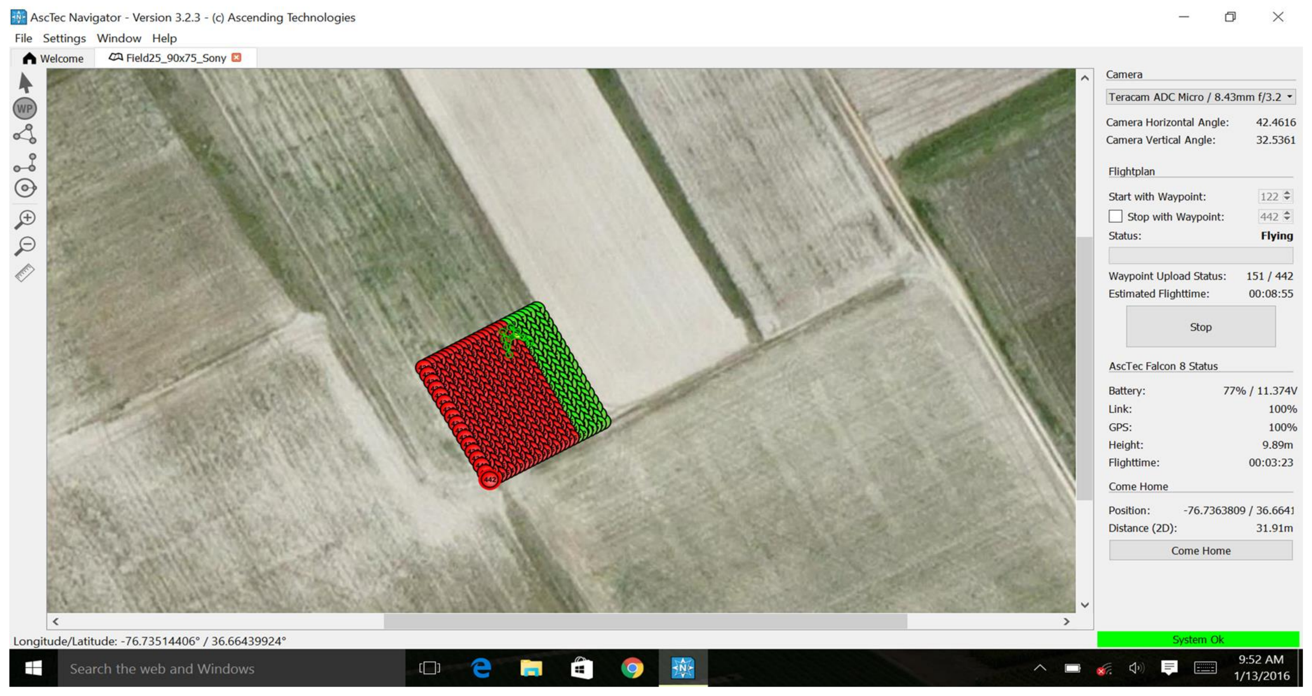

Figure 2: The flight plan of a waypoint flight. Images were collected at 10 meters with an overlap of 75% cross track and 90% along track.

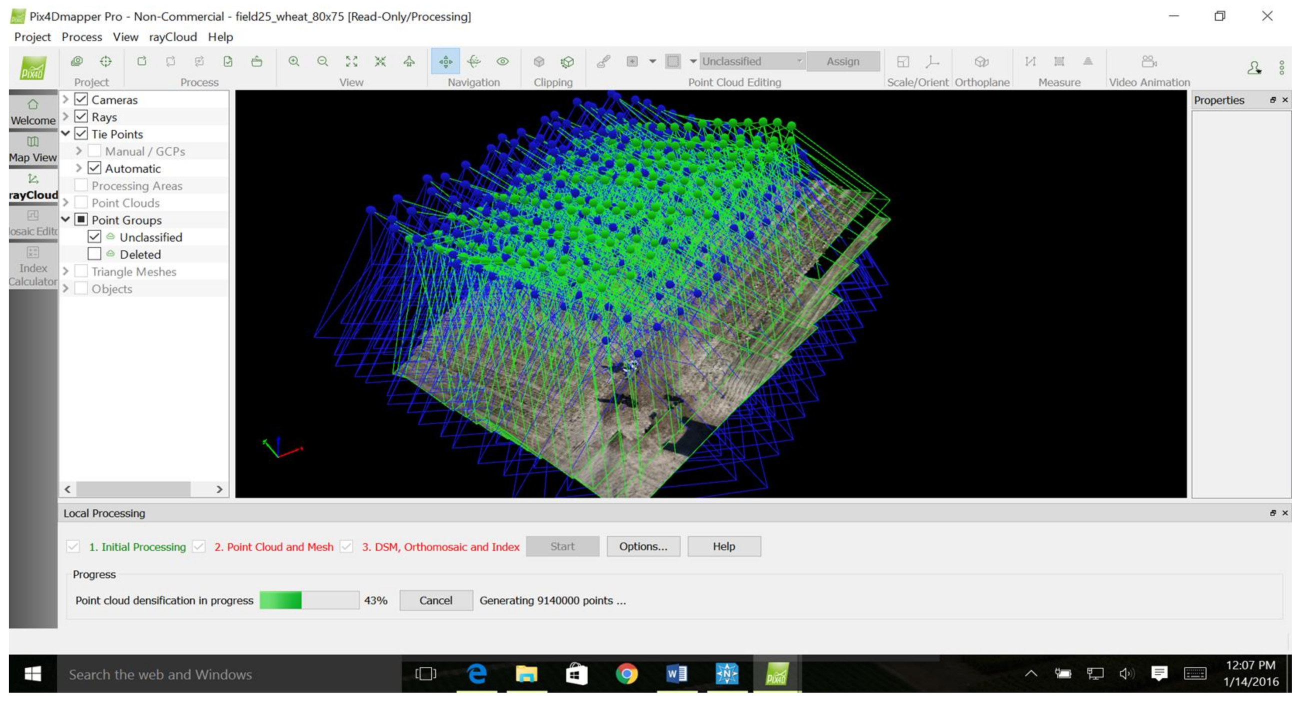

Figure 3: Images from a waypoint flight being merged into an orthomosaic with Pix4D.

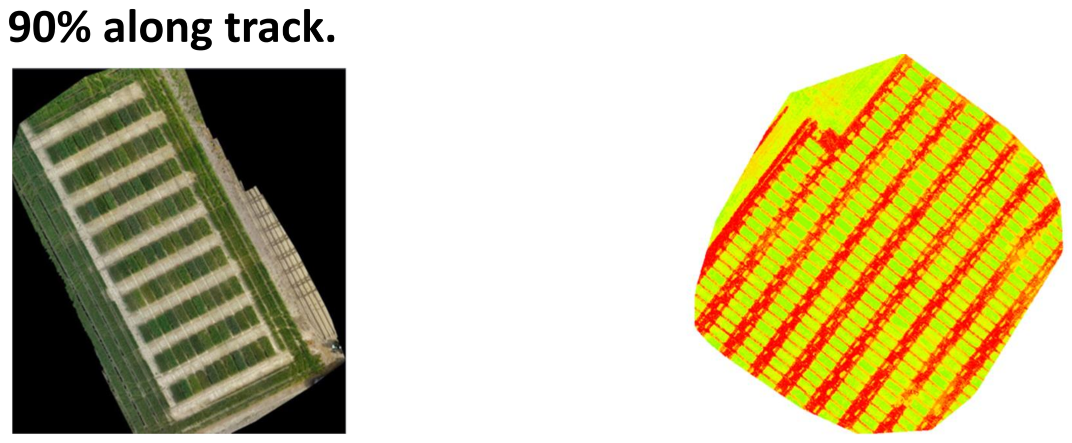

Figure 4: The orthomosaic of RGB images (left) and aerial NDVI (right). RGB altitude was at 10 m with 75% x 90% overlap. NDVI altitude was at 20 m with 75% x 75% overlap.

- **Results:**

Table 1: Correlation (R^2) of Aerial Greener area (%pixels with 60° <Hue<120°) from RGB digital camera in the three flying modes (orthomosaic and grouped images) to ground NDVI and yield on May 2 (GS65) in Suffolk, VA.

	GGA - Orthomosaic	GGA - Grouped Images
Ground NDVI	0.78	0.79
Yield	0.52	0.49

Table 2: Correlation (R^2) of Aerial NDVI from ADC Lite Tetracam in the three flying modes (orthomosaic, grouped images, and single image) to ground NDVI and yield on April 29 (GS65) in Warsaw, VA.

	Aerial NDVI - Orthomosaic	Aerial NDVI- Grouped Images	Aerial NDVI - Single Image
Ground NDVI	0.76	0.74	0.55
Yield	0.64	0.59	0.51

Table 3: Correlation (R^2) of Aerial canopy temperature (CT) from the FLIR camera in the two flying modes (grouped images and single image) to ground NDVI and yield on May 9 (GS70) in Suffolk, VA.

	CT – Grouped Images	CT – Single Image
Yield	0.08	0.57

- **Discussion & Conclusions:**

➢ Correlation between GGA and ground NDVI was almost identical for both the orthomosaic and grouped images. However, the orthomosaic was slightly better correlated with yield.

➢ The orthomosaic image for aerial NDVI produced the highest correlation with both ground NDVI and yield.
  - ➢ Waypoint flights were flown at an altitude of 20 m. Due to the narrow field of view on the tetracam, the altitude was 30 m for grouped images and 40 m for a single image. As altitude increased, correlation decreased.

➢ A single image provided the best correlation between yield and canopy temperature.
  - ➢ This could be due to the difference in time between images collected. Since canopy temperature is influenced by environmental conditions (temperature, wind speed, sunlight, etc.), one image is necessary for a constant environment among all plots.
  - ➢ Due to the difference in time between images, we were unable to orthomosaic IR images. Future work this year will focus on rectifying this issue.

➢ Overall, an orthomosaic provided the best correlation with ground NDVI and yield for RGB and NIR images.

Acknowledgements: Virginia Crop Improvement Association, Virginia Peanut Board, Virginia-Carolina Peanut Association

References: Xiang, H. & Tian, L.(2011). Development of a low-cost agricultural remote sensing system based on an autonomous unmanned aerial vehicle (UAV). *Biosystems Engineering* 108:174-190