Phenotyping Using Unmanned Aircraft Systems (UAS) for Peanut (*Arachis hypogaea* L.)

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Introduction

In the past, the collection of crop data was performed by researchers, graduate and undergraduate students. This was expensive, labor-intensive and in some cases involved destructive for hand sampling techniques. These constraints often lead to under-represented crop information due to limited sampling as well as the introduction of possible human errors. With the introduction of Unmanned Aircraft Systems (UAS), some of these hurdles can be overcome. These systems quickly automate hours and hours of tedious data collection. The UAS can complete these tasks in terms of minutes instead of hours and can do so with a high degree of accuracy. The purpose of the poster is to describe the initiation of the Texas A&M peanut breeding CasonUAS program.

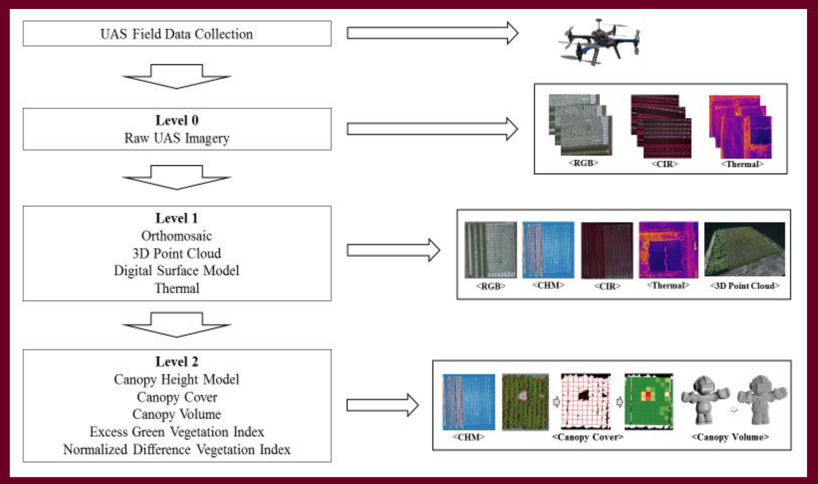
Materials and Methods

The 2020 crop season was the first full season data was collected on peanut by the Texas A&M AgriLife Research peanut breeding program located in Stephenville, Tx. Flights were conducted at multiple locations to develop preliminary data for analysis. A total of 24 flights were conducted at 4 different locations and were processed and analyzed where applicable. Unmanned Aircraft Systems data was collected starting in May and ending in November. A Matrice 200 v2 with a slantrange 4P+ camera and a Mavic Pro 2 with a 20 megapixel RBG camera were used to collect UAS data. To improve the quality of the data and georeferencing, multiple Ground Control Points (GCPs) were used to survey plots using a post-processed kinematic GPS (PPK-GPS) device. The single GPS antenna on a UAS is accurate to approximately 3 to 5 m. By coupling that antenna with a kinematic GPS device the accuracy is improved to < 2-3 cm. The raw images were processed by the Structure from Motion (SfM) algorithm to generate Digital Surface Model (DSM), orthomosaic images, and 3D point cloud data. UAS-based phenotypic data including canopy cover, canopy height and Vegetation Index (VI) was extracted.

A screen shot of a mission in the Pix4D mission planning app.

Matrice 200 v2 in flight

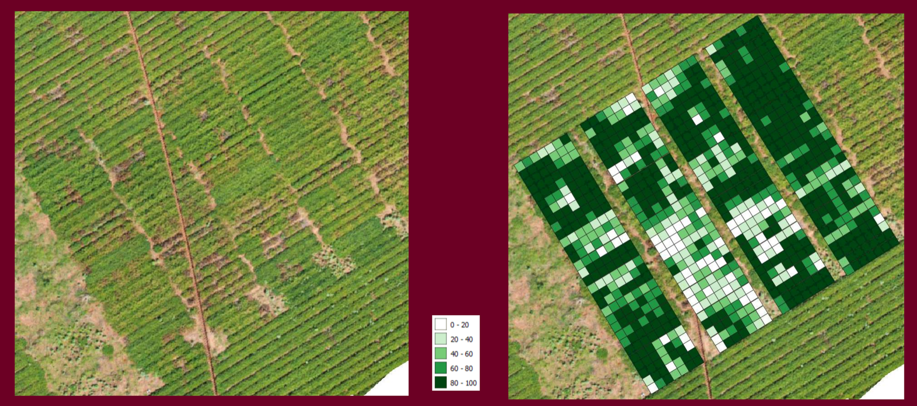
Results and Discussion



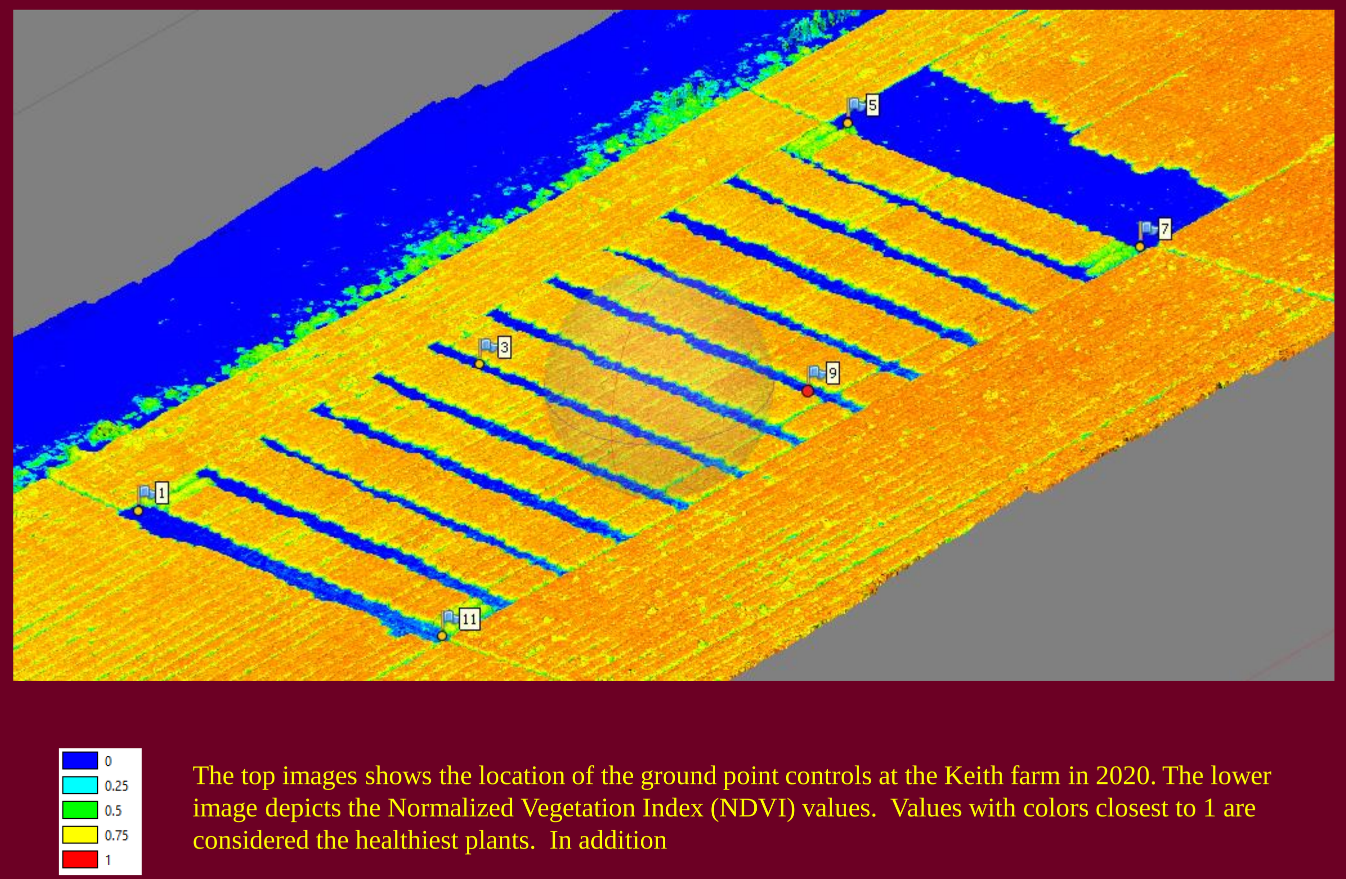
Data collection and processing workflow for the Texas A&M AgriLife Research UAS program

Vmap rover station collection of GPS coordinates

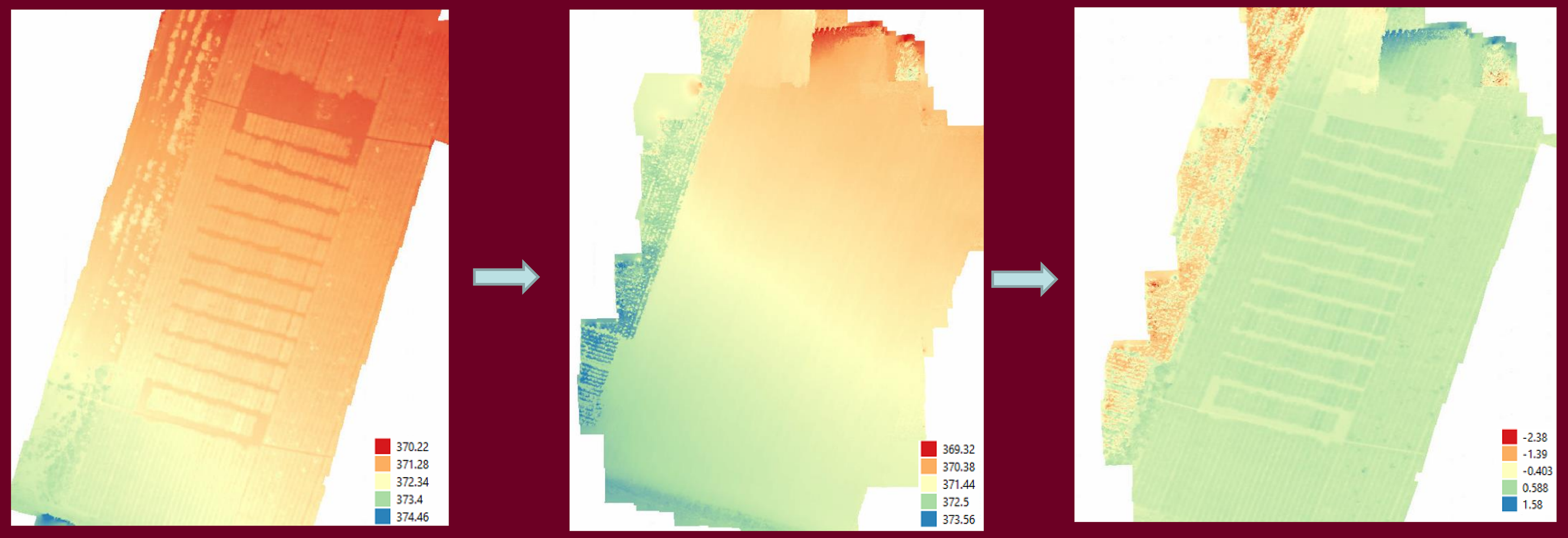
Although data was collected at several locations the primary location involved weekly flights through out the season form planting until harvest. Hand measurements for plot length, plant heights, yield and grade were taken as a means of ground truthing UAS data. Although collected data is still being finalized plant height estimates by UAS are consistent with the ground measurement that were taken. In addition, Normalized Difference Vegetation Index (NDVI) was estimated and is presented below. This will be correlated with actual yield and grade to determine is this is an indicator of actual plot yields. Further analysis will be conducted on the biomass and its relationship to yield, grade and plant maturity. In addition to this location, flights were also conducted to estimate stand counts and leafspot (*Nothopassalora personata and Passalora arachidicola)* and is currently being processed



Orthomosaic images generated from UAS imagery (left) and canopy cover (%) within each 0.9×0.9m grid calculated from the orthomosaic image



The top images shows the location of the ground point controls at the Keith farm in 2020. The lower image depicts the Normalized Vegetation Index (NDVI) values. Values with colors closest to 1 are considered the healthiest plants. In addition



Digital Surface Model (DSM) Digital Terrain Model (DTM) Canopy Height Model (CHM)

Canopy Height Model (CHM) is determined by subtracting Digital Terrain Model (DTM) from Digital Surface Model (DSM). The measurements in the legend are in meters.

Conclusions and Direction

As mentioned data indicates UAS can be used to estimate stand counts, crop growth patterns and can also associated with disease ratings. The ability to collect data high quality data in a quick efficient way represents a huge benefit for our program. Our intention is to continue to expand the program. The Texas Peanut Producers Board generously funded the data analysis for one location in 2020 to develop this preliminary data. We are currently seeking funding for additional locations and have submitted several grants using these results to expand our research.

References:

Ashapure, A., J. Jung, J. Yeom, A. Chang, M, Maeda and J. Landivar. 2019. A Novel Framework to Detect Conventional tillage and No-tillage Cropping Systems Effect on Cotton Growth and Development Using Multitemporal UAS Data. ISPRS Journal of Photogrammetry and Remote Sensing. 152:49-64 doi: 10.1016/j.isprsjprs.2019.04.003.

Chang, A., J. Jung, M. Maeda and J. Landivar. 2017. Crop Height Monitoring with digital imagery from Unmanned Aerial Systems. Computers and Electronics in Agriculture 141:232-237. https://doi.org/10.1016/j.compag.2017.07.008.

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Shi Y, Thomasson JA, Murray SC, Pugh NA, Rooney WL, Shafian S, et al. (2016) Unmanned Aerial Vehicles for High-Throughput Phenotyping and Agronomic Research. PLoS ONE 11(7): e0159781. doi:10.1371/journal.pone.0159781.

Funding Agencies:

Texas A&M AgriLife Research
Texas Peanut Producers Board
National Peanut Board