The Impact of Drone Technology on Precision Agriculture at The Morehead State University Farm

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Introduction

We are investigating and monitoring the environmental status of the agricultural fields and pastures at the Morehead State University (MSU) Farm to provide the basis for implementing precision agriculture programs. The farm is located north of I-64 and Morehead, Kentucky in Rowan County.

The MSU Farm, also known as the Derrickson Agricultural Complex, covers nearly 350 acres and offers students numerous hands-on learning opportunities. The complex is known for raising sheep, cattle and swine, equine breeding and boarding, vegetable and grain production, and freshwater shrimp and tilapia production.

Management of the MSU farm is working to become more efficient in operations, modernize operations, and better serve the university and region. For instance, the MSU Farm recently partnered with Kentucky Proud and Aramark to supply campus dining facilities with high quality fruits, vegetables and beef. The MSU farm assists farmers in finding new and innovative ways to produce crops more effectively and for this reason is starting to adopt precision agriculture strategies.

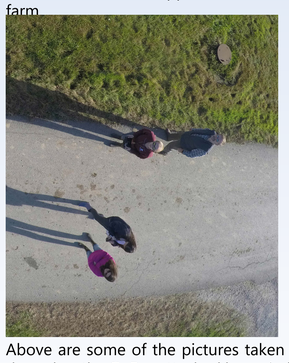
The goal of this project is to produce orthorectified photomosaic maps and 3D models capable of supporting precision agricultural activities and analyses. These analyses include such activities as enhancing crop growth, monitoring climate change, regulating drainage, and other agricultural operations. We are creating the maps and 3D models using unmanned aerial vehicles (UAVs) carrying a variety of remote sensing cameras. The team is dedicated to making the maps and models as accurate as possible that will make possible more research opportunities and involve additional participants.

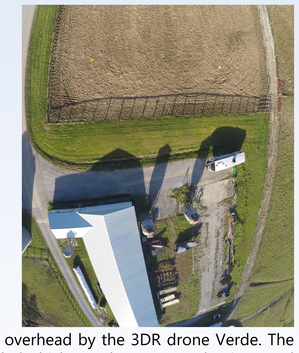
Flight Process

UAV-based mapping begins with mission planning including site selection, evaluating obstacles, checking weather conditions, selecting and inspecting equipment, programming flights (using the Tower app), and ensuring safe operations. The UAV-borne camera is programmed to systematically collect high-resolution and overlapping images of the target area.

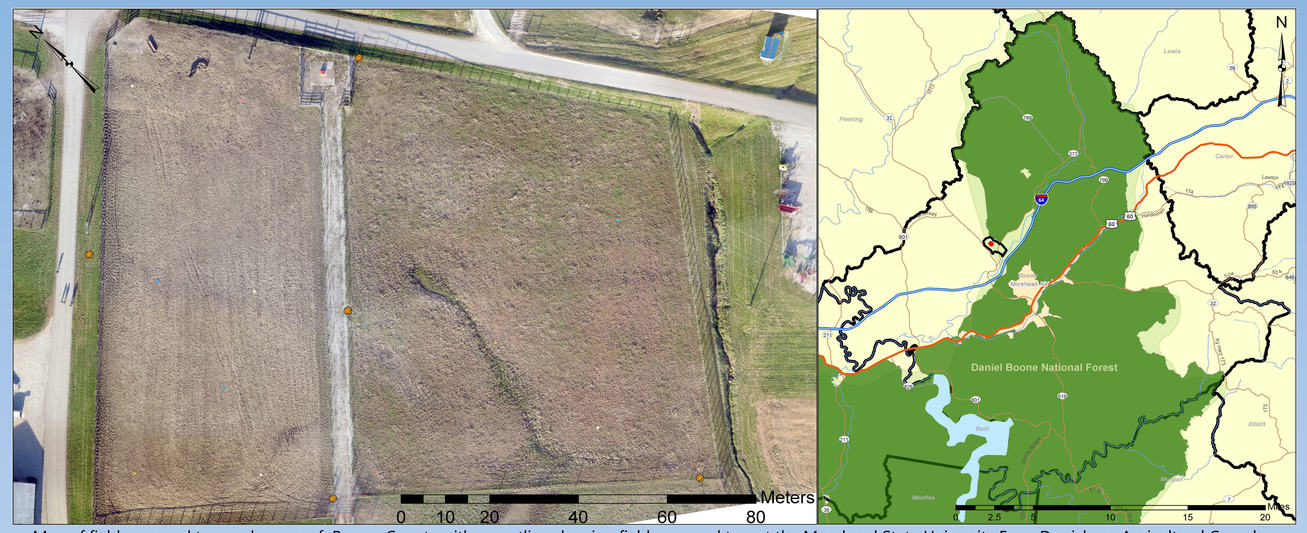
Images are processed in photogrammetric software (Pix4DMapper) to fine-tune and align image locations. The processing identifies corresponding pixels across multiple overlapping images and calculates angular offsets. This allows the software to generate two primary products; a seamless georeferenced orthorectified mosaic of the images and a 3D model of the ground surface.

Screenshot of Tower app on an Android tablet preparing for a mission at the farm.

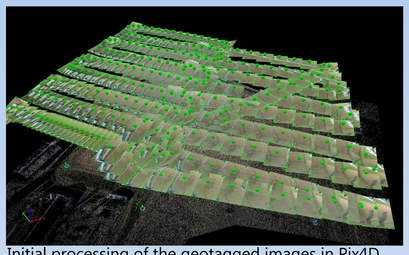




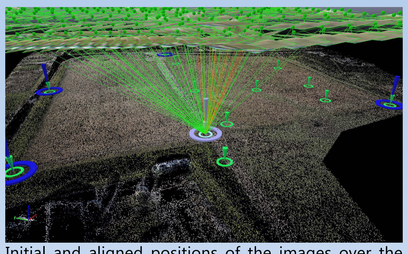
Above are some of the pictures taken overhead by the 3DR drone Verde. The drone has the GoPro attached by a gimbal which was the same mechanism used during the flights. In the right photo you can see the slight curvature of the Earth's landscape.



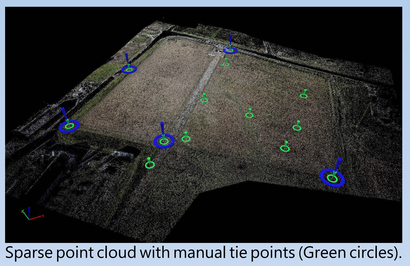
Map of fields one and two and a map of Rowan County with an outline showing fields one and two at the Morehead State University Farm Derrickson Agricultural Complex.



Initial processing of the geotagged images in Pix4D Mapper.



Initial and aligned positions of the images over the sparse point cloud.



Sparse point cloud with manual tie points (Green circles).

Dense point cloud.

Close up of the dense point cloud focused on a bull.

3D mesh based on the dense point cloud.

3D map made from the orthomosaic of fields one and two in the fall of 2018 at the Morehead State University Farm Derrickson Agricultural Complex.

Precision Agriculture

Precision agriculture is the process of implementing new technology to gain detailed information about a field to increase crop yields and profits, while decreasing waste and also decreasing the resources that are traditionally needed to grow crops. Precision agriculture programs typically focus on the interactions of land, water, fertilizer, herbicides and pesticides.

> "One developing area of precision agriculture involves monitoring and analyzing data related to the weather, soil, pest or hydration conditions of a specific farm, field or even plant to make exact and predictive farming decisions. Collecting and transmitting [these] data in meaningful ways has been a barrier, but innovators are working to change that," (Sustainable America).

Using technology like UAVs has proven effective when implementing precision agriculture techniques in farmland that has decreased crop yields or land that is non-cultivable because of past farming. UAVs are unlike other technologies because they can collect data continually so the health of the land can be monitored without being disturbed by farmers and scouts in the fields. This allows for a more precise and controlled application technique.

Pictured above is one of the bovine raised at the Morehead State Farm.

Results

Our mission is to continue the MSU UAV Farm project while learning how to operate UAVs, collect images during a flight, and successfully process those images into maps and 3D models. We met the objectives through extensive fieldwork and deliberate photo processing. The process of configuring the collected images into a map is displayed in the images to the left. The map is a product of our flight teams, all of which carefully followed the same steps to attain conclusive maps covering different areas.

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