Comparative Analysis of UAS Acquisition Methods

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Introduction

The goal of this project was to produce a procedural framework for imagery acquisition and processing by harnessing the power of drones, cameras, apps, software, and computing power.

The study area chosen for this project was La Jolla Valley and Serrano Canyon, located within Point Mugu State Park.

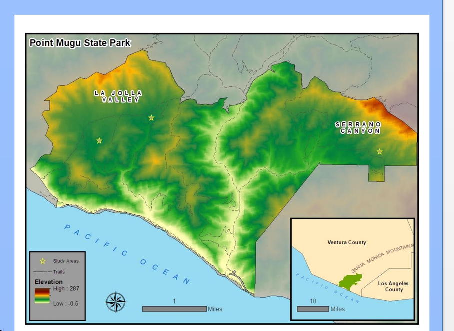


Figure 1. *The study areas La Jolla Valley and Serrano Canyon*

These locales provide wide-open fields with an abundance of grass species, but with limited shrubs and trees.

Project Tools

UAS: eBee Plus by senseFly & Phantom 3 Standard by DJI

Software: PhotoScan by Agisoft & Pix4D

Apps: Pix4D Ctrl+ by Pix4D & Map Pilot by Maps Made Easy

PhotoScan Pix4D mapper Maps Pix4D Capture

Table 1. *A Comparison of Equipment, Cost, Software, and App*

	Quadcopter: Phantom 3 Standard DJI 	Fixed Wing: eBee Plus senseFly 
Price	$499.99	$17,990
Battery Life	Short, up to 20-25 minutes	Long, up to 59 minutes
Good for mapping:	Small Scale	Small to Very Large Scale
Camera	RGB 12 Megapixel (MP) 2.7K HD Video 20mm Equivalent Lens	S.O.D.A. (RGB) 20 MP & Sequoia (Multispectral) Four 1.2 MP sensors (NIR, red-edge, red & green) One 16 MP RGB sensor
Primary Application	DJI GO	eMotion

Data and Data Sources

The remotely sensed data presented is all created from primary sources. The collected UAS imagery ultimately aided in generating: orthomosaics, digital elevation models, and vegetation indices. Some secondary vector data for trails, roads, and boundaries was obtained from Ventura County's website.

Methodologies

Results

March

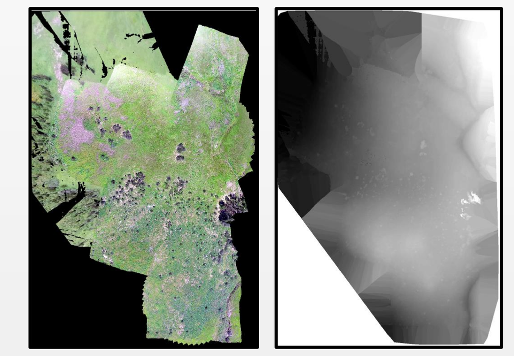
1th

Student Pilots

Before the first trip to the field, we were FAA compliant. At least one team member was flying with a temporary license to operate an unmanned vehicles.

Data Processing

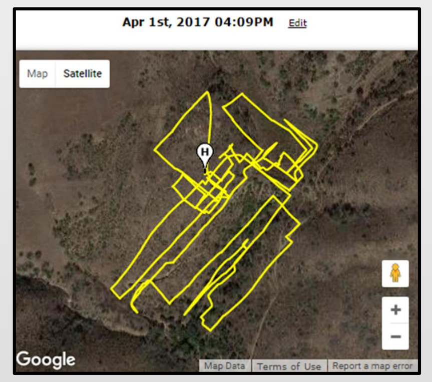
Pix4D was the only software able to process images collected during the first flight.



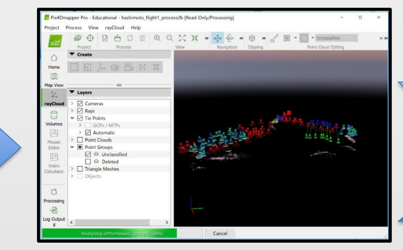
April

2th

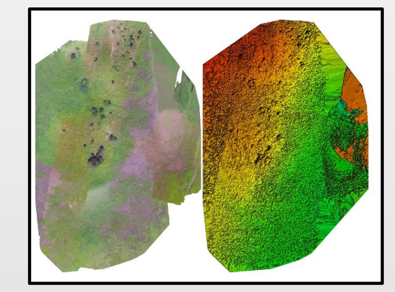
Student Pilots

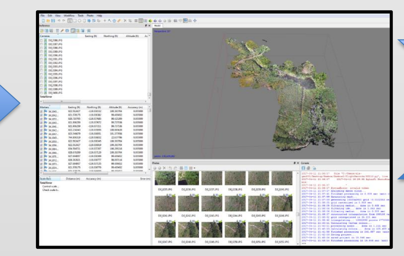


At the end of our second trip, it became clear that manually flying the Phantom 3 in straight lines with at least 70 percent overlap is not feasible.

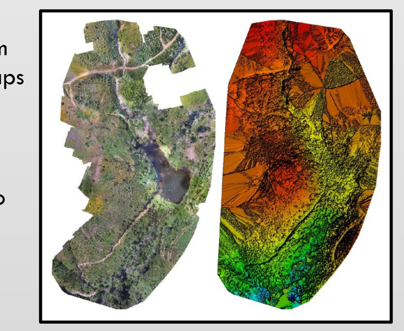


Pix4D's algorithms fill in the gaps created by the flight paths during acquisition. In doing so, it creates distortion in the surrounding areas.



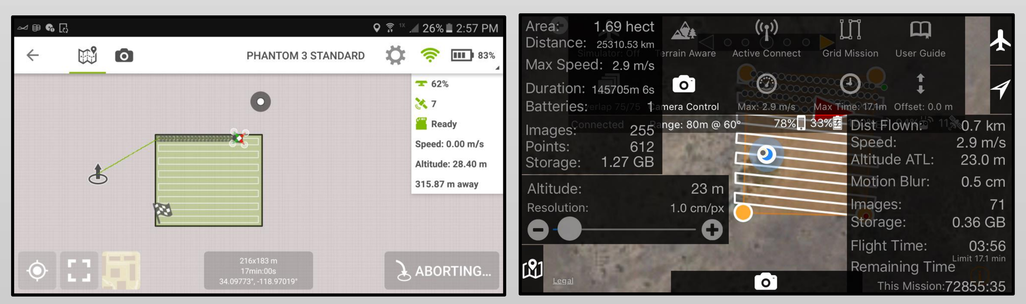


PhotoScan's algorithm does not fill in the gaps created by the flight paths during acquisition. Rather, it opts for null values so that it won't create distortion in the surrounding areas.



3th

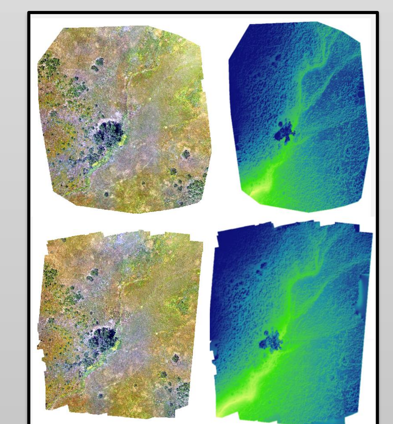
AutoPilots



During our third trip to the field, two autonomous-flight mobile applications were incorporated. The Pix4d (left) and Map Pilot for DJI (right) apps ensured that our flight paths were uniform, and that the overlap between images remained constant at at least 75 percent.

Data Processing

The same mission flight with 497 images was both processed in Pix4D (top) and PhotoScan (bottom). Each imaging software produced different image resolution, acreage, elevation ranges, and coloration.



June

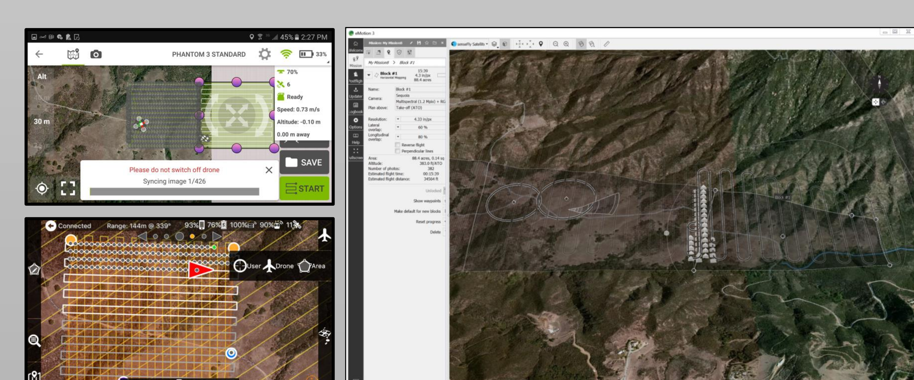
4th

AutoPilots

There was nothing significant to report due to technical issues with the eBee Plus during our fourth trip to the field.

5th

AutoPilots

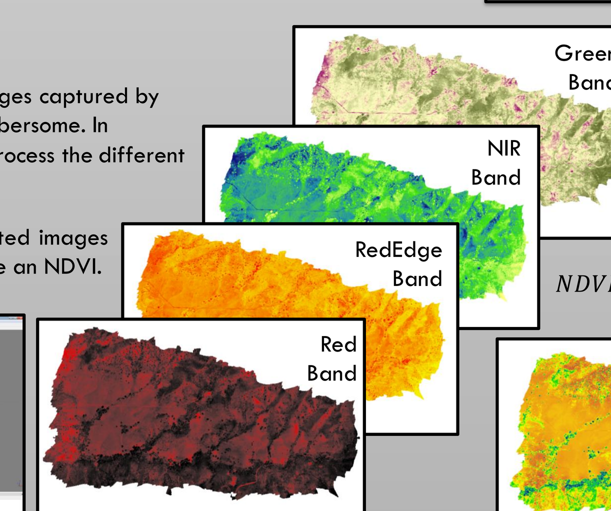


During our fifth trip to the field, eMotion, an autonomous-flight mobile application was utilized for the first time along with the eBee Plus. The software is standard with the purchase of an eBee.

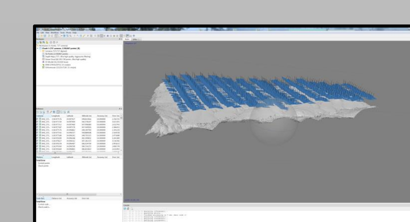
The Trimble Geo 7X was utilized to get readings of the soccer cones that served as ground control point targets and which were visible in the collected UAS imagery.

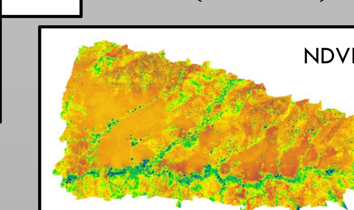
When processing the multispectral images captured by Sequoia, the procedure was more cumbersome. In PhotoScan, it was especially hard to process the different bands.

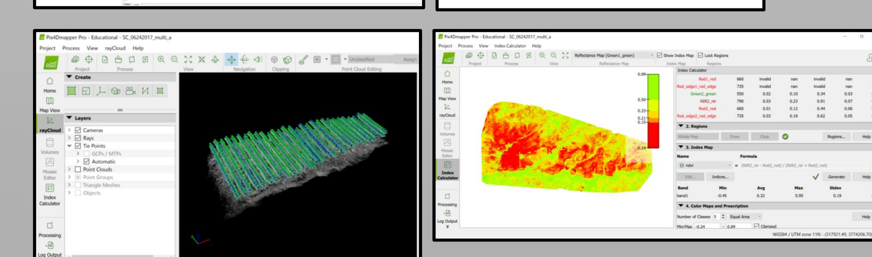
Pix4D was easily recognized the calibrated images and the multispectral camera, to produce an NDVI.

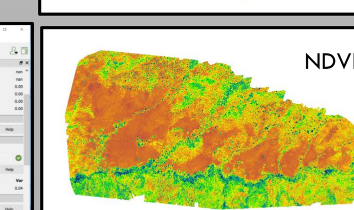


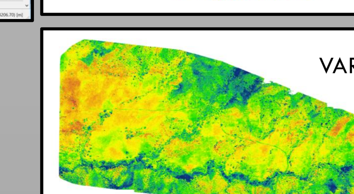
$$NDVI = \frac{(NIR - Red)}{(NIR + Red)}$$











$$VARI = \frac{(Green - Red)}{(Green + Red - Blue)}$$

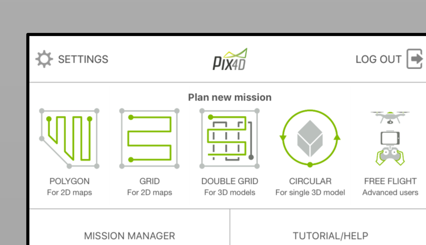
The visible atmospherically resistant index (VARI) script that we created in Python, was applied to the Pix4D orthomosaic image. To measure the healthy and green vegetation using only the RGB bands for a comparison with the multispectral camera.

July

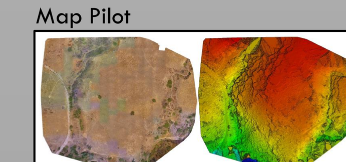
6th

AutoPilots

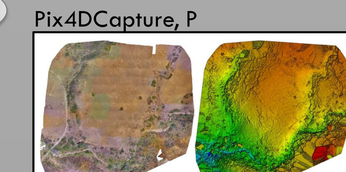
Our aim for the sixth flight to the field was to compare the Pix4DCapture and Map Pilot apps. We also flew two grid and two double grid missions using Pix4DCapture with exaggerated flight settings for flight speed and camera angle to compare and visualize the effects.



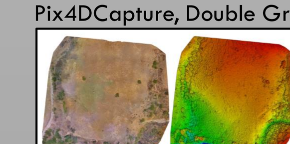
Map Pilot



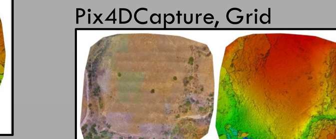
Pix4DCapture, P



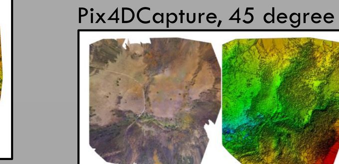
Pix4DCapture, Double Grid



Pix4DCapture, Grid



Pix4DCapture, 45 degree Grid



Discussions

Our project's outcome is unique in that one of our results was a method. The standard operating procedure (SOP) that we developed is essentially an optimized methodology that can be used like a set of instructions by future researchers. These instructions would benefit researchers who are interested in trying to replicate our results. We safely estimate that our SOP is viable for the next three years. We foresee significant improvements in camera resolution, software version updates, and firmware upgrades, all of which will eventually make our SOP obsolete at some point in the future.

Limitations

Because of the flawed sampling of GCPs, we decided not to use those ground-truth points to georectify the images during processing. Moreover, we could not compare the UASs' built-in GPS units with one another because the ground-truth points would serve as the baseline for that part of the analysis.

Conclusions

The images collected with the low-cost Phantom 3 Standard's camera can stand up to the high-end eBee Plus S.O.D.A. and Sequoia cameras. However, the Phantom 3 Standard does require many auxiliary products in order to be comparable to the eBee Plus imagery. Our results found Pix4D Mapper Pro was more efficient at imagery processing. PhotoScan is the cheaper image processing software which is capable of producing similar results as Pix4D Mapper Pro but processing times were longer.

Future researchers can expand on our work by incorporating vegetation indices into software like eCognition for a comprehensive vegetation analysis to study the health of vegetation, track invasive grasslands, and protect native plants. Similarly, the supervised classification tool in ArcGIS Desktop can be applied to our orthomosaic images to monitor the health of vegetation. In addition, a time-lapse series of the study areas can be conducted to monitor not only the long-term vegetation health but also monitor fire-regime using the NDVI, VARI, modified soil vegetation index (MSAVI), and burned area index (BAI).

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