

Title: “enrGies_2016-04-13--MorganCountyAL_Tornado--BeginingTrack__KMLtiles”

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1.0 Data Set Overview:

- “enrGies” is a commercial engineering and operations-based company located in Huntsville, AL that, among other items, provides expertise and services related to unmanned aircraft systems (UAS). In collaboration with the NOAA UAS Program Office, the University of Alabama in Huntsville, the Morgan County AL Emergency Management Agency, and the National Weather Service Weather Forecast Office in Huntsville, AL, enrGies donated expertise, operational time, GIS computer processing resources, and expertise toward the acquisition and delivery of aerial imagery of a damage path produced by an EF-2 tornado that occurred on the evening of Thursday March 31, 2016 along a ~9 mile track across parts of Morgan County, AL in support of Intensive Operations Period (IOP) #3 for the 2016 VORTEX-Southeast field campaign.
- The imagery for this dataset was obtained on date:
04-13-2016
- The approximate center point of the collected imagery product is located at the following coordinates:
34.468715 Latitude, -86.929459 Longitude

2.0 Instrument Description:

- The UAS was composed of the senseFly eBee platform, integrated with the CanonPowerShotS110 5.2 4000x3000 (RGB) camera as the optical sensor
- For more information regarding either this UAV platform or the optical sensor payload, please refer to the following internet links:
https://www.sensefly.com/fileadmin/user_upload/sensefly/documents/brochures/eBee_RTK_en.pdf
https://www.sensefly.com/fileadmin/user_upload/sensefly/documents/manuals/user_manual_s110_v3.pdf

3.0 Data Collection and Processing:

- The data was collected by the integrated camera payload from the eBee UAV platform at a nominal altitude ranging between approximately 300 to 400 feet AGL. A pre-planned semi-autonomous “lawnmower” flight pattern was utilized to cover the area of interest and collect the raw data, which was later processed to generate the finished two-dimensional orthomosaic product. Further GIS processing report and associate metadata, provided below.
- The original horizontal spatial resolution (aka: Ground Sample Distance) of the associated product was 4.92 cm/pixel; however, some slight degradation of this value can be expected due to the conversion and compression into the more versatile “tiled KML” data format.

4.0 Data Format:

- Tiled KML

5.0 Data Remarks:

- N/A

6.0 References:

- N/A

7.0 Processing Quality Report:

- See following pages, below

Quality Report



Important: Click on the different icons for:



Help to analyze the results in the Quality Report



Additional information about the sections



Click [here](#) for additional tips to analyze the Quality Report









Summary



Project	2016_04_13_tornado___begining_track
Processed	2016-04-14 08:31:45
Average Ground Sampling Distance (GSD)	4.92 cm / 1.94 in
Area Covered	0.6019 km ² / 60.1861 ha / 0.2325 sq. mi. / 148.8 acres
Time for Initial Processing (without report)	07m:16s

Quality Check



 Images	median of 13845 keypoints per image	
 Dataset	185 out of 206 images calibrated (89%), all images enabled	
 Camera Optimization	0.49% relative difference between initial and optimized internal camera parameters	
 Matching	median of 1444.61 matches per calibrated image	
 Georeferencing	yes, no 3D GCP	

Preview

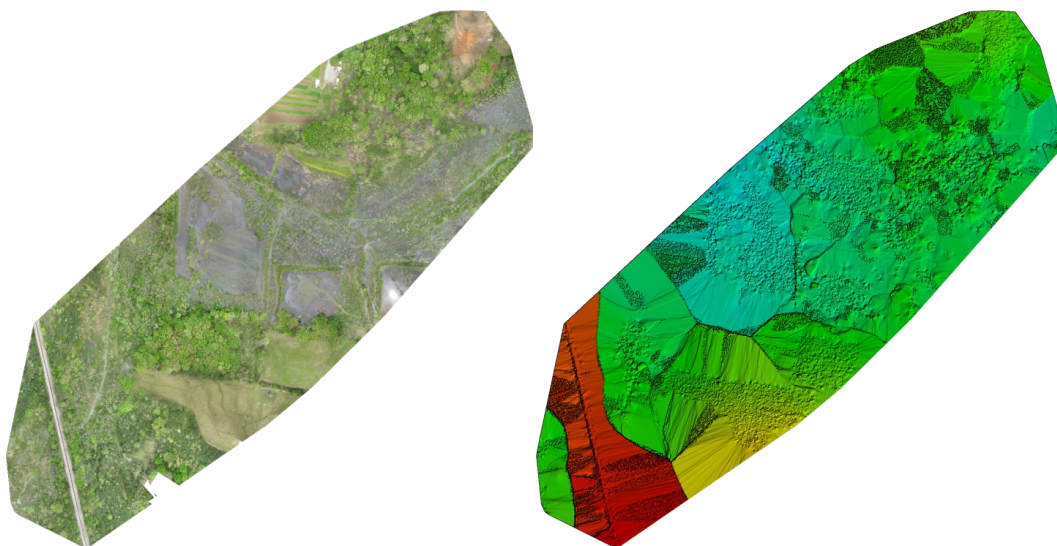


Figure 1: Orthomosaic and the corresponding sparse Digital Surface Model (DSM) before densification.

Calibration Details



Number of Calibrated Images	185 out of 206
Number of Geolocated Images	206 out of 206

Initial Image Positions

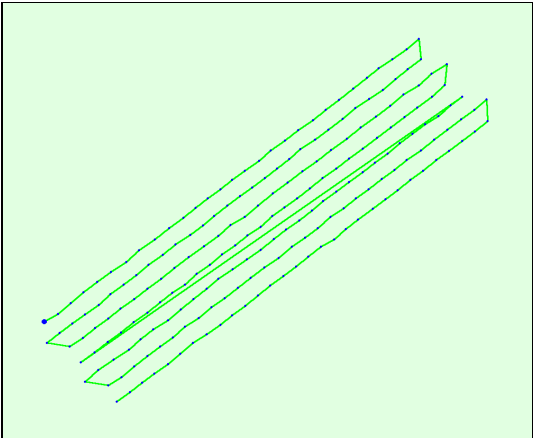


Figure 2: Top view of the initial image position. The green line follows the position of the images in time starting from the large blue dot.

Computed Image/GCPs/Manual Tie Points Positions

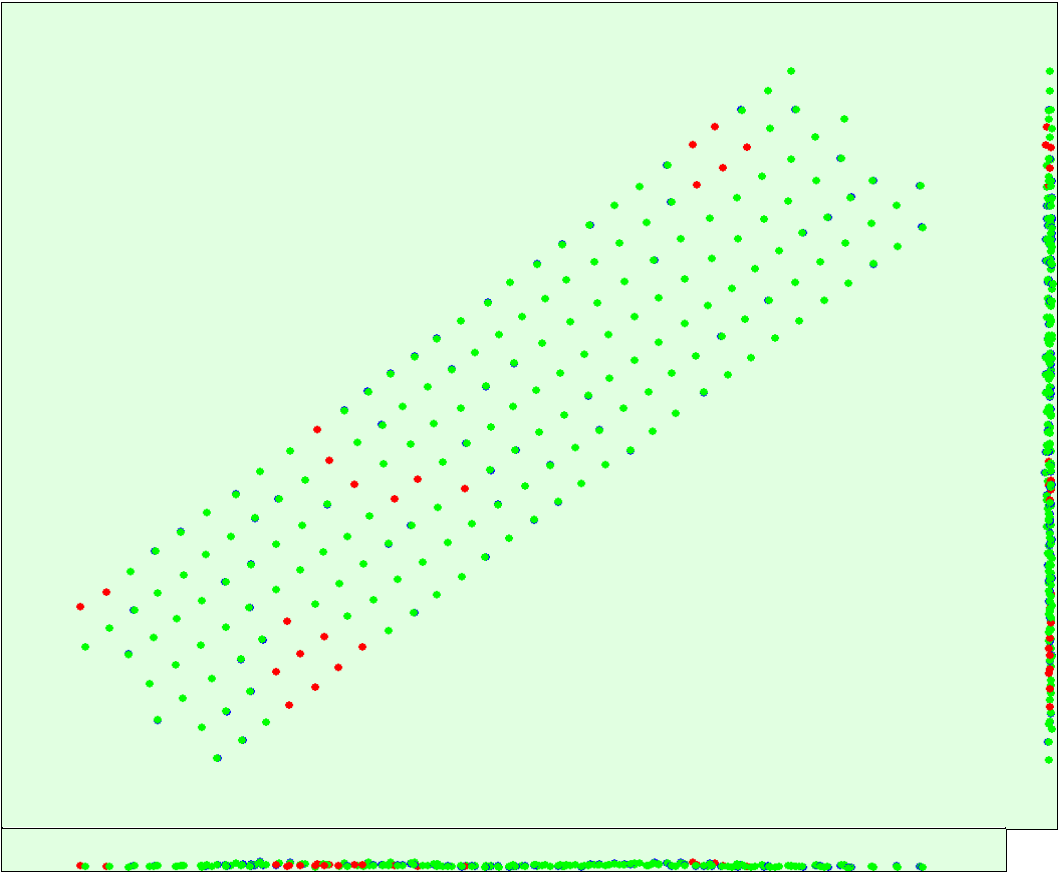
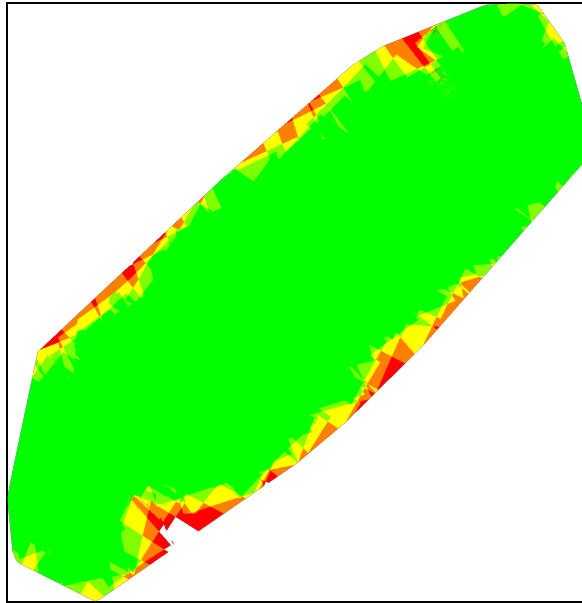


Figure 3: Offset between initial (blue dots) and computed (green dots) image positions as well as the offset between the GCPs initial positions (blue crosses) and their computed positions (green crosses) in the top-view (XY plane), front-view (XZ plane), and side-view (YZ plane). Red dots indicate disabled or uncalibrated images.

Overlap



Number of overlapping images: 1 2 3 4 5+

Figure 4: Number of overlapping images computed for each pixel of the orthomosaic. Red and yellow areas indicate low overlap for which poor results may be generated. Green areas indicate an overlap of over 5 images for every pixel. Good quality results will be generated as long as the number of keypoint matches is also sufficient for these areas (see Figure 5 for keypoint matches).

Bundle Block Adjustment Details



Number of 2D Keypoint Observations for Bundle Block Adjustment	298845
Number of 3D Points for Bundle Block Adjustment	102166
Mean Reprojection Error [pixels]	0.169242

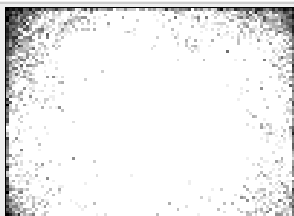
Internal Camera Parameters

CanonPowerShotS110_5.2_4000x3000 (RGB). Sensor Dimensions: 7.440 [mm] x 5.580 [mm]



EXIF ID: CanonPowerShotS110_5.2_4000x3000

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	2860.478 [pixel] 5.320 [mm]	2047.508 [pixel] 3.808 [mm]	1494.393 [pixel] 2.780 [mm]	-0.040	-0.012	0.007	0.000	0.004
Optimized Values	2874.709 [pixel] 5.347 [mm]	1972.701 [pixel] 3.669 [mm]	1494.011 [pixel] 2.779 [mm]	-0.039	-0.007	0.005	-0.000	-0.002



The number of Automatic Tie Points (ATPs) per pixel averaged over all images of the camera model is color coded between black and white. White indicates that, in average, more than 16 ATPs are extracted at this pixel location. Black indicates that, in average, 0 ATP has been extracted at this pixel location. Click on the image to see the average direction and magnitude of the reprojection error for each pixel. Note that the vectors are scaled for better visualization.

? 2D Keypoints Table



	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	13845	1445
Mn	11514	107
Max	15442	4611
Mean	13655	1615

? 3D Points from 2D Keypoint Matches



	Number of 3D Points Observed
In 2 Images	63525
In 3 Images	17201
In 4 Images	8210
In 5 Images	4899
In 6 Images	3025
In 7 Images	1983
In 8 Images	1323
In 9 Images	853
In 10 Images	521
In 11 Images	329
In 12 Images	179
In 13 Images	77
In 14 Images	29
In 15 Images	11
In 16 Images	1

? 2D Keypoint Matches

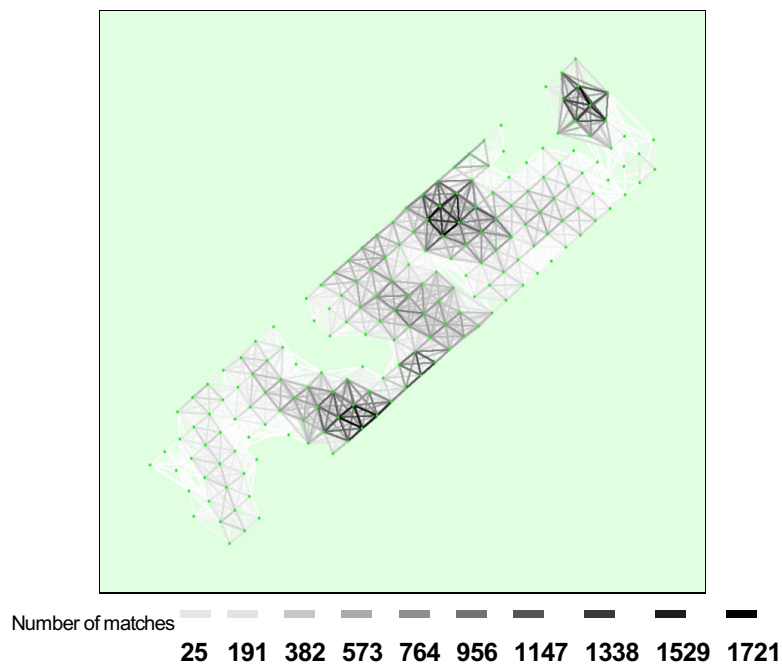


Figure 5: Top view of the image computed positions with a link between matching images. The darkness of the links indicates the number of matched 2D keypoints between the images. Bright links indicate weak links and require manual tie points or more images.

Geolocation Details



? Absolute Geolocation Variance



Mn Error [m]	Max Error [m]	Geolocation Error X [%]	Geolocation Error Y [%]	Geolocation Error Z [%]
-	-6.07	0.00	0.00	0.00
-6.07	-4.86	0.00	0.00	0.00
-4.86	-3.64	0.00	0.00	0.00
-3.64	-2.43	0.00	0.00	0.00
-2.43	-1.21	0.54	0.00	1.62
-1.21	0.00	48.65	52.43	50.81
0.00	1.21	50.27	47.57	46.49
1.21	2.43	0.54	0.00	1.08
2.43	3.64	0.00	0.00	0.00
3.64	4.86	0.00	0.00	0.00
4.86	6.07	0.00	0.00	0.00
6.07	-	0.00	0.00	0.00
Mean [m]		-0.001027	-0.006681	0.014700
Sigma [m]		0.328037	0.355790	0.586624
RMS Error [m]		0.328039	0.355853	0.586808

Min Error and Max Error represent geolocation error intervals between -1.5 and 1.5 times the maximum accuracy of all the images. Columns X, Y, Z show the percentage of images with geolocation errors within the predefined error intervals. The geolocation error is the difference between the initial and computed image positions. Note that the image geolocation errors do not correspond to the accuracy of the observed 3D points.

? Relative Geolocation Variance



Relative Geolocation Error	Images X [%]	Images Y [%]	Images Z [%]
[-1.00, 1.00]	100.00	100.00	100.00
[-2.00, 2.00]	100.00	100.00	100.00
[-3.00, 3.00]	100.00	100.00	100.00
Mean of Geolocation Accuracy [m]	2.219157	2.219157	3.242697
Sigma of Geolocation Accuracy [m]	0.117106	0.117106	0.320595

Images X, Y, Z represent the percentage of images with a relative geolocation error in X, Y, Z.

Geolocation Orientational Variance	RMS [degree]
Omega	3.796335
Phi	4.211099
Kappa	8.844463

Geolocation RMS error of the orientation angles given by the difference between the initial and computed image orientation angles.

Processing Options



Hardware	CPU: Intel(R) Core(TM) i7-5820K CPU @ 3.30GHz RAM: 32GB GPU: NVIDIA GeForce GTX970 (Driver: 10.18.13.5382)
Operating System	Windows 10 Pro, 64-bit
Camera Model Name	CanonPowerShotS110_5.2_4000x3000 (RGB)
Image Coordinate System	WGS84
Output Coordinate System	WGS84 / UTMzone 16N
Keypoints Image Scale	Custom, Image Scale: 0.5
Advanced: Matching Image Pairs	Aerial Grid or Corridor
Advanced: Matching Strategy	Use Geometrically Verified Matching: yes

Advanced: Keypoint Extraction	Targeted Number of Keypoints: Automatic
Advanced: Calibration	Calibration Method: Alternative, Internal Parameters Optimization: int_all, External Parameters Optimization: ext_all, Rematch: yes

Point Cloud Densification details



Processing Options



Image Scale	multiscale, 1/2 (Half image size, Default)
Point Density	Optimal
Minimum Number of Matches	3
3D Textured Mesh Generation	no
Advanced: Matching Window Size	7x7 pixels
Advanced: Image Groups	group1
Advanced: Use Densification Area	yes
Advanced: Use Annotations	yes
Advanced: Limit Camera Depth Automatically	no
Advanced: Point Cloud Classification (beta)	yes, Minimum Object Length [m]: 0.1, Maximum Object Length [m]: 400, Minimum Object Height [m]: 0.1
Time for Point Cloud Densification	24m:40s
Time for Point Cloud Classification	05m:33s
Time for 3D Textured Mesh Generation	NA

Results



Number of Generated Tiles	1
Number of 3D Densified Points	6972194
Average Density (per m ³)	23.39

DSM, Orthomosaic and Index Details



Processing Options



DSM and Orthomosaic Resolution	1 x GSD (4.93 [cm/pixel])
DSM Filters	Noise Filtering: yes, Surface Smoothing: yes, Smooth
DSM Generation	yes, Method: Triangulation, Merge Tiles: yes
Time for DSM Generation	01m:59s
Time for Orthomosaic Generation	16m:58s