# **Quality Report**



Generated with Pix4Denterprise version 4.3.31



**Important**: Click on the different icons for:

- ? Help to analyze the results in the Quality Report
- Additional information about the sections



Click <u>here</u> for additional tips to analyze the Quality Report

## **Summary**

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Project	stan_3k_1_re
Processed	2019-01-25 03:57:54
Camera Model Name(s)	RedEdge_5.5_1280x960 (Blue), RedEdge_5.5_1280x960 (Green), RedEdge_5.5_1280x960 (Red), RedEdge_5.5_1280x960 (NIR), RedEdge_5.5_1280x960 (Red edge)
Rig name(s)	«MicaSense 5 band»
Average Ground Sampling Distance (GSD)	7.53 cm / 2.96 in
Area Covered	0.596 km <sup>2</sup> / 59.5825 ha / 0.23 sq. mi. / 147.3077 acres
Time for Initial Processing (without report)	02h:51m:18s

## **Quality Check**



? Images	median of 6709 keypoints per image	
O Dataset	11515 out of 12115 images calibrated (95%), 5 images disabled	<b>②</b>
? Camera Optimization	1.32% relative difference between initial and optimized internal camera parameters	<b>②</b>
Matching	median of 1411.96 matches per calibrated image	<b>②</b>
? Georeferencing	yes, no 3D GCP	<u> </u>





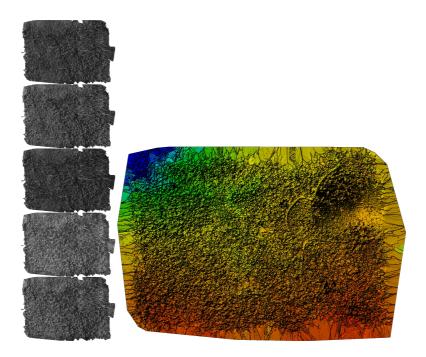


Figure 1: Orthomosaic and the corresponding sparse Digital Surface Model (DSM) before densification.

## **Calibration Details**



Number of Calibrated Images	11515 out of 12120
Number of Geolocated Images	12120 out of 12120

## Initial Image Positions



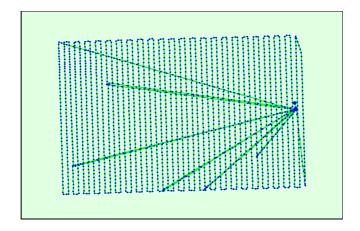
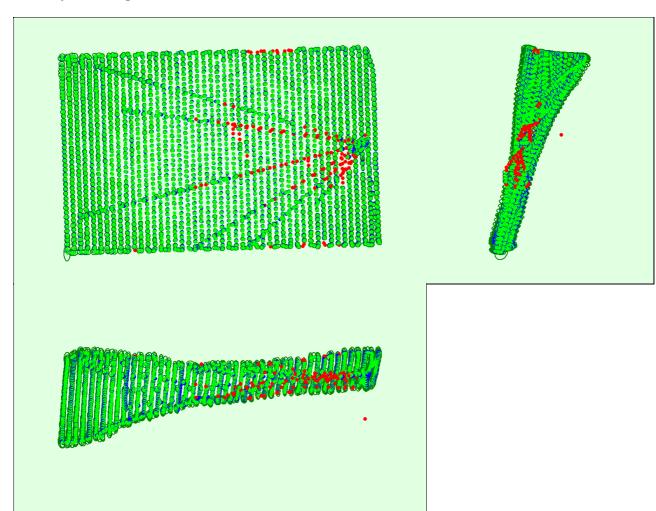


Figure 2: Top view of the initial image position. The green line follows the position of the images in time starting from the large blue dot.







Uncertainty ellipses 50x magnified

## Absolute camera position and orientation uncertainties

	X [m]	Y [m]	Z [m]	Omega [degree]	Phi [degree]	Kappa [degree]
Mean	0.098	0.098	0.194	0.049	0.043	0.019
Sigma	0.017	0.018	0.037	0.006	0.007	0.005



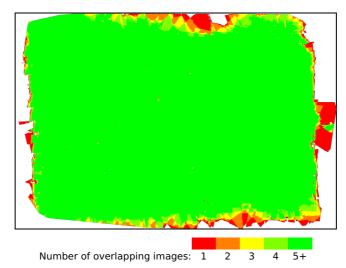


Figure 4: Number of overlapping images computed for each pixel of the orthomosaic.

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**

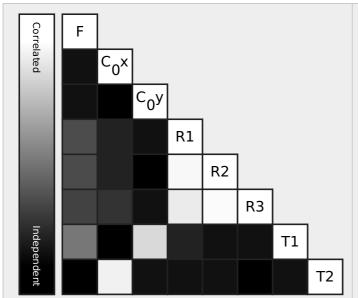
Number of 2D Keypoint Observations for Bundle Block Adjustment	4898268
Number of 3D Points for Bundle Block Adjustment	1700279
Mean Reprojection Error [pixels]	0.196

#### Internal Camera Parameters

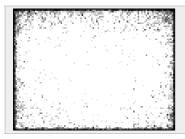
## **☐** RedEdge\_5.5\_1280x960 (Blue). Sensor Dimensions: 4.800 [mm] x 3.600 [mm]

EXIF ID: RedEdge\_5.5\_1280x960

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	1466.667 [pixel] 5.500 [mm]	657.605 [pixel] 2.466 [mm]	495.123 [pixel] 1.857 [mm]	-0.097	0.149	-0.017	0.000	0.000
Optimized Values	1446.787 [pixel] 5.425 [mm]	654.841 [pixel] 2.456 [mm]	495.001 [pixel] 1.856 [mm]	-0.097	0.150	-0.028	0.000	-0.000
Uncertainties (Sigma)	0.260 [pixel] 0.001 [mm]	0.238 [pixel] 0.001 [mm]	0.180 [pixel] 0.001 [mm]	0.002	0.012	0.026	0.000	0.000



The correlation between camera internal parameters determined by the bundle adjustment. White indicates a full correlation between the parameters, ie. any change in one can be fully compensated by the other. Black indicates that the parameter is completely independent, and is not affected by other parameters.



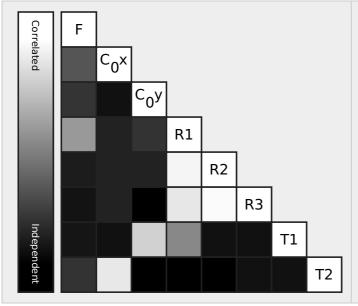
The number of Automatic Tie Points (ATPs) per pixel, averaged over all images of the camera model, is color coded between black and white. White indicates that, on average, more than 16 ATPs have been extracted at the pixel location. Black indicates that, on average, 0 ATPs have been extracted at the pixel location. Click on the image to the see the average direction and magnitude of the re-projection error for each pixel. Note that the vectors are scaled for better visualization. The scale bar indicates the magnitude of 1 pixel error.

## Internal Camera Parameters

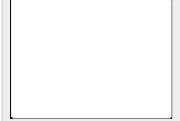
#### RedEdge\_5.5\_1280x960 (Green). Sensor Dimensions: 4.800 [mm] x 3.600 [mm]

EXIF ID: RedEdge\_5.5\_1280x960

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	1466.667 [pixel] 5.500 [mm]	657.835 [pixel] 2.467 [mm]	481.299 [pixel] 1.805 [mm]	-0.099	0.143	-0.021	0.000	0.001
Optimized Values	1443.557 [pixel] 5.413 [mm]	655.713 [pixel] 2.459 [mm]	481.601 [pixel] 1.806 [mm]	-0.096	0.128	0.012	0.000	0.000
Uncertainties (Sigma)	0.245 [pixel] 0.001 [mm]	0.077 [pixel] 0.000 [mm]	0.063 [pixel] 0.000 [mm]	0.000	0.004	0.008	0.000	0.000



The correlation between camera internal parameters determined by the bundle adjustment. White indicates a full correlation between the parameters, ie. any change in one can be fully compensated by the other. Black indicates that the parameter is completely independent, and is not affected by other parameters.



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, on average, more than 16 ATPs have been extracted at the pixel location. Black indicates that, on average, 0 ATPs have been extracted at the pixel location. Click on the image to the see the average direction and magnitude of the re-projection error for each pixel. Note that the vectors are scaled for better visualization. The scale bar indicates the magnitude of 1 pixel error.

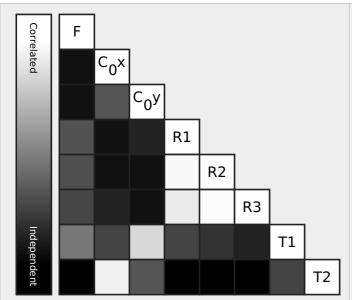
#### Internal Camera Parameters

#### RedEdge\_5.5\_1280x960 (Red). Sensor Dimensions: 4.800 [mm] x 3.600 [mm]

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EXIF ID: RedEdge\_5.5\_1280x960

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	1466.667 [pixel] 5.500 [mm]	657.200 [pixel] 2.465 [mm]	493.864 [pixel] 1.852 [mm]	-0.100	0.131	-0.003	-0.000	0.000
Optimized Values	1448.756 [pixel] 5.433 [mm]	654.441 [pixel] 2.454 [mm]	493.726 [pixel] 1.851 [mm]	-0.099	0.125	0.020	-0.000	-0.000
Uncertainties (Sigma)	0.263 [pixel] 0.001 [mm]	0.256 [pixel] 0.001 [mm]	0.194 [pixel] 0.001 [mm]	0.002	0.013	0.029	0.000	0.000



The correlation between camera internal parameters determined by the bundle adjustment. White indicates a full correlation between the parameters, ie. any change in one can be fully compensated by the other. Black indicates that the parameter is completely independent, and is not affected by other parameters.



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, on average, more than 16 ATPs have been extracted at the pixel location. Black indicates that, on average, 0 ATPs have been extracted at the pixel location. Click on the image to the see the average direction and magnitude of the re-projection error for each pixel. Note that the vectors are scaled for better visualization. The scale bar indicates the magnitude of 1 pixel error.

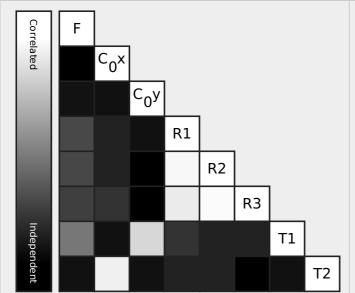
#### Internal Camera Parameters

#### RedEdge 5.5 1280x960 (NIR). Sensor Dimensions: 4.800 [mm] x 3.600 [mm]

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EXIF ID: RedEdge\_5.5\_1280x960

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	1466.667 [pixel] 5.500 [mm]	666.605 [pixel] 2.500 [mm]	482.221 [pixel] 1.808 [mm]	-0.105	0.153	-0.045	0.000	0.000
Optimized Values	1449.593 [pixel] 5.436 [mm]	663.259 [pixel] 2.487 [mm]	482.424 [pixel] 1.809 [mm]	-0.106	0.161	-0.058	0.000	-0.000
Uncertainties (Sigma)	0.259 [pixel] 0.001 [mm]	0.226 [pixel] 0.001 [mm]	0.172 [pixel] 0.001 [mm]	0.001	0.011	0.025	0.000	0.000



The correlation between camera internal parameters determined by the bundle adjustment. White indicates a full correlation between the parameters, ie. any change in one can be fully compensated by the other. Black indicates that the parameter is completely independent, and is not affected by other parameters.



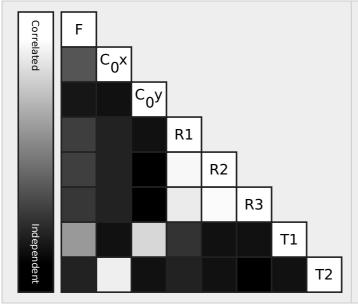
The number of Automatic Tie Points (ATPs) per pixel, averaged over all images of the camera model, is color coded between black and white. White indicates that, on average, more than 16 ATPs have been extracted at the pixel location. Black indicates that, on average, 0 ATPs have been extracted at the pixel location. Click on the image to the see the average direction and magnitude of the re-projection error for each pixel. Note that the vectors are scaled for better visualization. The scale bar indicates the magnitude of 1 pixel error.

## Internal Camera Parameters

#### RedEdge\_5.5\_1280x960 (Red edge). Sensor Dimensions: 4.800 [mm] x 3.600 [mm]

EXIF ID: RedEdge\_5.5\_1280x960

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	1466.667 [pixel] 5.500 [mm]	661.440 [pixel] 2.480 [mm]	495.379 [pixel] 1.858 [mm]	-0.103	0.155	-0.049	0.000	0.001
Optimized Values	1447.250 [pixel] 5.427 [mm]	658.330 [pixel] 2.469 [mm]	494.343 [pixel] 1.854 [mm]	-0.103	0.156	-0.054	0.000	0.000
Uncertainties (Sigma)	0.255 [pixel] 0.001 [mm]	0.195 [pixel] 0.001 [mm]	0.149 [pixel] 0.001 [mm]	0.001	0.010	0.022	0.000	0.000



The correlation between camera internal parameters determined by the bundle adjustment. White indicates a full correlation between the parameters, ie. any change in one can be fully compensated by the other. Black indicates that the parameter is completely independent, and is not affected by other parameters.



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, on average, more than 16 ATPs have been extracted at the pixel location. Black indicates that, on average, 0 ATPs have been extracted at the pixel location. Click on the image to the see the average direction and magnitude of the re-projection error for each pixel. Note that the vectors are scaled for better visualization. The scale bar indicates the magnitude of 1 pixel error.

## Camera Rig «MicaSense 5 band» Relatives. Images: 12115



	Transl X [m]	Transl Y [m]	Transl Z [m]	Rot X [degree]	Rot Y [degree]	Rot Z [degree]	
RedEdge_5.5_1280x960 (Green)	Reference Ca	Reference Camera					
RedEdge_5.5_1280x960 (Blue)							
Initial Values	0.030	0.000	0.000	0.000	0.000	0.000	
Optimized values	0.030	0.000	0.000	-0.100	0.133	-0.373	
Uncertainties (sigma)				0.007	0.010	0.001	
RedEdge_5.5_1280x960 (Red)							
Initial Values	0.000	0.022	0.000	0.000	0.000	0.000	
Optimized values	0.000	0.022	0.000	0.057	0.109	-0.064	
Uncertainties (sigma)				0.008	0.010	0.001	
RedEdge_5.5_1280x960 (NIR)							
Initial Values	0.030	0.022	0.000	0.000	0.000	0.000	
Optimized values	0.030	0.022	0.000	-0.143	-0.109	0.118	
Uncertainties (sigma)				0.007	0.009	0.001	
RedEdge_5.5_1280x960 (Red edge)							
Initial Values	0.015	0.011	0.000	0.000	0.000	0.000	
Optimized values	0.015	0.011	0.000	-0.065	-0.552	-0.321	
Uncertainties (sigma)				0.006	0.008	0.001	

## 2D Keypoints Table



	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	6709	1412
Min	4732	92
Max	9280	5323
Mean	6751	1520

## 2D Keypoints Table for Camera RedEdge\_5.5\_1280x960 (Blue)

	Number of 2D Keypoints per Image Number of Matched 2D Keypoints per Image	
Median	6176	880
Min	5082	95
Max	8450	4027
Mean	6194	1012

## 2D Keypoints Table for Camera RedEdge\_5.5\_1280x960 (Green)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image	
Median	6703	1520	
Min	5596	140	
Max	8876	5323	
Mean	6726	1627	

## 2D Keypoints Table for Camera RedEdge\_5.5\_1280x960 (Red)

Number of 2D Keypoints per Image		Number of Matched 2D Keypoints per Image	
Median 6409		806	

Min	4732	92
Max	8615	3737
Mean	6390	923

## 2D Keypoints Table for Camera RedEdge\_5.5\_1280x960 (NIR)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image	
Median	7360	1387	
Min	6261	155	
Max	9100	4700	
Mean	7395	1475	

## 2D Keypoints Table for Camera RedEdge\_5.5\_1280x960 (Red edge)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image	
Median	7247	1514	
Min	5813	180	
Max	9280	4875	
Mean	7271	1600	

## Median / 75% / Maximal Number of Matches Between Camera Models

	RedEdge_5.5_12 (Blue)	RedEdge_5.5_1 (Green)	RedEdge_5.5_128 (Red)	RedEdge_5.5_128 (NIR)	RedEdge_5 (Red edge)
RedEdge_5.5_1280x960 (Blue)	13 / 93 / 2830	7 / 30 / 1827	21 / 165 / 1819	16 / 65 / 879	18 / 96 / 1450
RedEdge_5.5_1280x960 (Green)		10 / 46 / 3963	7 / 26 / 1284	8 / 35 / 1585	10 / 45 / 2893
RedEdge_5.5_1280x960 (Red)			14 / 90 / 2797	13 / 51 / 660	16 / 79 / 1065
RedEdge_5.5_1280x960 (NIR)				17 / 159 / 3773	24 / 202 / 1983
RedEdge_5.5_1280x960 (Red edge)					15 / 116 / 3011

## ? 3D Points from 2D Keypoint Matches

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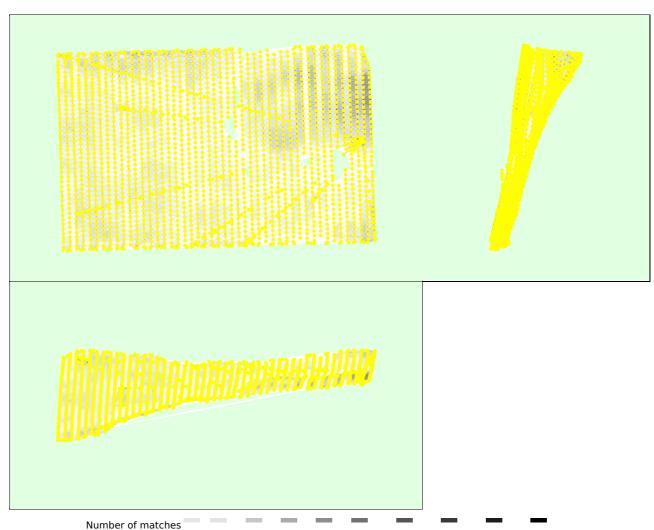
	Number of 3D Points Observed
In 2 Images	1127404
In 3 Images	282798
In 4 Images	119194
In 5 Images	59032
In 6 Images	34089
In 7 Images	20562
In 8 Images	14121
In 9 Images	9954
In 10 Images	7175
In 11 Images	5621
In 12 Images	4128
In 13 Images	3142
In 14 Images	2567
In 15 Images	2020
In 16 Images	1497
In 17 Images	1220
In 18 Images	964
In 19 Images	841
In 20 Images	599
In 21 Images	533
In 22 Images	467
In 23 Images	369
In 24 Images	286

In 25 Images	271
In 26 Images	183
In 27 Images	161
In 28 Images	128
In 29 Images	140
In 30 Images	99
In 31 Images	97
In 32 Images	87
In 33 Images	59
In 34 Images	46
In 35 Images	51
In 36 Images	32
In 37 Images	32
In 38 Images	27
In 39 Images	26
In 40 Images	23
In 41 Images	22
In 42 Images	25
In 43 Images	20
In 44 Images	18
In 45 Images	12
In 46 Images	14
In 47 Images	11
In 48 Images	5
In 49 Images	12
In 50 Images	8
In 51 Images	3
In 52 Images	7
In 53 Images	3
In 54 Images	3
In 55 Images	7
In 56 Images	3
In 57 Images	5
In 58 Images	2
In 59 Images	4
In 60 Images	2
In 61 Images	5
In 62 Images	3
In 63 Images	2
In 64 Images	3
In 65 Images	2
In 66 Images	1
In 67 Images	1
In 68 Images	2
In 69 Images	1
In 70 Images	1
In 71 Images	1
In 72 Images	2
In 73 Images	1
In 74 Images	1
In 75 Images	2
In 76 Images	3
In 77 Images	1
In 78 Images	2
In 79 Images	1
In 80 Images	1
In 83 Images	2
In 84 Images	3
In 85 Images	3

In 86 Images	1
In 87 Images	1
In 98 Images	1
In 105 Images	1







25 222 444 666 888 1111 1333 1555 1777 2000

Figure 5: Computed image positions with links between matched 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



Min Error [m]	Max Error [m]	Geolocation Error X [%]	Geolocation Error Y [%]	Geolocation Error Z [%]
-	-15.00	0.00	0.00	0.00
-15.00	-12.00	0.00	0.00	0.00
-12.00	-9.00	0.00	0.00	0.00
-9.00	-6.00	0.00	0.00	0.00
-6.00	-3.00	0.29	0.00	0.17
-3.00	0.00	52.95	51.26	46.52
0.00	3.00	46.02	48.54	53.31
3.00	6.00	0.74	0.20	0.00
6.00	9.00	0.00	0.01	0.00

9.00	12.00	0.00	0.00	0.00
12.00	15.00	0.00	0.00	0.00
15.00	-	0.00	0.00	0.00
Mean [m]		-0.000850	-0.002160	0.000122
Sigma [m]		0.853977	1.171183	0.936975
RMS Error [m]		0.853978	1.171185	0.936975

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

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Relative Geolocation Error	Images X [%]	Images Y [%]	Images Z [%]
[-1.00, 1.00]	99.96	99.99	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]	5.000000	5.000000	10.000000
Sigma of Geolocation Accuracy [m]	0.000000	0.000000	0.000000

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

## **Initial Processing Details**

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#### **System Information**

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Hardware	CPU: Intel(R) Xeon(R) Platinum 8124M CPU @ 3.00GHz RAM: 69GB GPU: no info (Driver: unknown)
Operating System	Linux 4.15.0-1031-aws x86 64

## **Coordinate Systems**

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Image Coordinate System	WGS 84 (EGM 96 Geoid)
Output Coordinate System	WGS 84 / UTM zone 10N (EGM 96 Geoid)

## **Processing Options**

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Detected Template	No Template Available
Keypoints Image Scale	Custom, Image Scale: 1
Advanced: Matching Image Pairs	Aerial Grid or Corridor
Advanced: Matching Strategy	Use Geometrically Verified Matching: no
Advanced: Keypoint Extraction	Targeted Number of Keypoints: Automatic
Advanced: Calibration	Calibration Method: Standard Internal Parameters Optimization: All External Parameters Optimization: All Rematch: Custom, yes
Rig «MicaSense 5 band» processing	optimize relative rotation using a subset of secondary cameras

## **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	yes
3D Textured Mesh Settings:	Resolution: Medium Resolution (default) Color Balancing: no
LOD	Generated: no
Advanced: 3D Textured Mesh Settings	Sample Density Divider: 1
Advanced: Image Groups	Blue, Green, Red, NIR, Red edge
Advanced: Use Processing Area	yes
Advanced: Use Annotations	yes
Time for Point Cloud Densification	10m:09s
Time for Point Cloud Classification	55s
Time for 3D Textured Mesh Generation	12m:02s

## Results

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Number of Generated Tiles	1
Number of 3D Densified Points	12935681
Average Density (per m <sup>3</sup> )	5.88

# DSM, Orthomosaic and Index Details



## **Processing Options**



DSM and Orthomosaic Resolution	1 x GSD (7.53 [cm/pixel])	
DSM Filters	Noise Filtering: yes Surface Smoothing: yes, Type: Sharp	
Raster DSM	Generated: yes Method: Triangulation Merge Tiles: yes	
Orthomosaic	Generated: yes Merge Tiles: yes GeoTIFF Without Transparency: no Google Maps Tiles and KML: no	
Radiometric calibration with reflectance target	yes	
Index Calculator: Reflectance Map	Generated: yes Resolution: 1 x GSD (7.53 [cm/pixel]) Merge Tiles: yes	
Index Calculator: Indices	ndvi	
Index Calculator: Index Values	Polygon Shapefile [cm/grid]: 400	
Time for DSM Generation	58s	
Time for Orthomosaic Generation	57m:50s	
Time for DTM Generation	00s	
Time for Contour Lines Generation	00s	
Time for Reflectance Map Generation	01h:10m:20s	
Time for Index Map Generation	47s	

#### **Camera Radiometric Correction**



Camera Name	Band	Radiometric Correction Type	Reflectance target
RedEdge_5.5_1280x960	Blue	Camera and Sun Irradiance	<b>②</b>
RedEdge_5.5_1280x960	Green	Camera and Sun Irradiance	<b>②</b>
RedEdge_5.5_1280x960	Red	Camera and Sun Irradiance	•
RedEdge_5.5_1280x960	NIR	Camera and Sun Irradiance	•
RedEdge_5.5_1280x960	Red edge	Camera and Sun Irradiance	•