Sub pixel aerotriangulation accuracy with a common drone and PHOTOMOD

Yannis Yanniris Msc Photogrammetric Engineer - yyanniris@gmail.com

Sub pixel aerotriangulation accuracy with a common drone and PHOTOMOD
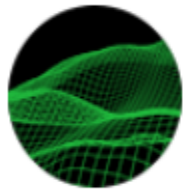
- Up to now we expect accuracy of common drones to be about the pixel size.
- Newer projects show that sub pixel accuracy is possible using photographs from a common drone and careful use of PHOTOMOD-UAS

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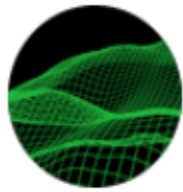For this work several projects over villages were performed with:

- Phantom4 pro drone (1 inch sensor with mechanical shutter)
- PHOTOMOD-UAS 6.3

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Characteristics of the flights

- Performed with the standard flight program of DJI with
- 5cm pixel size
- 60% overlap and 60% sidelap

Sub pixel aerotriangulation accuracy with a common drone and PHOTOMOD

Tasks for completing each project

- Premark Ground Control Points
- Geodetic measurments with GNSS
- Flight plan and Flight
- Download the geotaged photographs
- Process Photographs with PHOTOMOD-UAS

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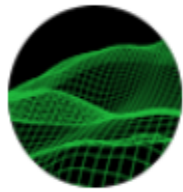
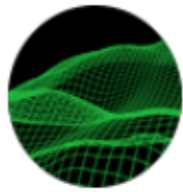*Sub pixel aerotriangulation accuracy with a common drone and PHOTOMOD*
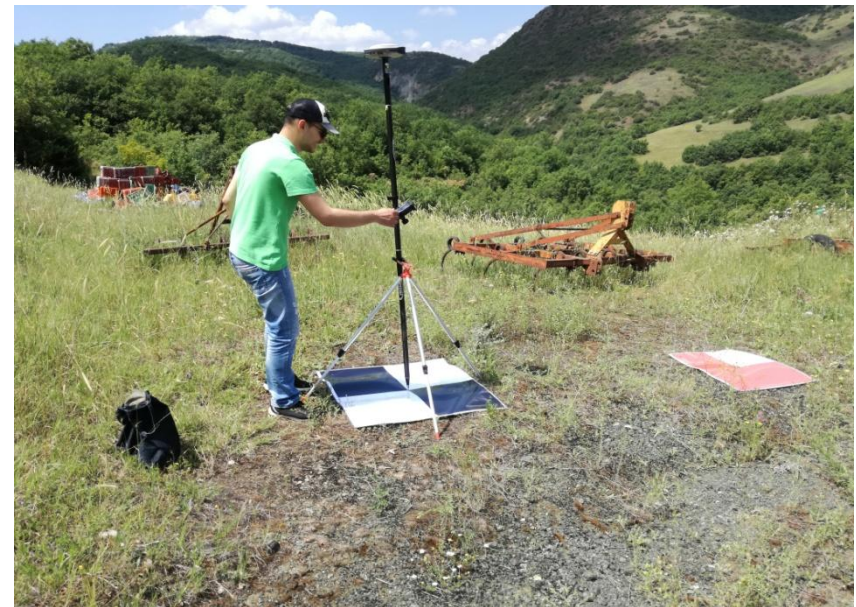
Premark Ground Control Points

- Premarked
on cement roads
with red color

- Or with removable
printed targets
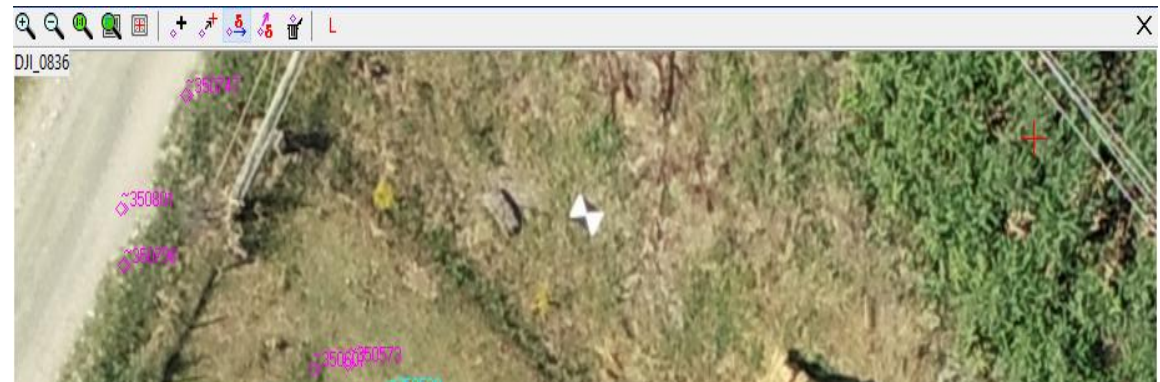
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Measure Ground Control Points

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Planning and conducting the Flight

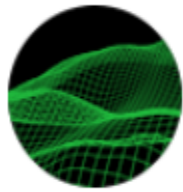Yannis Yanniris Msc Photogrammetric Engineer - yyanniris@gmail.com

Sub pixel aerotriangulation accuracy with a common drone and PHOTOMOD

Download geotaged images

- Phantom geotags images automaticaly but only with X,Y,Z
- Mission Planner (open source) gives file with X,Y,Z,Yaw,Pitch,Roll of each image
- Photomod handles both cases effectively.

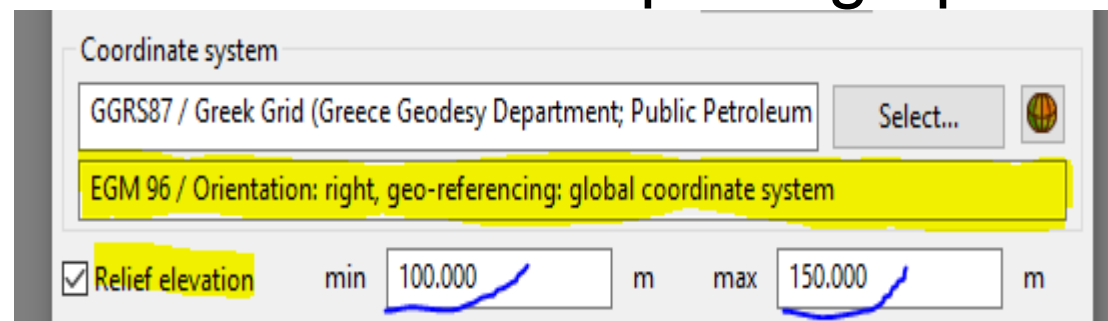Yannis Yanniris Msc Photogrammetric Engineer - yyanniris@gmail.com

Sub pixel aerotriangulation accuracy with a common drone and PHOTOMOD

Process Photographs with PHOTOMOD-UAS

Several things must be taken into account.
- It is good to define a geoid
- Careful definition of project min, max relief elevation
- Phantom gives smallest values in Z of photographs

Coordinate system

GGRS87 / Greek Grid (Greece Geodesy Department; Public Petroleum   Select...

EGM 96 / Orientation: right, geo-referencing: global coordinate system

☑ Relief elevation   min 100.000 m   max 150.000 m
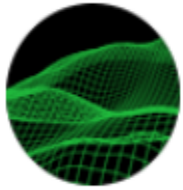
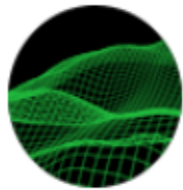Yannis Yanniris Msc Photogrammetric Engineer - yyanniris@gmail.com

Sub pixel aerotriangulation accuracy with a common drone and PHOTOMOD

Process Photographs with PHOTOMOD-UAS

- Select a camera previously calibrated
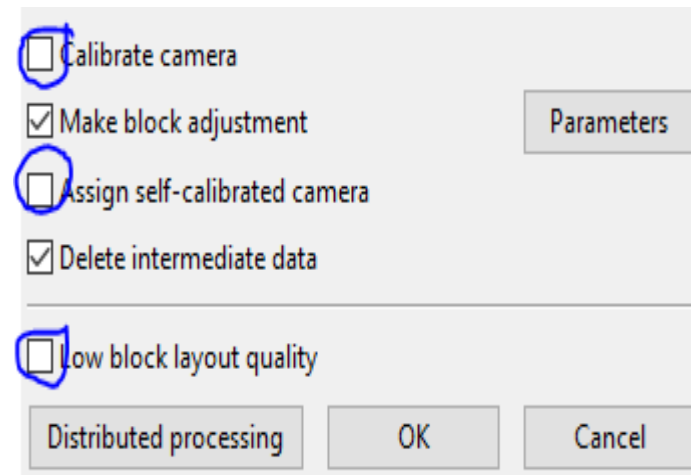- Split block by external orientation data

The result will be a well oriented block

Sub pixel aerotriangulation accuracy with a common drone and PHOTOMOD

Process Photographs with PHOTOMOD-UAS

- Automeasure points
-Without camera calibration
  -Without low block quality

Sub pixel aerotriangulation accuracy with a common drone and PHOTOMOD

Process Photographs with PHOTOMOD-UAS

- Import and measure GCP's
- Change accuracy of GCP's to a realistic value 1 or 2 cm
- Perform Block Adjustment using only GCP's and not projection centers
- Change image precision measurement to 0.5 or 1 pixel

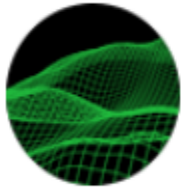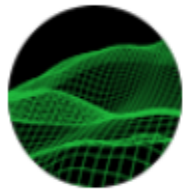Yannis Yanniris Msc Photogrammetric Engineer - yyanniris@gmail.com

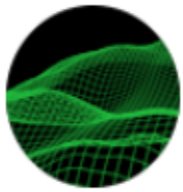*Sub pixel aerotriangulation accuracy with a common drone and PHOTOMOD*

Process Photographs with PHOTOMOD-UAS

- Import and measure GCP's
- Change accuracy of GCP's to a realistic value 1 or 2 cm

Triangulation points [total: 14493 / visible: 9]

Code	Name	Type	X, m	Y, m	Z, m	Std. dev. X, m	Std. dev. Y, m	Std. dev. Z, m	Number of meas.
14485	F1	Ground Control	338306.966	4350238.954	117.541	0.01	0.01	0.02	3
14486	F2	Ground Control	337883.247	4350243.324	117.569	0.01	0.01	0.02	6
14487	F3	Ground Control	337998.01	4350838.732	116.675	0.01	0.01	0.02	6
14488	F4	Ground Control	338337.425	4350721.999	116.613	0.01	0.01	0.02	9
14489	F5	Ground Control	338583.66	4351146.602	114.99	0.01	0.01	0.02	7
14490	F6	Ground Control	338305.879	4351268.769	115.715	0.01	0.01	0.02	10
14491	F7	Ground Control	338119.314	4351376.876	115.993	0.01	0.01	0.02	10
14492	F8	Ground Control	338401.621	4351731.967	114.889	0.01	0.01	0.02	4
14493	F9	Ground Control	338644.175	4351521.32	114.686	0.01	0.01	0.02	7

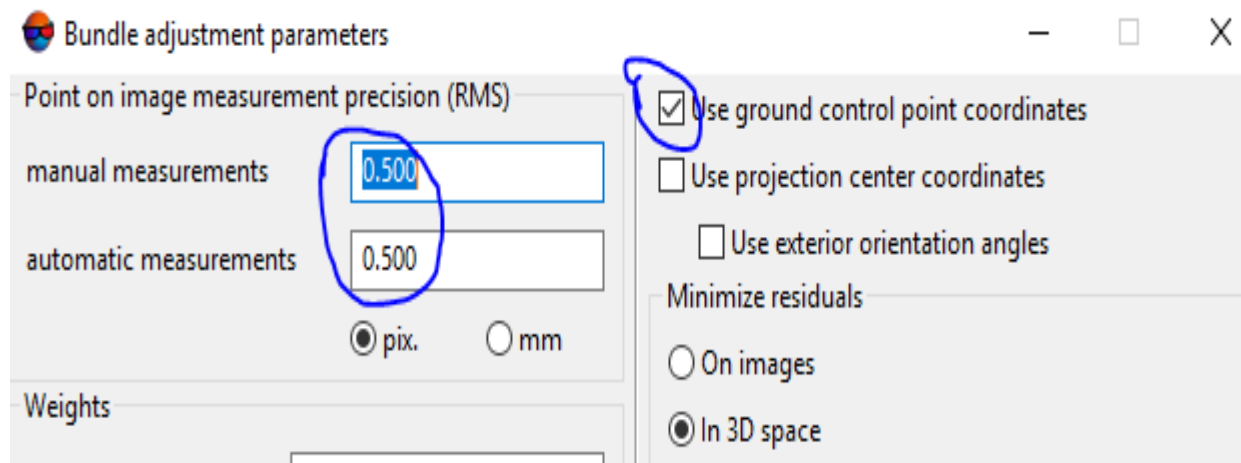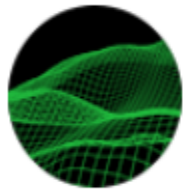Yannis Yanniris Msc Photogrammetric Engineer - yyanniris@gmail.com

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Process Photographs with PHOTOMOD-UAS

- Perform Block Adjustment using only GCP's and not projection centers
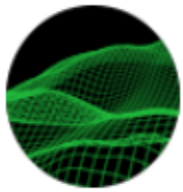- Change image precision measurement to 0.5 or 1 pixel

Sub pixel aerotriangulation accuracy with a common drone and PHOTOMOD
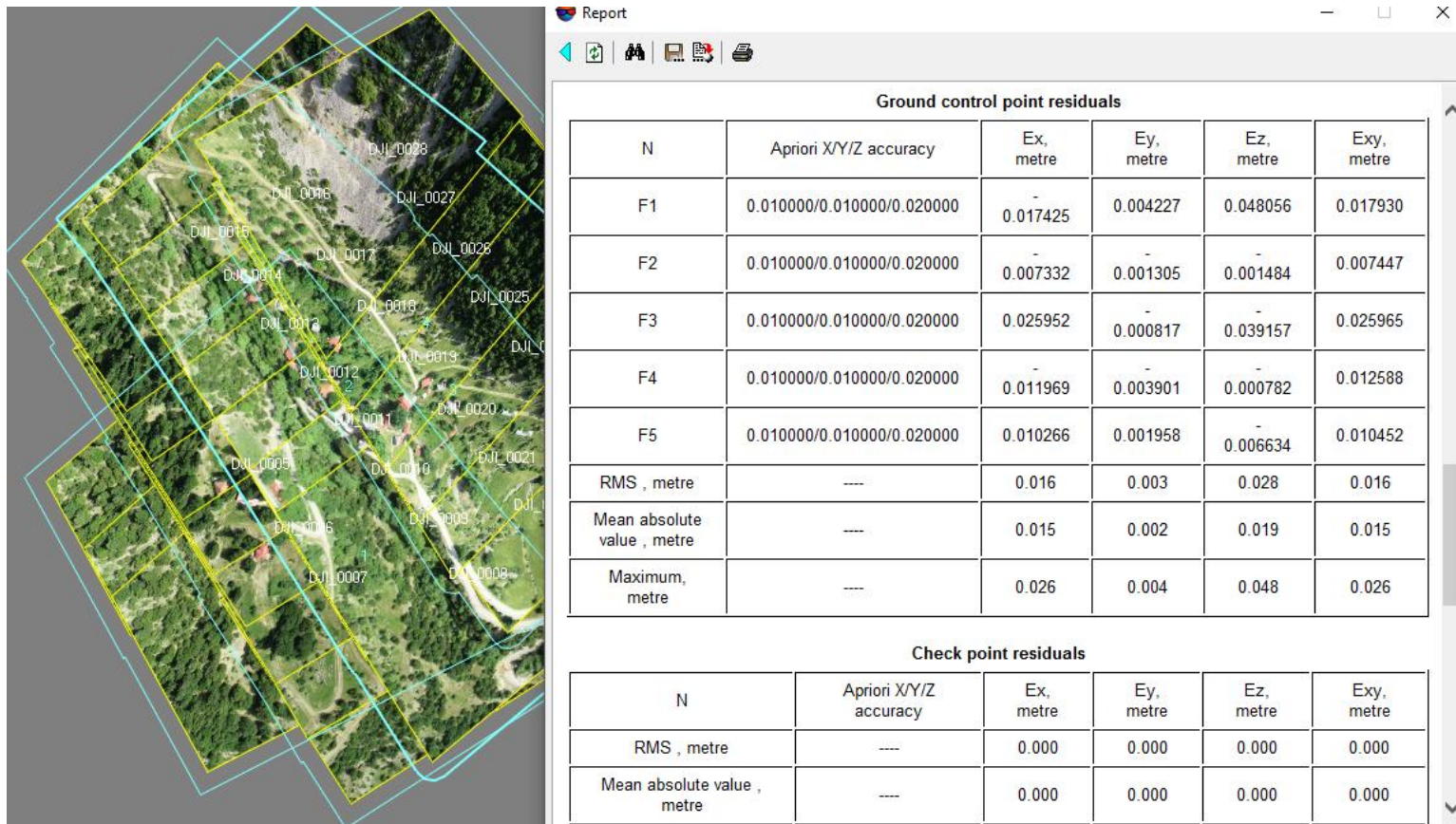
RESULTS

- More than 30 villages were processed with the above procedure.
- All RMS errors of GCP's were less than the GSD
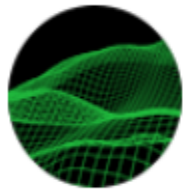- Some samples are give and a final table with accuracies

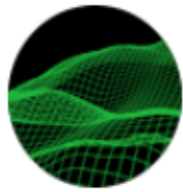*Sub pixel aerotriangulation accuracy with a common drone and PHOTOMOD*

RESULTS

Ground control point residuals

N	Apriori X/Y/Z accuracy	Ex, metre	Ey, metre	Ez, metre	Exy, metre
F1	0.010000/0.010000/0.020000	-0.017425	0.004227	0.048056	0.017930
F2	0.010000/0.010000/0.020000	-0.007332	-0.001305	-0.001484	0.007447
F3	0.010000/0.010000/0.020000	0.025952	-0.000817	-0.039157	0.025965
F4	0.010000/0.010000/0.020000	-0.011969	-0.003901	-0.000782	0.012588
F5	0.010000/0.010000/0.020000	0.010266	0.001958	-0.006634	0.010452
RMS , metre	----	0.016	0.003	0.028	0.016
Mean absolute value , metre	----	0.015	0.002	0.019	0.015
Maximum, metre	----	0.026	0.004	0.048	0.026

Check point residuals

N	Apriori X/Y/Z accuracy	Ex, metre	Ey, metre	Ez, metre	Exy, metre
RMS , metre	----	0.000	0.000	0.000	0.000
Mean absolute value , metre	----	0.000	0.000	0.000	0.000

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Sub pixel aerotriangulation accuracy with a common drone and PHOTOMOD

RESULTS

Residuals

RMS | Mean abs. value | Max

Ex, Ey, Ez, Exy (metre)
ground control points
  0.013 , 0.015 , 0.069 , 0.020
control projection centers
  1.068* , 6.383* , 10.941* , 6.472*

Stereopair residuals

tie points
  from mean
    0.032 , 0.018 , 0.072 , 0.036
  mutual
    0.044 , 0.025 , 0.103 , 0.051
targeted points
  from mean
    0.000 , 0.000 , 0.000 , 0.000
  mutual
    0.000 , 0.000 , 0.000 , 0.000
tie - projection centers
  from mean
    0.000 , 0.000 , 0.000 , 0.000
  mutual
    0.000 , 0.000 , 0.000 , 0.000

Image residuals

Ex, Ey, Exy (mm)
tie points
  0.001 , 0.001 , 0.001
targeted points
  0.000 , 0.000 , 0.000

Block adjustment

Report

Block processing report

PHOTOMOD version 6.3.2229 x64

Project properties and initial data

Project	Karditsa_AgiosBissarios
Report time	Monday, September 17, 2018, 4:52:07 PM
Cameras	Phantom4pro-Baltinos-FC6310[SELFCAL].x-cam
GSD, metre	0.047
Coordinate system	----
Height range, metre	100.000 - 150.000
Area, metre^2	1313948.235
Number of images	185
Number of strips	7
Number of tie points	14484
Number of ground control points	9
Number of check points	0

Processing parameters

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Sub pixel aerotriangulation accuracy with a common drone and PHOTOMOD

RESULTS

Name	GSD metre	RMS X	Y	Z	XY	Exy/GSD	σ_0	terain
AgiosBissarios	0.047	0.013	0.015	0.069	0.02	**42.55%**	0.944	flat
Argyri	0.044	0.036	0.023	0.048	0.043	**97.73%**	0.974	mountainous
Bathylakos	0.051	0.01	0.008	0.021	0.013	**25.49%**	0.92	mountainous
Bragkiana	0.054	0.029	0.018	0.121	0.034	**62.96%**	0.906	mountainous
Dafnospilia2	0.056	0.022	0.015	0.043	0.027	**48.21%**	1.039	Hilly
Filia	0.049	0.024	0.033	0.23	0.04	**81.63%**	0.961	flat
Grimpiana	0.056	0.064	0.068	0.085	0.093	**166.07%**	0.923	mountainous
KatvKtimeni	0.049	0.015	0.008	0.028	0.017	**34.69%**	1.034	Hilly
Kedros	0.051	0.024	0.015	0.018	0.028	**54.90%**	1.02	mountainous
Mavraxades	0.049	0.027	0.009	0.154	0.028	**57.14%**	0.867	flat
Stefaniada	0.051	0.016	0.003	0.028	0.016	**31.37%**	1.031	mountainous

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Sub pixel aerotriangulation accuracy with a common drone and PHOTOMOD

RESULTS sorted

Name	GSD metre	RMS X	RMS Y	RMS Z	RMS XY	Exy/GSD	σ_0	terain
Grimpiana	0.056	0.064	0.068	0.085	0.093	**166.07%**	0.923	mountainous
Argyri	0.044	0.036	0.023	0.048	0.043	**97.73%**	0.974	mountainous
Filia	0.049	0.024	0.033	0.23	0.04	**81.63%**	0.961	flat
Bragkiana	0.054	0.029	0.018	0.121	0.034	**62.96%**	0.906	mountainous
Mavraxades	0.049	0.027	0.009	0.154	0.028	**57.14%**	0.867	flat
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Sub pixel aerotriangulation accuracy with a common drone and PHOTOMOD

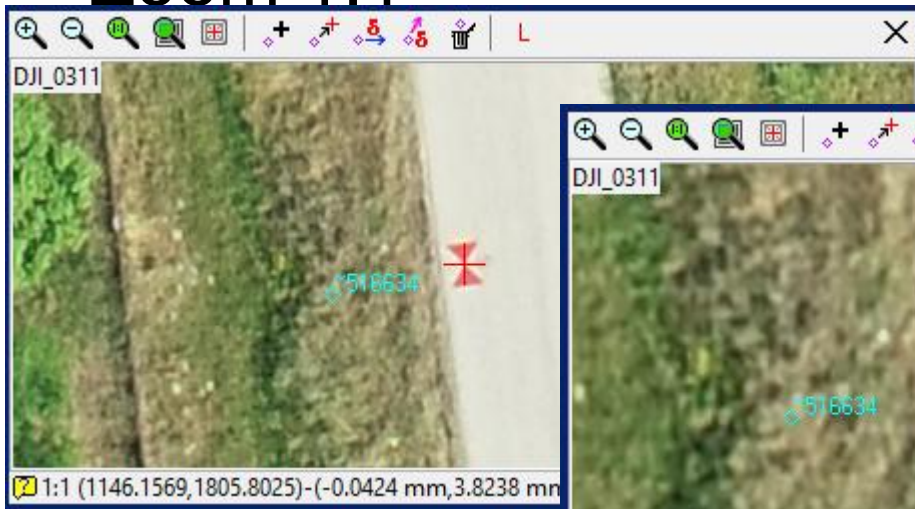# RESULTS
And the accuracy with a Sony RX100 Mark III

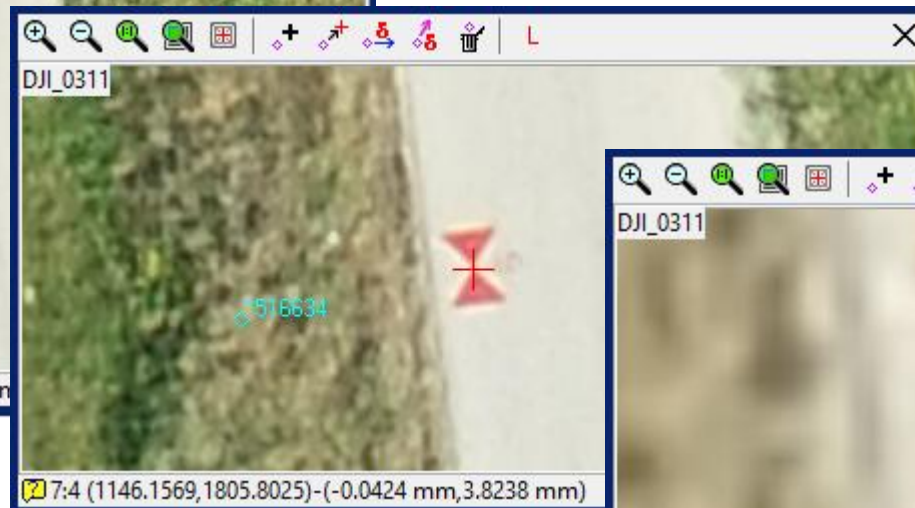*Sub pixel aerotriangulation accuracy with a common drone and PHOTOMOD*
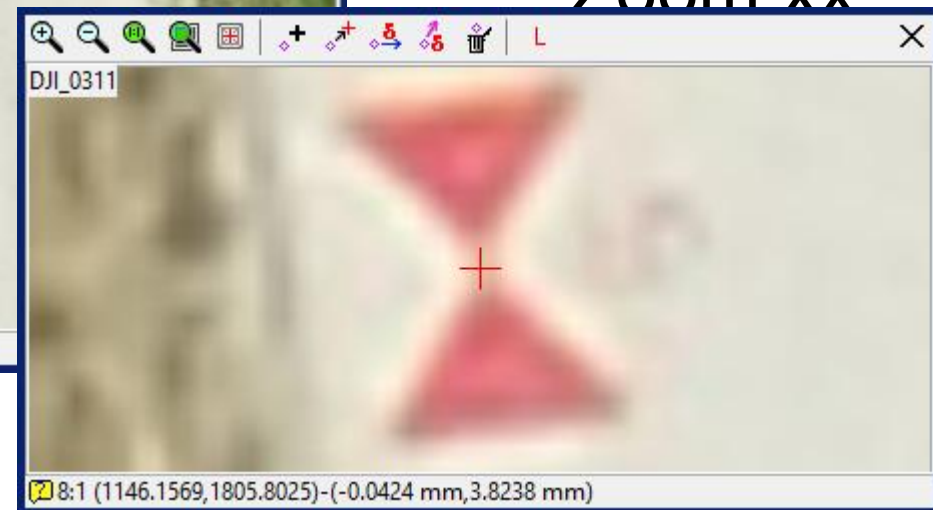
REASONS
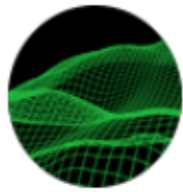
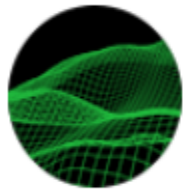- Good targets: can be measured accurately

Zoom 1:1

Zoom x4

Zoom xx

Sub pixel aerotriangulation accuracy with a common drone and PHOTOMOD

REASONS

- Good targets: can be measured accurately
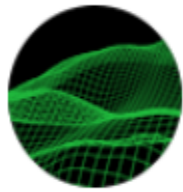- Pre-calibrated camera.
- Rigorous and careful adjustment.

Sub pixel aerotriangulation accuracy with a common drone and PHOTOMOD

Final product accuracy

Ok with aerotriangulation data but what is the accuracy of
final stereocompilation product?

Below we compare photogrammetric with surveying data
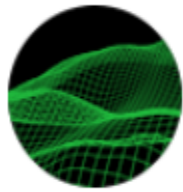In case of a city square.

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Sub pixel aerotriangulation accuracy with a common drone and PHOTOMOD

Final product accuracy
This is the are to be covered

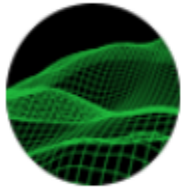*Sub pixel aerotriangulation accuracy with a common drone and PHOTOMOD*

Final product accuracy

A survey crew of 2 persons with GNSS and total station, surveyed the area in **10 hours**.
With office work a final line drawing was produced.

A photogrammetric crew of 2 persons put 5 Ground Control Points, measured them with GNSS and made a drone flight with GSD of 2cm in **1 hour** .
A photomod project was set up in the office, stereo compilation work was done producing a 3d line drawing. Other products were DSM, 3DTIN, True Ortho, 3D Model
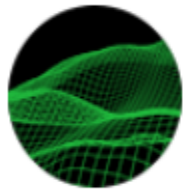
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Sub pixel aerotriangulation accuracy with a common drone and PHOTOMOD

Final product accuracy
The product of the two methods compaired
Field survey

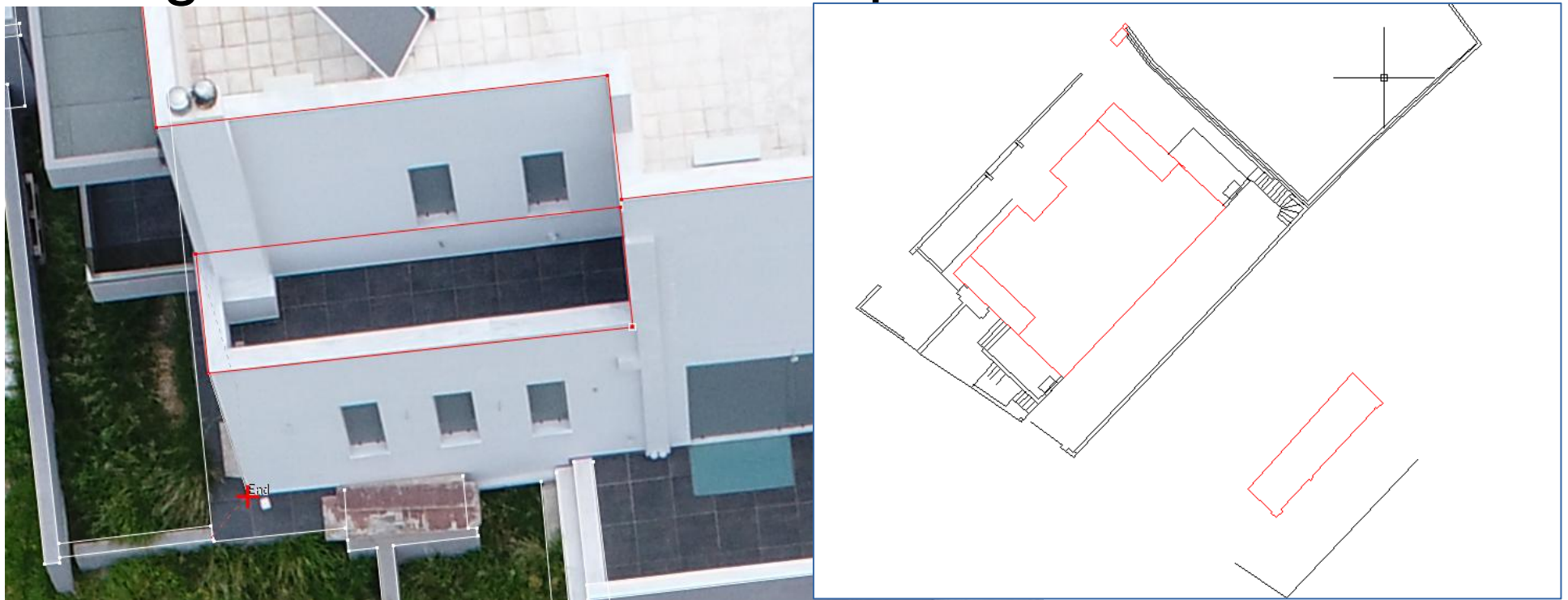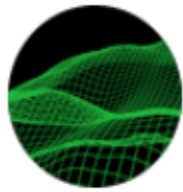Yannis Yanniris Msc Photogrammetric Engineer - yyanniris@gmail.com
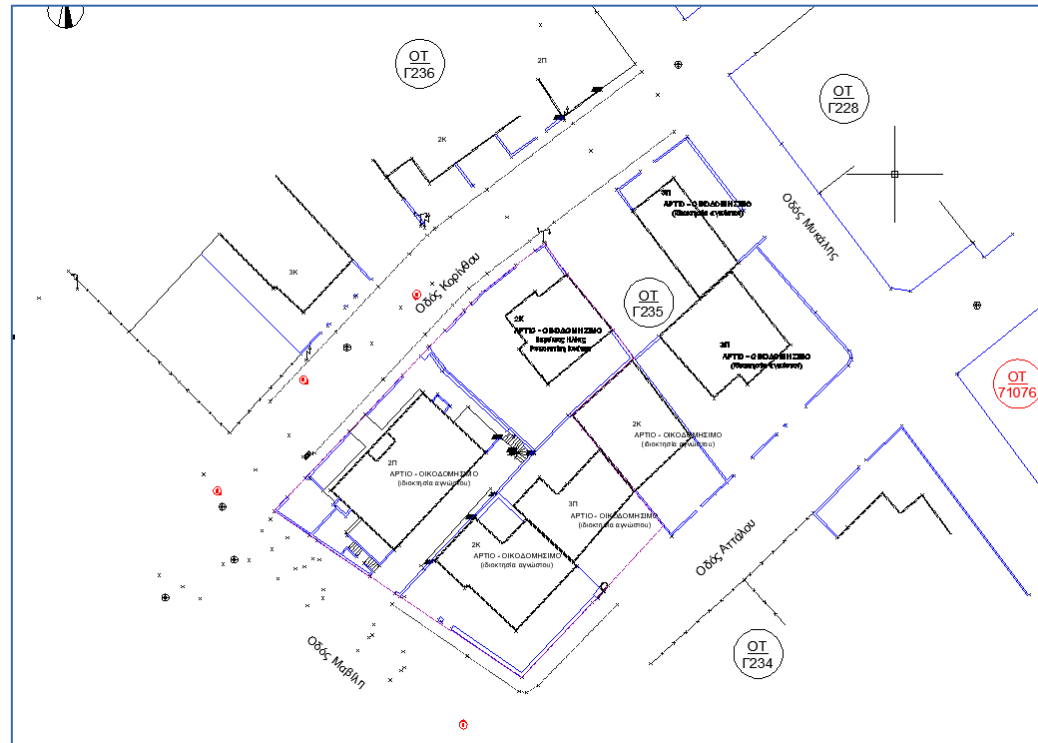
Sub pixel aerotriangulation accuracy with a common drone and PHOTOMOD

Final product accuracy
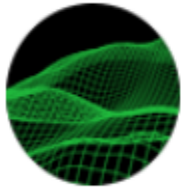# The product of the two methods compaired
Photogrammetric stereo compilation

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Sub pixel aerotriangulation accuracy with a common drone and PHOTOMOD

Final product accuracy
The product of the two methods compaired
10 well defined points were compared horizontaly

TYPE	AA	difference centimeters	difference m
surrounding wall	1	3	0.030
surrounding wall	2	1	0.010
surrounding wall	3	0.8	0.008
surrounding wall	4	1.3	0.013
surrounding wall	5	2.8	0.028
building corner	6	2.6	0.026
surrounding wall	7	3.7	0.037
building corner	8	1.6	0.016
surrounding wall	9	0.6	0.006
shaft corner	10	3.8	0.038
	mean	**2.12**	**0.021**

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Thank You

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