



Aerial + Ground



**TUTORIAL
TERRESTRIAL IMAGE
PROCESSING**

X-PHOTO AERIAL + GROUND



DESCRIPTION

- Create Point Cloud from Images
- Create 3D Surface from Point Cloud
- Stereo Drawing Tool

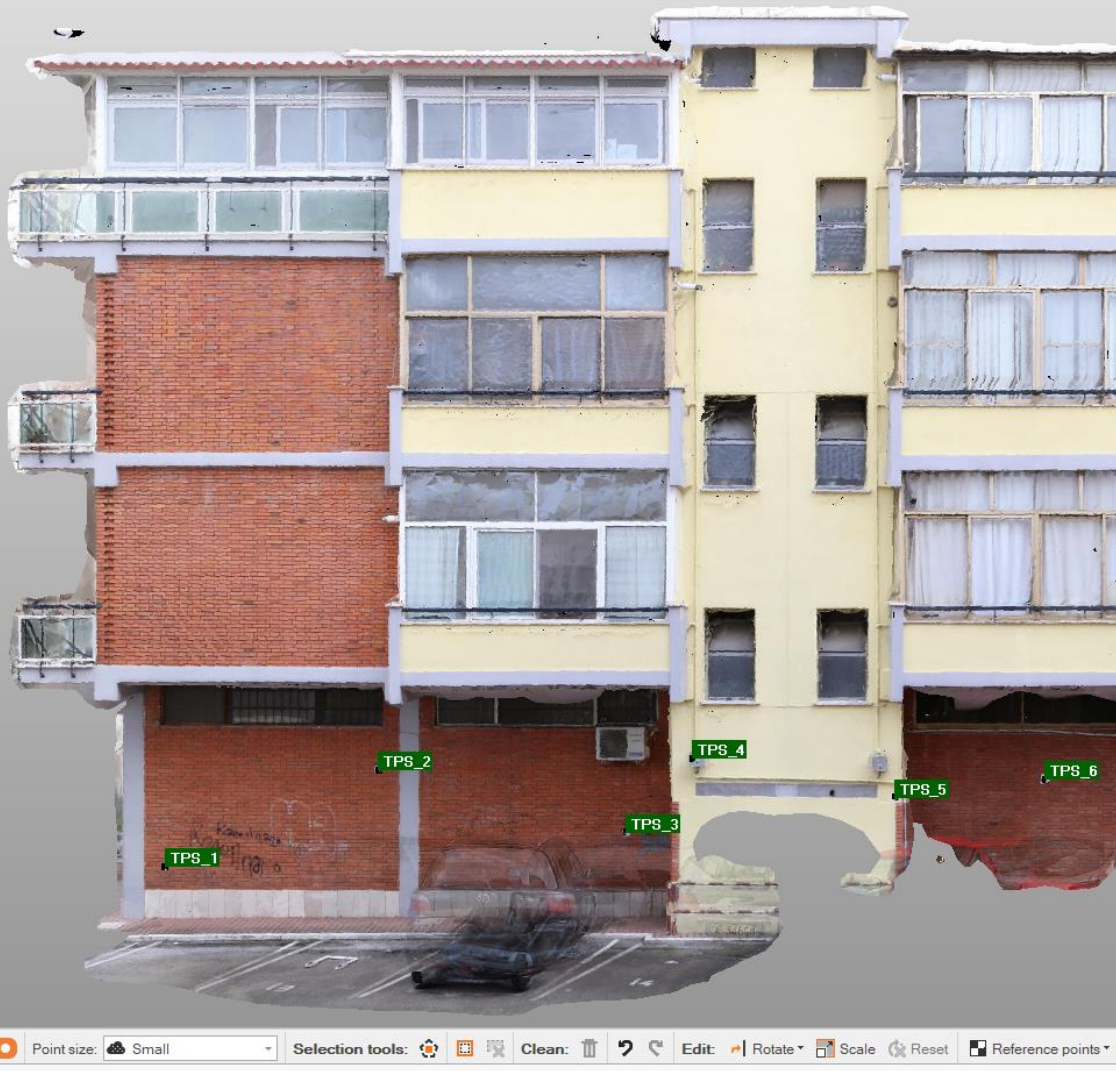
GOAL

- Import and manage data to create Point Clouds and elaboration from images

DATA

- X-PHOTO TERRESTRIAL.gfdoff
- Terrestrial Images Folder





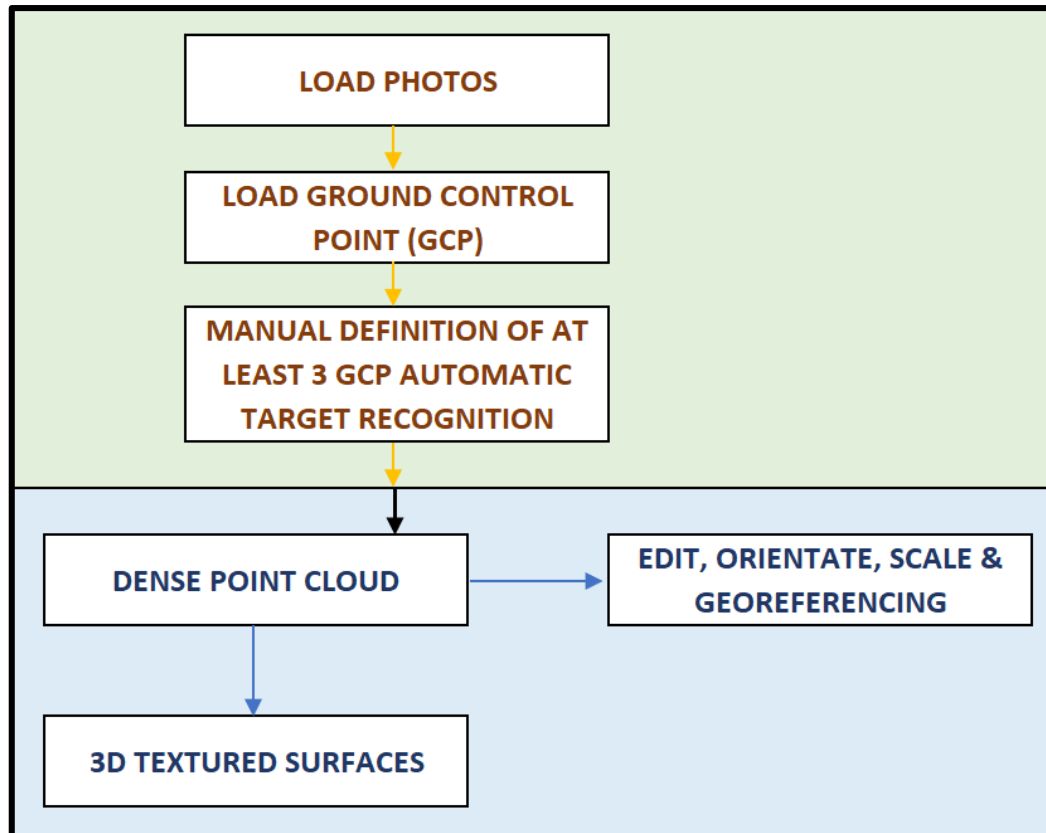
Aerial + Ground



X-PHOTO GROUND



Aerial + Ground: this package allows to use additional tools, generation of georeferenced point clouds and 3D textured surfaces



X-PHOTO Ground

REFERNCE POINT

3D Points with known coordinates. During the aerial and terrestrial photographs survey it is possible to use visible markers or targets and determinate the position with a topographic survey.

SPARSE CLOUD

It represents the Point Cloud created by the general alignment of the images used. It shows the Camera Orientation result.

DENSE CLOUD

It represents the complete Point Cloud created by the advanced calculation based on the images alignment and the ground control points used



X-PHOTO Ground

GRAPHIC PROCESSING UNIT - GPU

It is part of the graphic card which performs rapid mathematical calculation. It is possible to use a dedicated GPU to improve Dense Cloud calculation

STEREO DRAWING

It represents an advanced drawing tools based on analytical photogrammetry process. It is possible to use the Stereo Drawing function for the manual computation of coordinates in 3D space.

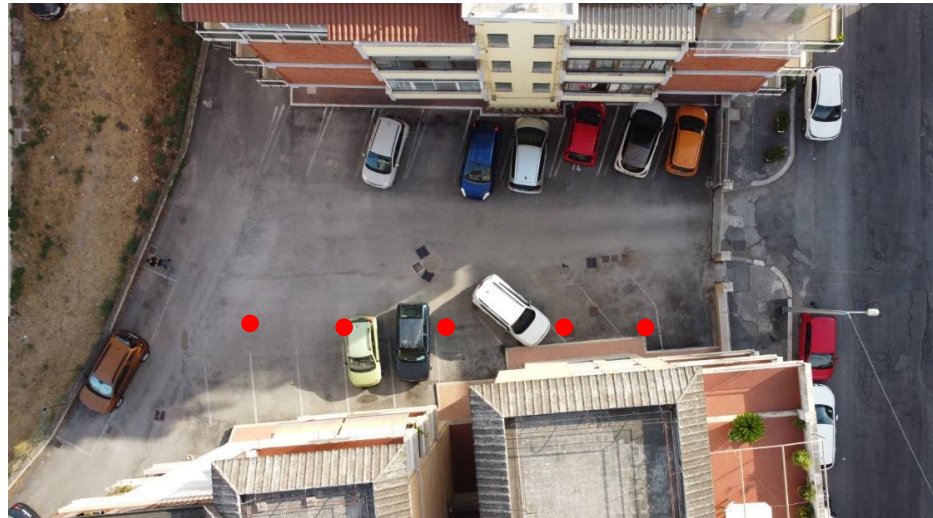


Terrestrial Photo Processing

Images Project - Horizontal Overlapping



Use **Terrestrial Images** folder to load photos from which it is possible to visualize camera parameters

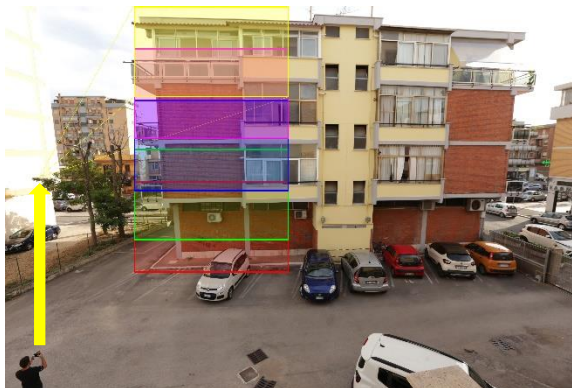


Starting
Data



Terrestrial Photo Processing

Images Project - Vertical Overlapping



Starting Data



Image Processing Project

Name	Type
X_PHOTO TERRESTRIAL	XPad.Office.Fusion Document
X_PHOTO TERRESTRIAL.gfd_bak	GFD_BAK File

Survey Surfaces Design 3D Imaging X-sections

Points point Photos manager Ref.points manager Measurements

Points [Lucani_Survey]

Type	Name	E	N	Z
ST_0001	325986.160m	4592201.244m	23.302m	
TPS_1	325980.722m	4592185.424m	17.975m	
TPS_2	325977.748m	4592187.091m	19.528m	
TPS_3	325974.306m	4592189.026m	18.540m	
TPS_4	325974.082m	4592190.865m	19.890m	
TPS_5	325971.267m	4592192.166m	19.267m	
TPS_6	325968.516m	4592192.285m	19.398m	
TPS_7	325966.273m	4592193.538m	18.632m	

Point TPS_3

Point data

Photo and messages

Photo/Sketch

Vocal messages

No message available.

OK Cancel

From Image_Processing folder open Fusion project: **X-PHOTO TERRESTRIAL.gfdoff**

The topographic survey was performed using **X-PAD Ultimate Survey** with **GeoMax Zoom 90** Robotic TPS orientated on 3 reference points acquired with **GeoMax Zenith35Pro** GNSS

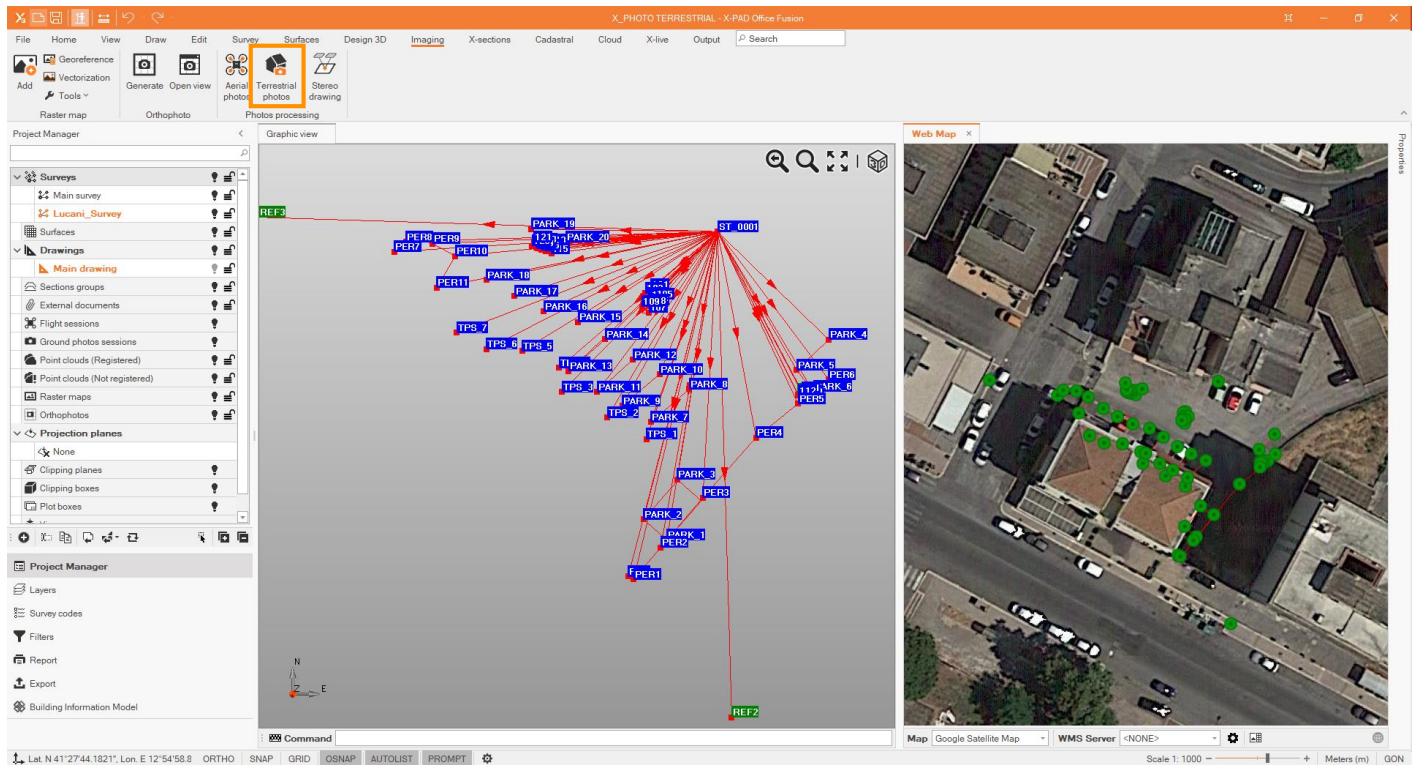
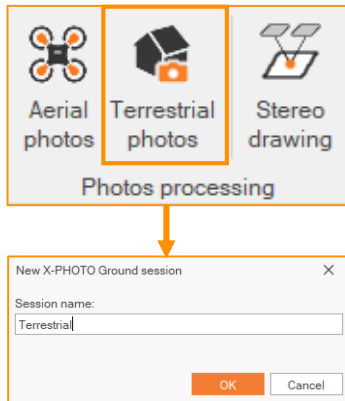
From Survey menu it is possible to select **Points** option to visualize the topographic points table and check the GCP (from **TPS_1** to **TPS_7**) position from the corresponding images



Photo Processing

Imaging Menu

PHOTO PROCESSING is available from Imaging menu, select **Terrestrial photo** and enter **Session Name**



Starting
Data

Camera
Orientation

GCP

Optimise
Orientation

Elaborations



Terrestrial Photo Processing

Images



Use **Terrestrial Images** folder to load photos from which it is possible to visualize camera parameters



STARTING DATA | CAMERA ORIENTATIONS | 3D RECONSTRUCTION

View: Photos | Reference points

IMG_7188.JPG 3/28/2020 3:53:43 PM 7.3 Mbytes
IMG_7194.JPG 3/28/2020 3:54:26 PM 10.3 Mbytes

Photo	
Used	<input checked="" type="checkbox"/>
File name	IMG_7188.JPG
Date	3/28/2020 3:53 PM
Size	7.3 Mbytes
Width (px)	5472
Height (px)	3648
Res. horizontal	72
Res. vertical	72
Lens parameters	
Focal length (mm)	45.0

Total: 75 | Used: 75 | Registered: 0

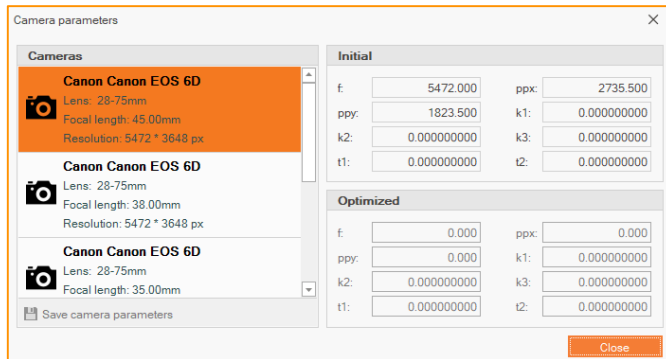
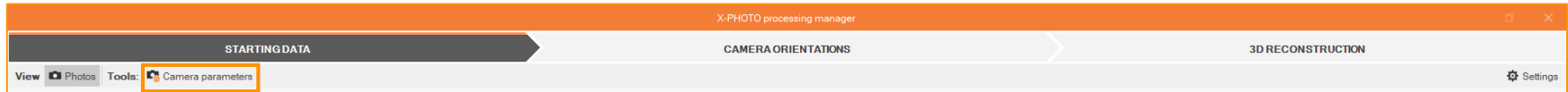
Other images formats are:
JPG, BMP, PNG

Starting
Data

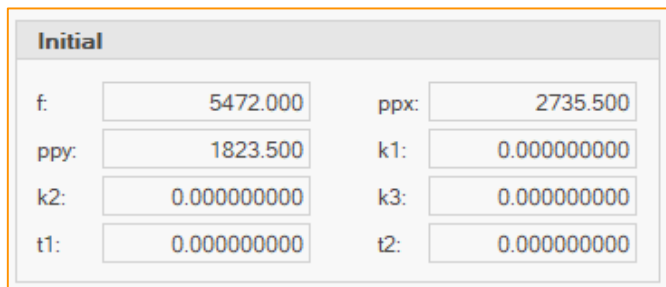


Terrestrial Photo Processing

Images - Camera Parameters



If the camera used is already in our list of camera with calibration parameters, from **Starting Data** menu it is possible to select **Camera parameters** and check the initial parameters for the current camera.

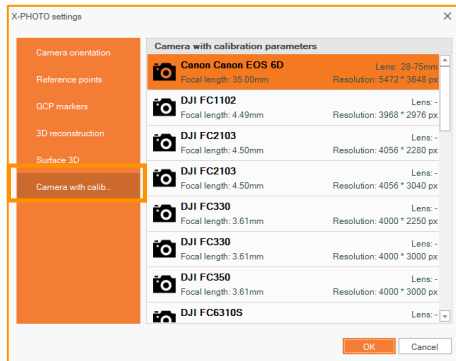
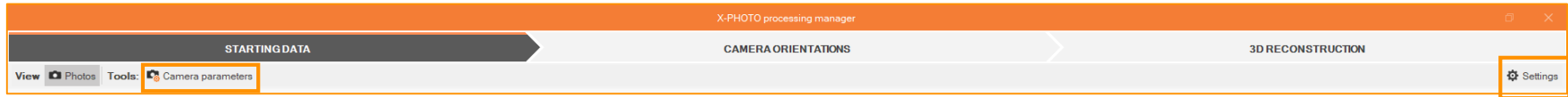


k1, k2, k3: radial distorsion
t1, t2: tangential distorsion
ppx, ppy: principal point x and y (pixels refers to image angles)
f: focal length



Terrestrial Photo Processing

Images - Camera Parameters



From main menu select **Settings**, then click on **Camera with calibration parameters** to check the camera's list.

If the camera used is not in the list it's possible to continue with elaboration and create a customized profile for the camera



Terrestrial Photo Processing Settings



From main menu click on **Settings** to set the default parameters for each X-Photo menu and tools

The screenshot displays the X-PHOTO processing manager interface with the Settings menu open. The interface is divided into three main sections: STARTING DATA, CAMERA ORIENTATIONS, and 3D RECONSTRUCTION. The Settings menu is located in the top right corner. Below the menu, six configuration windows are shown, each with a sidebar and a main content area. The windows are:

- Camera orientation:** Calculation mode: Incremental; Photos matching strategy: Match similar photos; Max tie points detected (per photo): 40000; Tie points detection level: Normal.
- Reference points:** Autodetect targets on ground: No; Targets type: Black circle target; Targets size (D): 0.270m; Distance tolerance: 0.050m; Elevation tolerance: 0.050m.
- GCP markers:** User: Blue; Calculated: Yellow; Projected: Orange.
- 3D reconstruction:** Use GPU (if available): Yes; Reconstruction level: Medium; Minimum photos per calculated point: 5.
- Surface 3D:** Max number of triangles: 100000.
- Camera with calibration parameters:** List of cameras including Canon EOS 6D, DJI FC1102, DJI FC2103, DJI FC330, and DJI FC350.

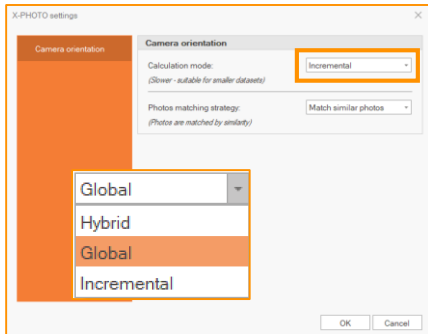
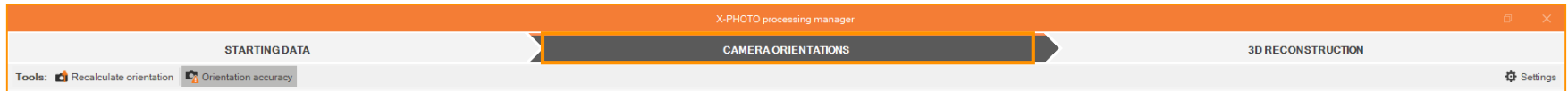
Starting Data



Aerial Photo Processing

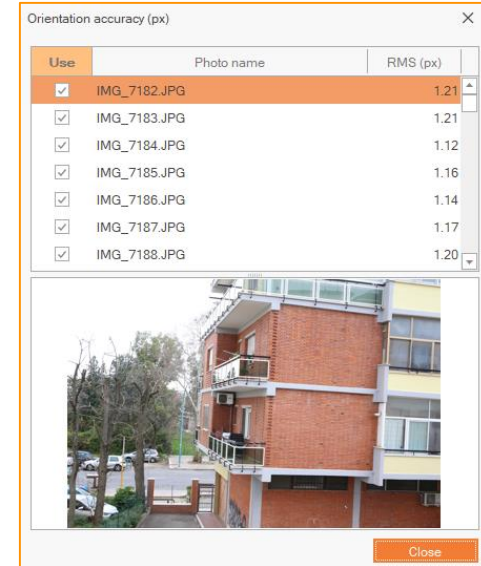
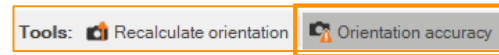
Camera orientation

Camera orientation is the result of a general Alignment of the images used. From this menu select **Global**. It's a necessary step to find out if we have a sufficient overlap between images



Hybrid Global + Incremental
Global Faster - suitable for larger database
Incremental
 Slower - suitable for smaller database

MAX RMS error
Root Mean Square error, it is a global indicator of the quality. The lower is the RMS value, the better is the solution. After calculation, it's possible to select "**Orientation Accuracy**" to check the RMS values.



CALCULATION MODE
 Different options are available with calculation algorithms based on the dataset

PHOTO MATCHING STRATEGY
 It's possible to match photos by similarity or all photos together

Tie Points are points of interest that can be recognized on images



Starting Data

Camera Orientation

Terrestrial Photo Processing



Reference Points

Load of Reference Points and Check points; X-PAD Fusion topographic points can be use

STARTING DATA				
View Photos Reference points Tools: Camera parameters				
Use	Name	E	N	Z
Reference point	TPS_1	325980.722m	4592185.424m	17.975m
Reference point	TPS_2	325977.748m	4592187.091m	19.528m
Reference point	TPS_3	325974.306m	4592189.026m	18.540m
Reference point	TPS_4	325974.082m	4592190.865m	19.890m
Reference point	TPS_5	325971.267m	4592192.166m	19.267m
Reference point	TPS_6	325968.516m	4592192.285m	19.398m
Reference point	TPS_7	325966.273m	4592193.538m	18.632m



Use this function to import GCP as **TXT** and **CSV**



Use this function to import GCP from X-Pad Fusion's **Survey**



Use this functions to **Delete** or change point's **View**

It is possible to define the Coordinate System only from the main interface of X-PAD Fusion using Survey option from the Survey menu




Terrestrial Photo Processing



Reference Points

Load of Reference Points and Check points; X-PAD Fusion topographic points can be use



Select point

Survey: Lucani Survey

Topographic points
 Reference points

Search:

- REF1
- 0049
- REF2
- REF3
- ST_001
- TPS_1**
- TPS_2
- TPS_3
- TPS_4
- TPS_5
- TPS_6
- TPS_7
- PARK_1
- PARK_2


OK Cancel

X-PHOTO processing manager

STARTING DATA CAMERA ORIENTATIONS REFERENCE POINTS OPTIMISE ORIENTATION 3D RECONSTRUCTION

View Photos Reference points Tools Camera parameters

Usage	Name	E	N	Z
Reference point	TPS_1	325980.722m	4592185.424m	17.975m
Reference point	TPS_2	325977.748m	4592187.091m	19.528m
Reference point	TPS_3	325974.306m	4592189.026m	18.540m
Reference point	TPS_4	325974.082m	4592190.865m	19.890m
Reference point	TPS_5	325971.267m	4592192.166m	19.267m
Reference point	TPS_6	325968.516m	4592192.285m	19.398m
Reference point	TPS_7	325966.273m	4592193.538m	18.632m



Map Google Map WMS Server <NONE>

Starting Data

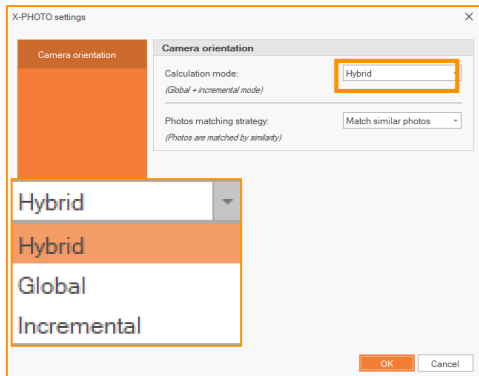


Terrestrial Photo Processing



Camera orientation

Camera orientation is the result of a general Alignment of the images used. From this menu select **Hybrid**. It's a necessary step to find out if we have a sufficient overlap between images



Hybrid

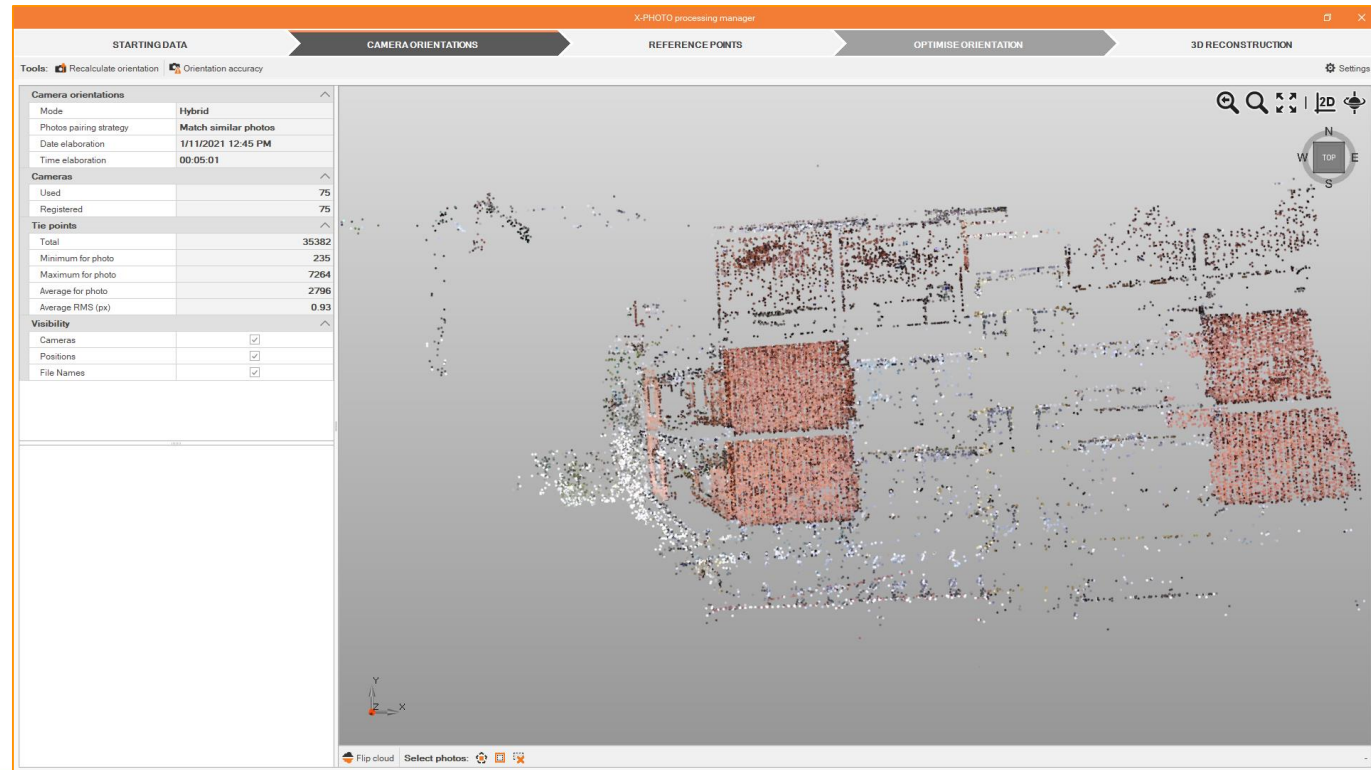
Global+Incremental

Global

Faster - suitable for larger database

Incremental

Slower - suitable for smaller database



Starting
Data

Camera
Orientation

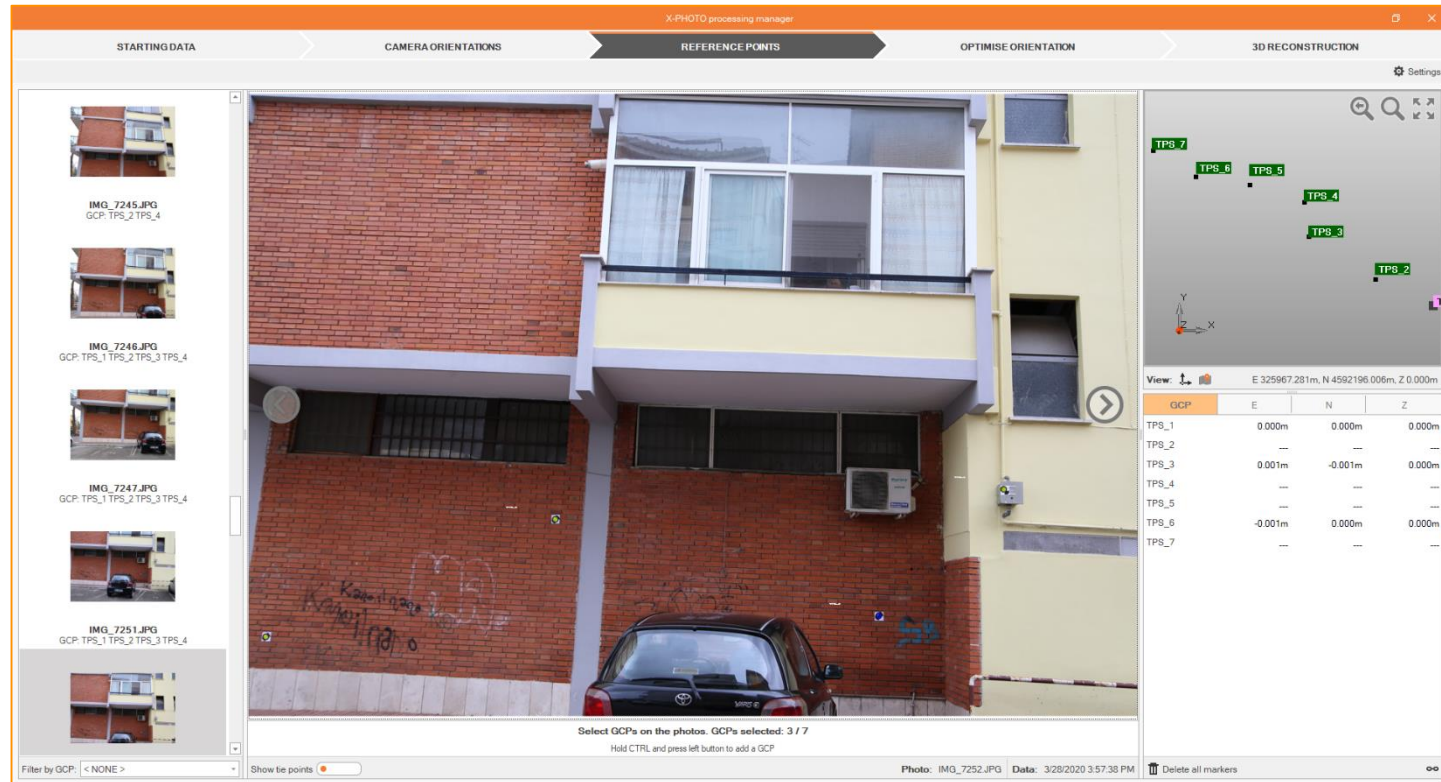
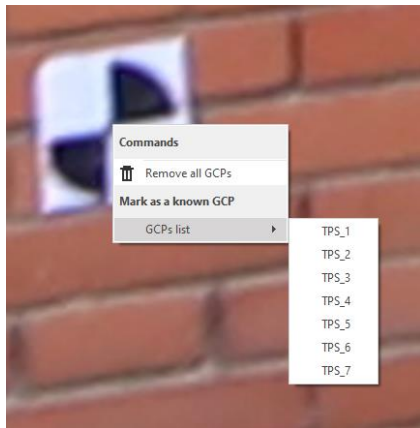


Terrestrial Photo Processing



GCP Definition

Manual definition of at least three GCP and automatic target recognition of all the others. Hold CTRL and press left button to add a GCP



It is also possible to press right button and select the GCP from the list to mark the GCP as a known GCP

Starting Data

Camera Orientation

GCP



Terrestrial Photo Processing

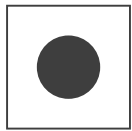


Targets Adjustment

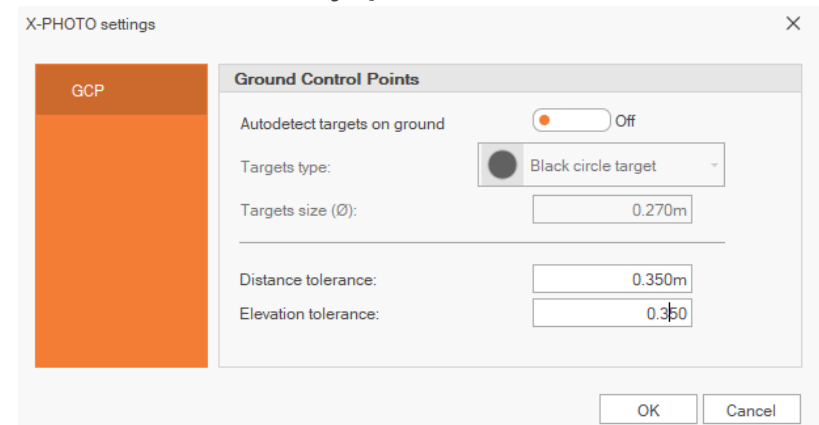
After the manual definition of at least three GCP, we can use automatic target recognition of all the others using GeoMax type or distance and elevation tolerances.

We need to select minimum three GCPs on the images in order to start Calibration

Using images with GPS position it's possible to filter GCPs by position



Using “**Black circle marker**” it's possible to use **Automatic GCP detection**



Targets available from: **C:\Program Files\GeoMax\X-PAD Office Fusion\Targets**



Terrestrial Photo Processing

Optimise Orientation



From **Optimise Calibration** menu it's possible to adjust markers position and improve the results of automatic target recognition

Type	Name	Δ E	Δ N	Δ Z	Δ Total
✓ GCP	TPS_1	0.000m	0.000m	0.000m	0.000m
✓ GCP	TPS_2	0.000m	0.000m	0.000m	0.001m
✓ GCP	TPS_3	0.000m	0.000m	0.000m	0.000m
✓ GCP	TPS_4	0.000m	0.000m	0.000m	0.001m
✓ GCP	TPS_5	0.000m	0.000m	-0.001m	0.001m
✓ GCP	TPS_6	0.000m	0.000m	0.000m	0.000m
✓ GCP	TPS_7	0.000m	0.000m	0.000m	0.001m

The screenshot shows the 'OPTIMISE ORIENTATION' step in the X-PHOTO processing manager. The interface is divided into several sections:

- STARTING DATA:** A table listing reference points (TPS_1 to TPS_7) with their respective Δ E, Δ N, Δ Z, and Δ Total values.
- REFERENCE POINTS:** A table listing reference points (TPS_1 to TPS_7) with their respective Δ E, Δ N, Δ Z, and Δ Total values.
- OPTIMISE ORIENTATION:** A grid of photo thumbnails showing the GCP markers on a brick wall. Each thumbnail has a 'Use photo' button and a file name (e.g., IMG_7188_Copy.JPG).
- 3D RECONSTRUCTION:** A section for 3D reconstruction, currently empty.
- Calculate orientation accuracy:** A section for calculating orientation accuracy, showing a table with columns for Name, E, N, Z, Photos, and Photos used.

The detailed view of a GCP marker shows the following data:

GCP	
Name	TPS_1
E	325980.722m
N	4592185.424m
Z	17.975m
Photos	
Number of photos	9
Photos used	9
Photos not used	0

At the bottom of the interface, there is a status bar with the text: "Adjust GCPs position (all GCPs should be adjusted). GCPs adjusted: 0 / 7". Below this, there are controls for Target color (Yellow), Photo zoom, and Photo size.

We recommend to adjust the GPCs position from at least three GCPs and using different images

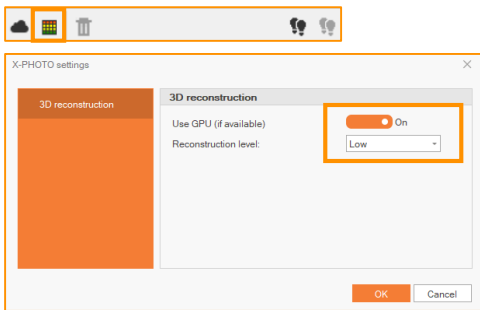


Terrestrial Photo Processing



3D Reconstruction

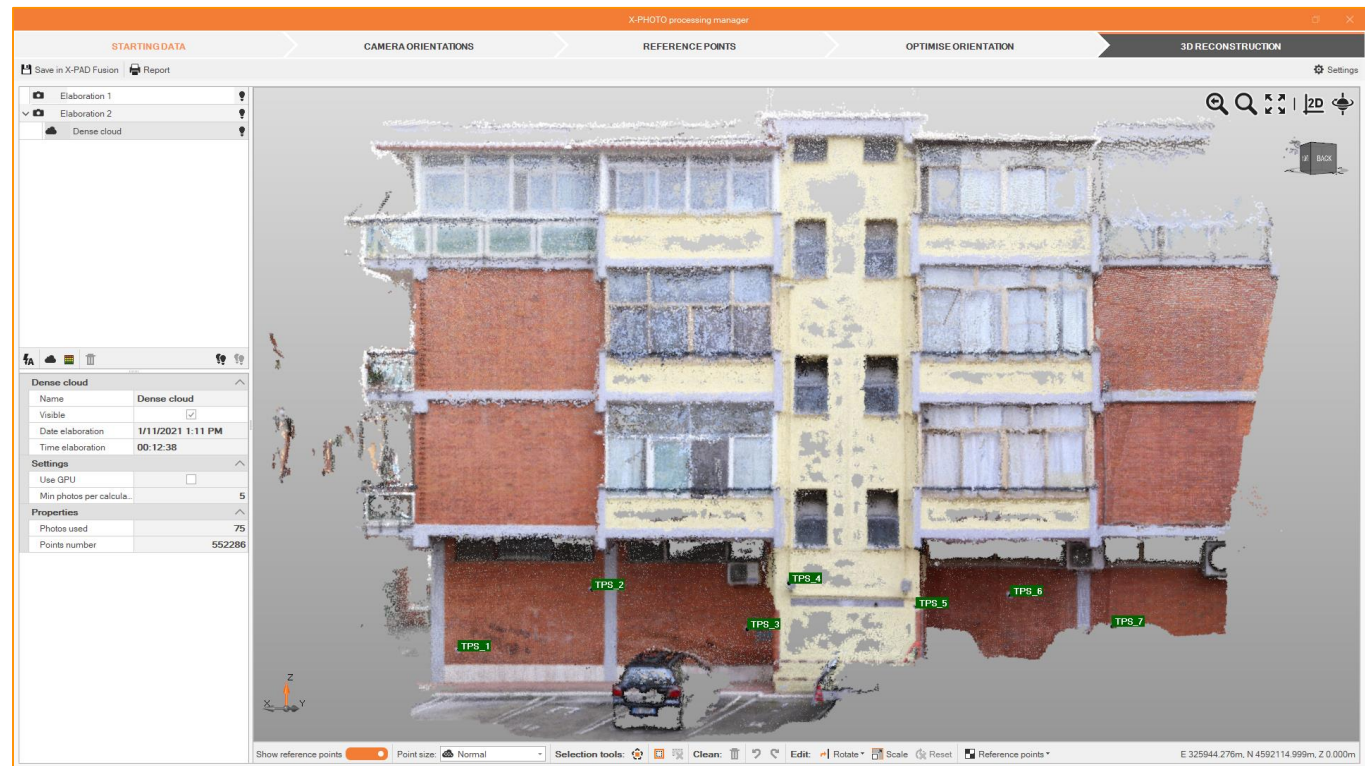
After Calibration we can run Dense Cloud process and create the corresponding Points Cloud in Low, Medium, High or Extreme resolution



GPU

This command allows to improve calculation using the dedicated GPU (Graphic Processing Unit)

Using GPU we can increase the number of points created with the same reconstruction level



Starting
Data

Camera
Orientation

GCP

Optimise
Orientation

Elaborations



Terrestrial Photo Processing



3D Reconstruction

From Elaboration menu it's possible to use different tools for Visualization, Clean and Editing Point Cloud

Show reference points Point size: Normal

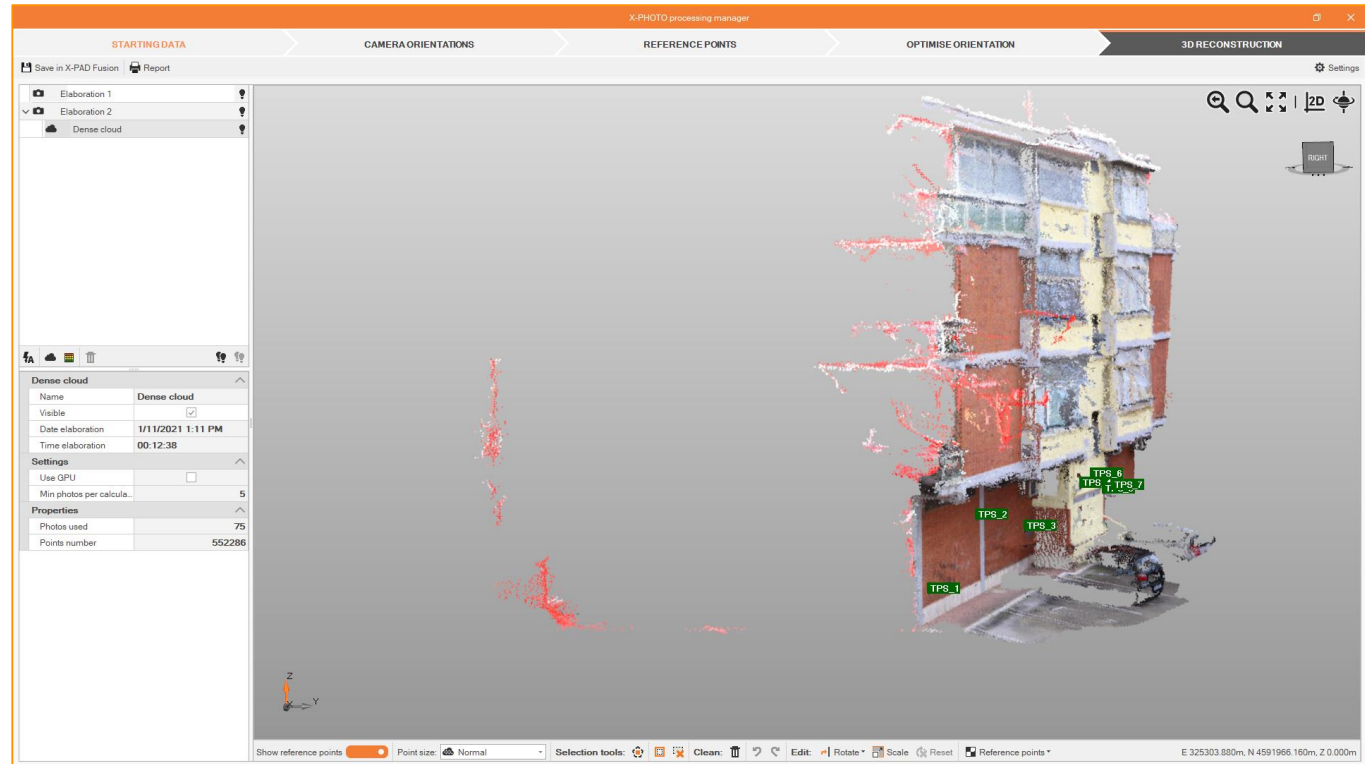
Reference Points and Point Cloud visualization

Selection tools: Clean:

Selection tools available to clean Point Cloud

Edit: Rotate Scale Reset Reference points

Editing tools available to Rotate, Scale Point Cloud or Add Reference Point to Georeference data



Starting Data

Camera Orientation

GCP

Optimise Orientation

Elaborations

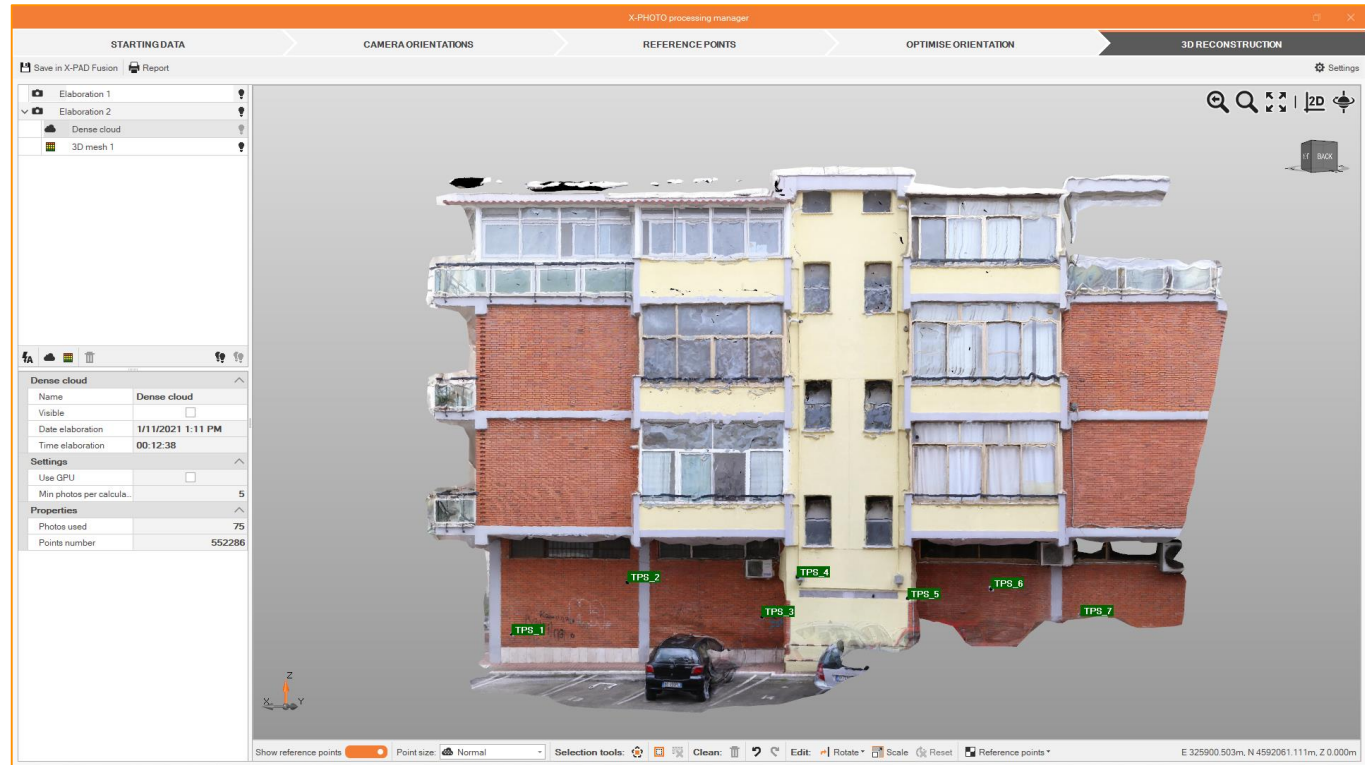
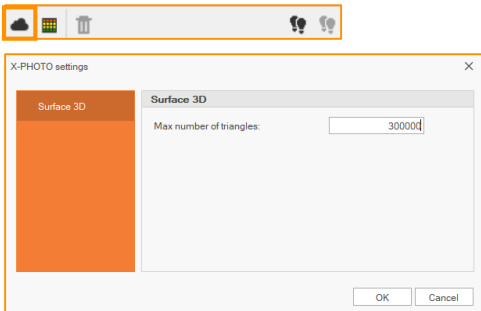


Terrestrial Photo Processing



3D Textured Surface

From Elaboration menu it's possible to create Surface 3D from Dense Cloud



Resolution and size

It's possible to increase the max number of triangles in order to increase the result

Starting
Data

Camera
Orientation

GCP

Optimise
Orientation

Elaborations

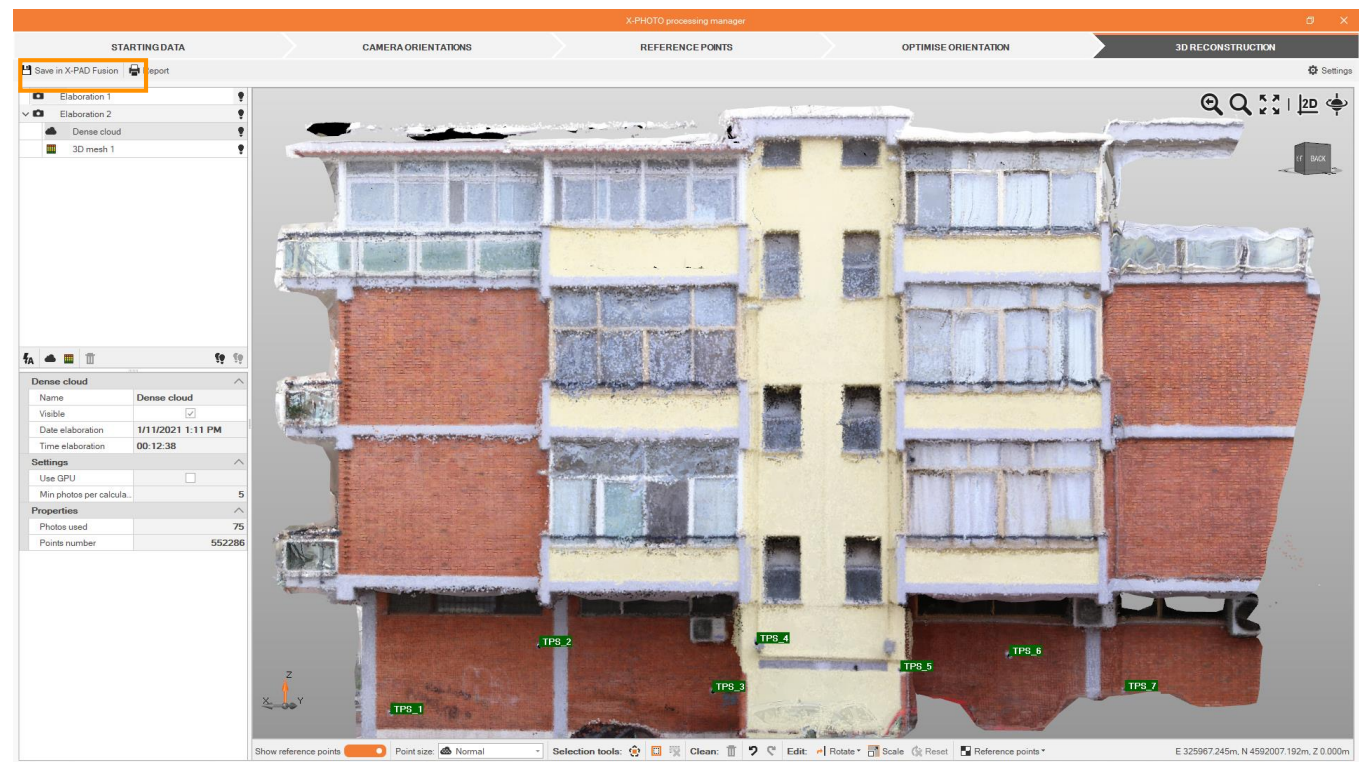
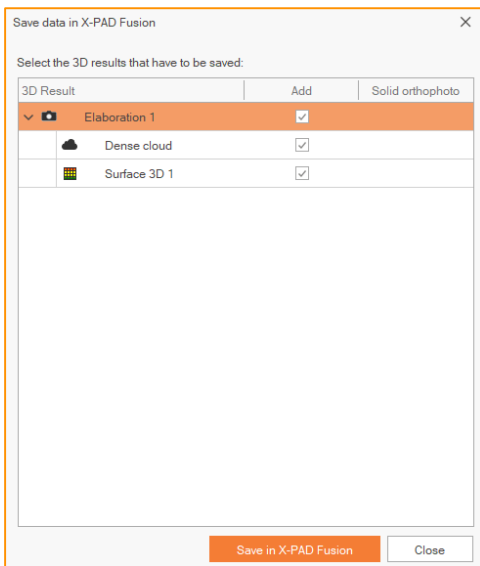


Terrestrial Photo Processing



Save Elaboration

From main menu it's possible select **Save data in X-PAD Fusion** and select the 3D results that have to be saved

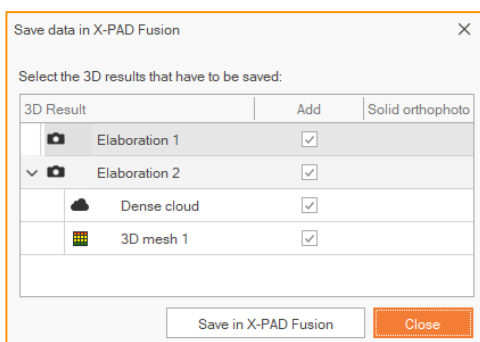


Terrestrial Photo Processing

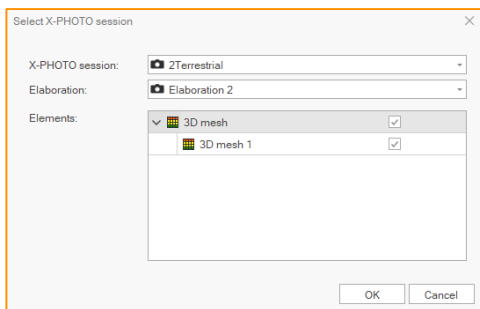


Save Elaboration - Report

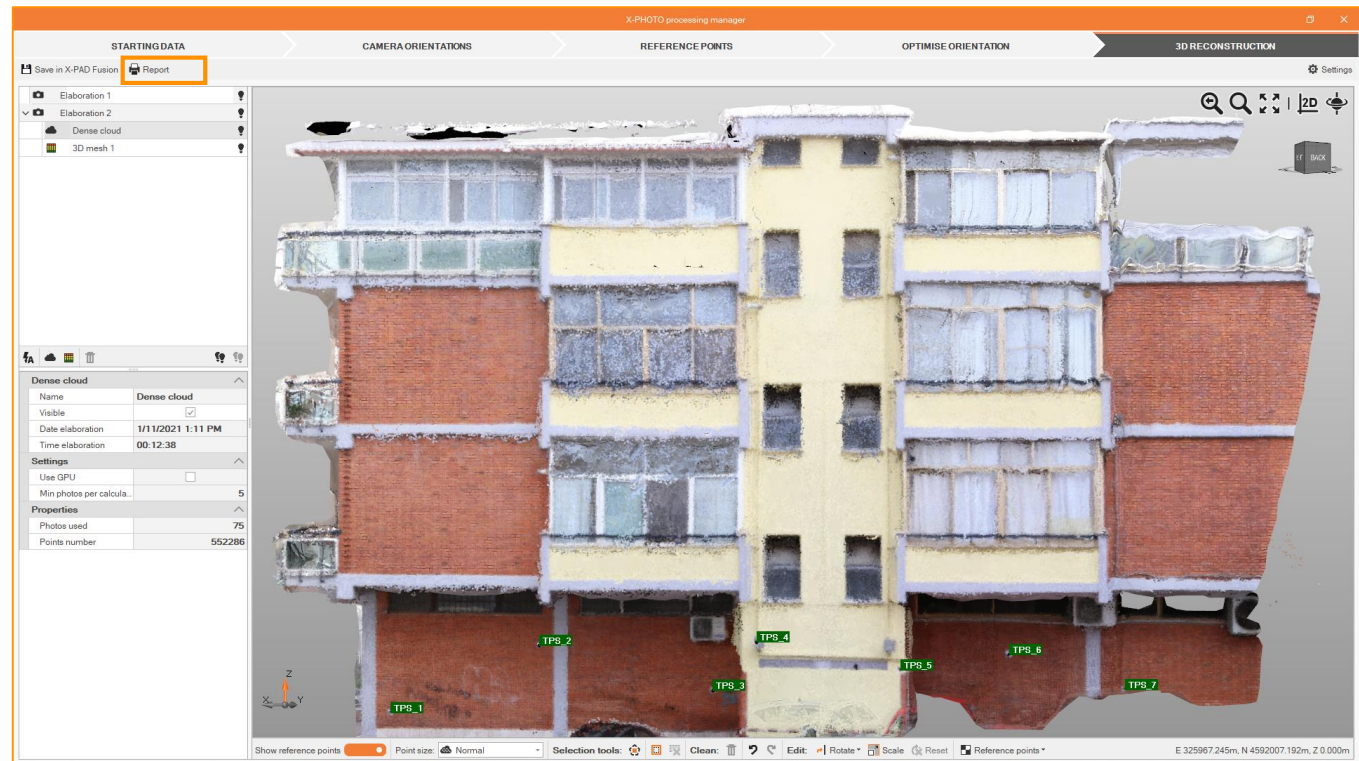
From main menu it's possible select **Save data in X-PAD Fusion** with the outputs that have to be saved or create the **X-Photo Report**



Save Data



Report



Starting
Data

Camera
Orientation

GCP

Optimise
Orientation

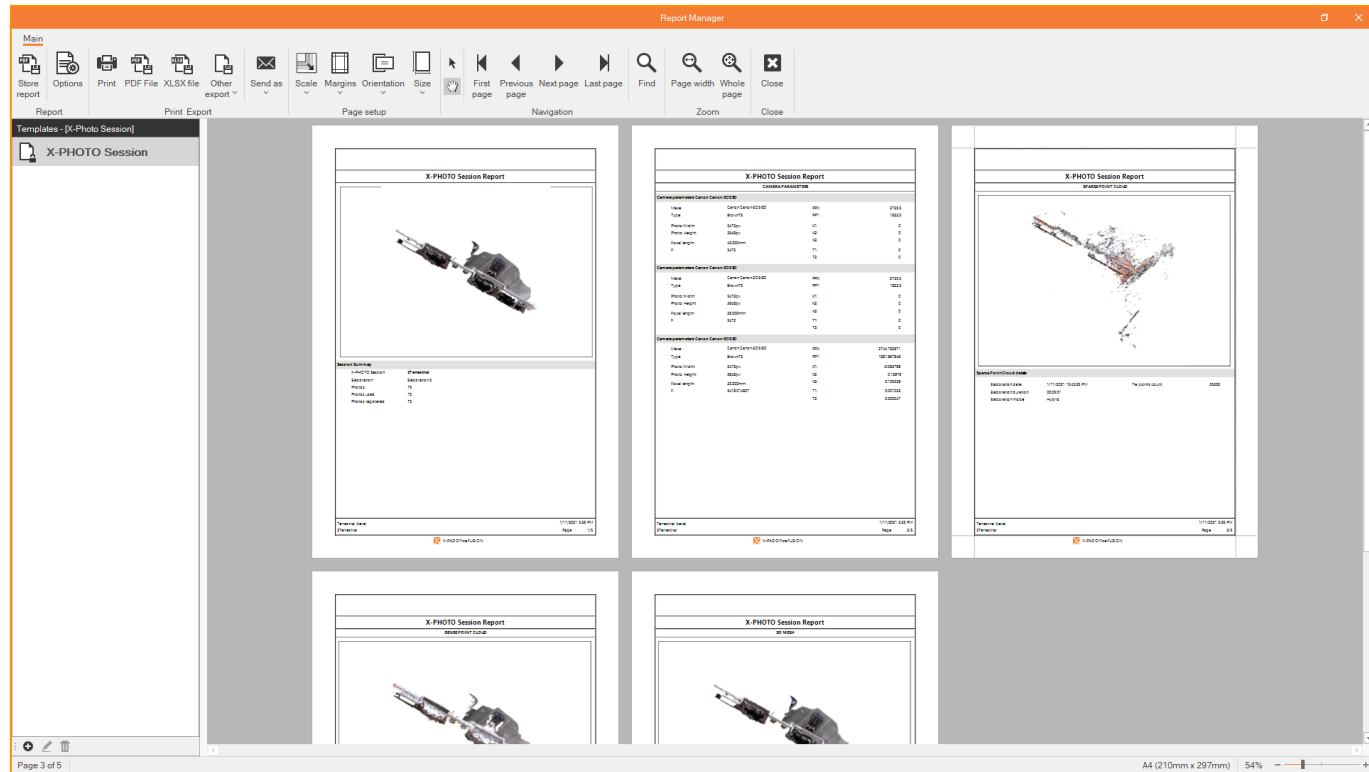
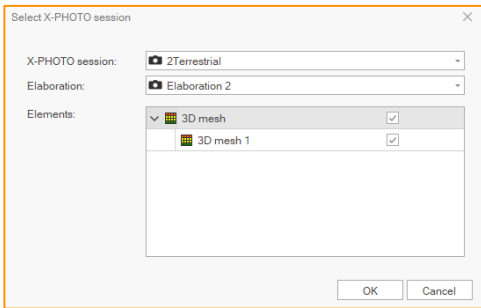
Elaborations



Terrestrial Photo Processing Report



From X-Photo Report it's possible to create a summary reports from processing to selected outputs



Starting Data

Camera Orientation

GCP

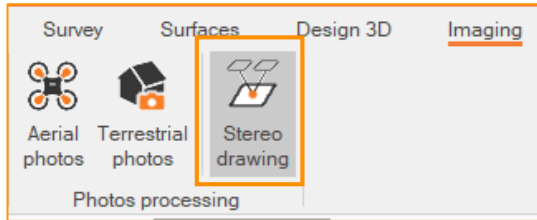
Optimise Orientation

Elaborations

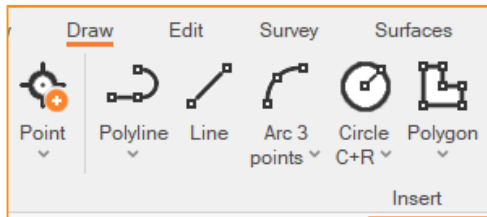


Stereo Drawing

X-Photo Drawing tools



Based on analytical photogrammetry process we can use the Stereo Drawing function for the manual computation of coordinates in 3D space



After selecting **Stereo Drawing** function, we can use one of the drawing tools from Draw menu.



We can select points and vertexes from **graphic view** or directly from the photos from **Stereo Drawing** panel.

Once created the point or object we can re-open Stereo Drawing panel and adjust vertexes position

