UAV IMAGE ACQUISITION

Advanced Remote Sensing

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Acronym

UAV: Unmanned Aerial Vehicle

GCPs: Ground Control Points

GPS: Global Positioning System

DEM: Digital Elevation Model

TIN: Triangular Irregular Networks

Objective

To generate a DEM and Orthomosaic image and visually determine its positional accuracy

Study Area

Olympic village in Munich, Germany

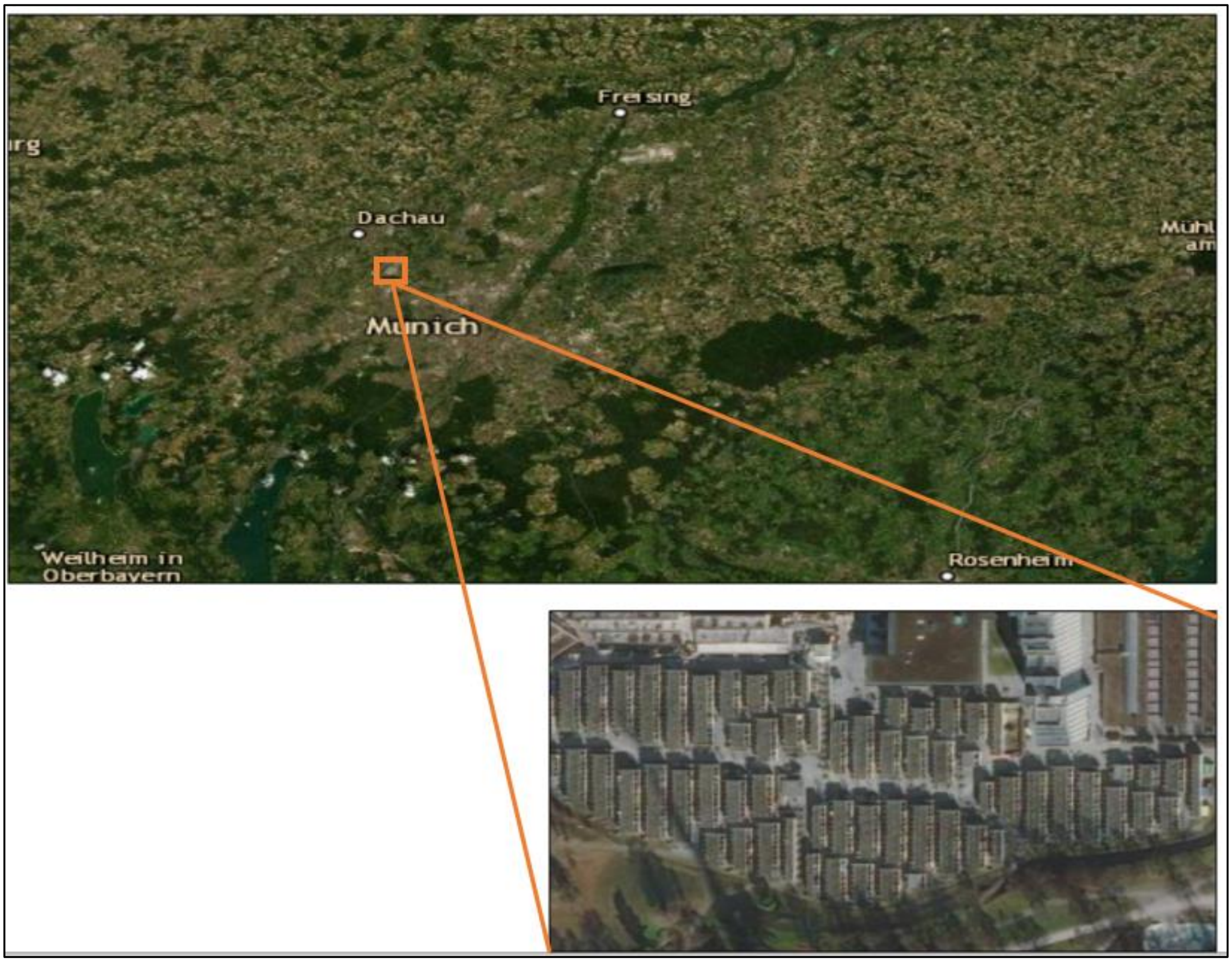


Figure 1: Study Area

Data Used

- 20 jpg images acquired from UAV
- 8 Ground Control Points acquired with highly accurate GPS

Methodology

For the entire procedure 30 days trial version of Agisoft Professional was used. The model view of the software, allowed user to display all the data. On the right to the model view there was catalogue view named as workspace where user could interact with and manage the data. At the button there was the job window which I learned that was useful when this software was used as the server or commander for several online processing versions. The photos for visualizing all the photos and console for keeping a track of the workflow was next to the job tab at the bottom of the screen.

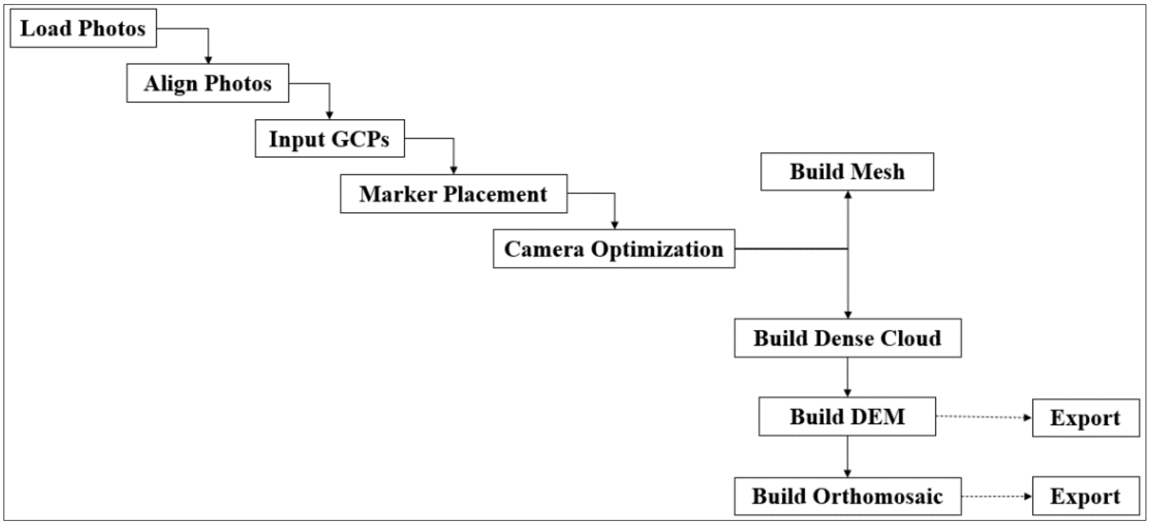


Figure 2: Methodology followed

Step 1: Loading images into Agisoft Metashape Professional

All the 20 photos provided were simply added to the software from the workflow tab. These images were added as point in the model view but initially I couldn't visualize the points and received the screen as shown in the figure 2:

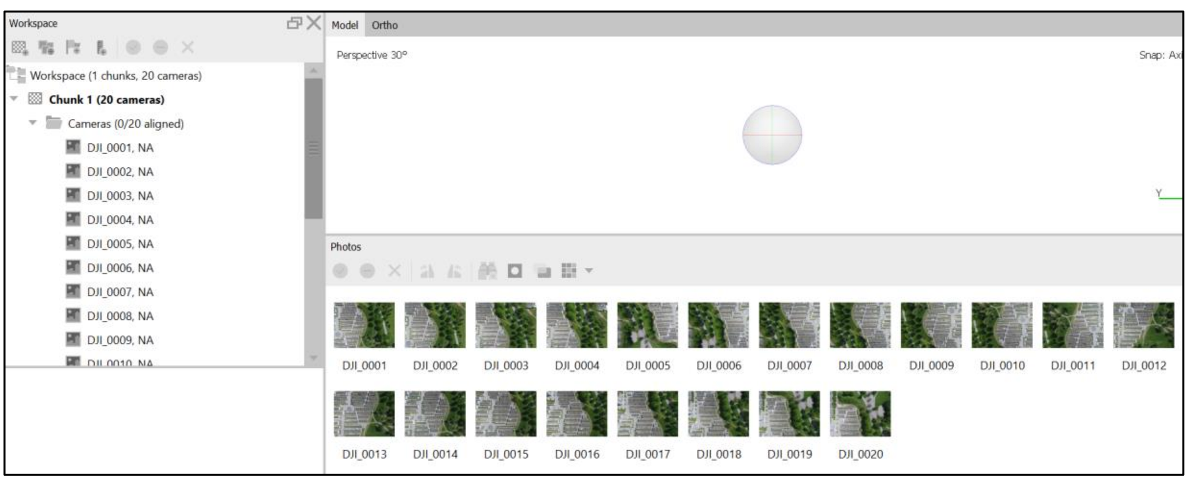
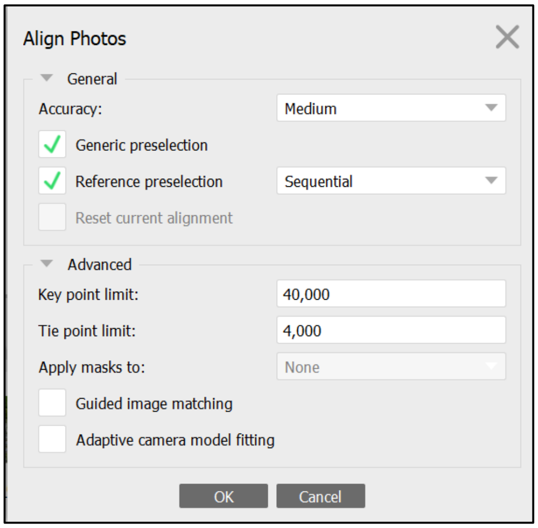


Figure 3: Importing photos

Step 2: Aligning photos

I was able to visualize these images as point cloud when alignment was done. In this process each image was checked for its prominent spots in the image and then checked with the neighboring image to find those prominent point and finally align the them creating mosaic of images. The point cloud represented every prominent point that was found in the images. The software is capable to generate the point by estimating the camera position and the orientation.



For the alignment procedure I choose the accuracy to medium to maintain efficient processing speed and capability with my device and choose reference preselection to sequential assuming that images provided to us were taken in sequential order and thus it might be a faster way rather than the estimated option.

Figure 4: Align photo popup box

The image shown in the figure 4 is after executing the alignment process.

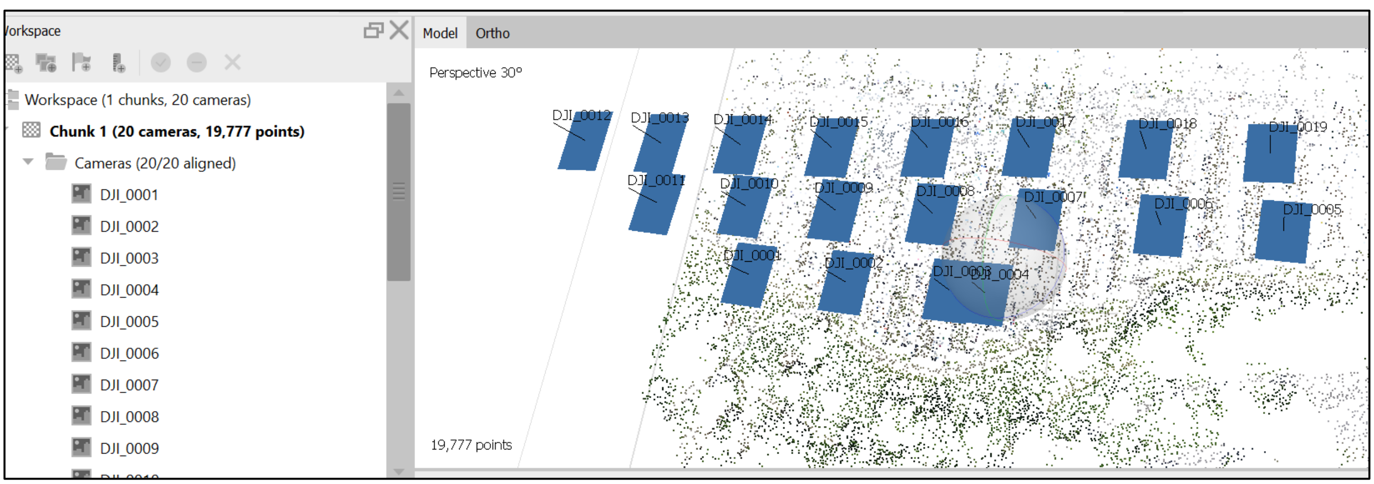


Figure 5: Aligned Image

And when each image was overlooked, we could find the prominent points as shown in the following figure 5:

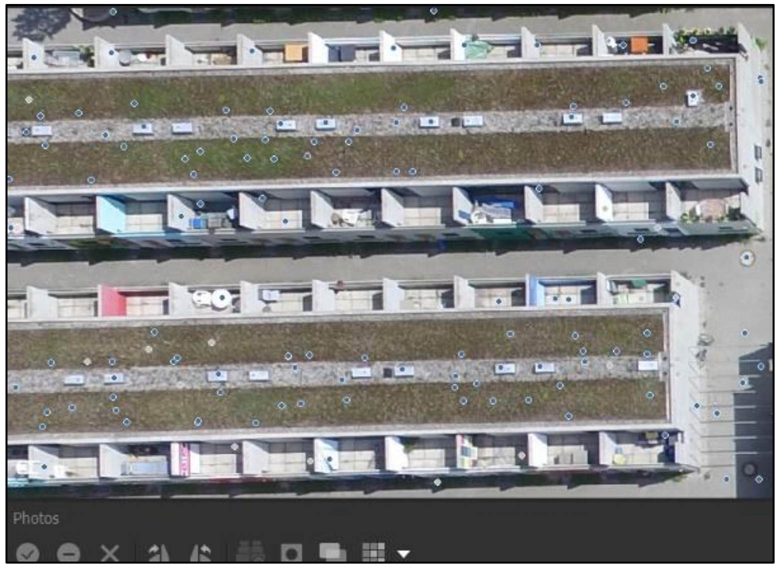


Figure 6: Prominent Points

Step 3: GCPs input as markers

After the images being aligned the next step in the methodology was to assign them the real-world coordinates. In the reference tab. I unchecked these images to avoid using photo computed location and so that I could include the GCPs that was provided to me as .txt file. I observed that such procedures are adopted to improve the accuracy as the GCPs will be obtained from highly accurate GPS devices.

To import GCPs I click on import reference button available at the top left corner of the reference tab. A window popped up where all the information regarding the reference points had to be set accurately. I left the coordinate system to WGS84 as these were the GPS coordinates and since GPS collects data in WGS84; unchecked rotation and accuracy (since Agisoft use same tool to import photo coordinates as well as GPC, so it might be unnecessary to enable rotation accuracy when importing GCP markers); and with tab as delimiter, column index was set as label =2, longitude=3, latitude=3 and altitude =5 with a start row as 2 by comparing the file that I was about to import.

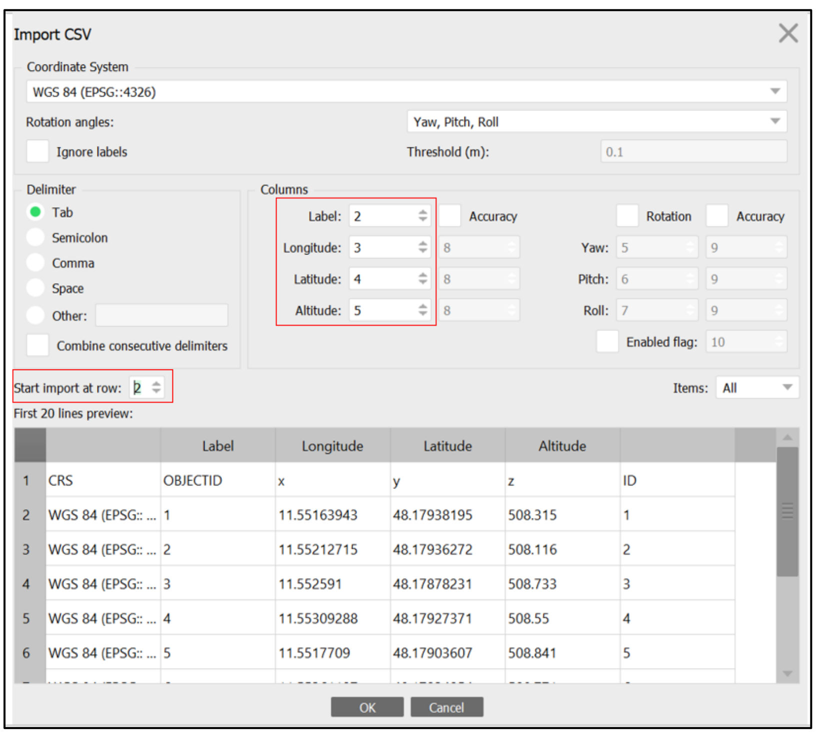


Figure 7: Import GCPs

The markers could be monitored from the left in reference pane and in case of not necessary could be checked or unchecked with the flag icon at the top in the tool bar.

Step 4: Placement of markers

Out of the whole process this step was the most time consuming as it was required to figure out the GCPs locations based on the reference images provided to us. For each image GCPs were assigned after identifying the checkpoint on the ground by right clicking at the center of the point and selecting the markers from the available points.

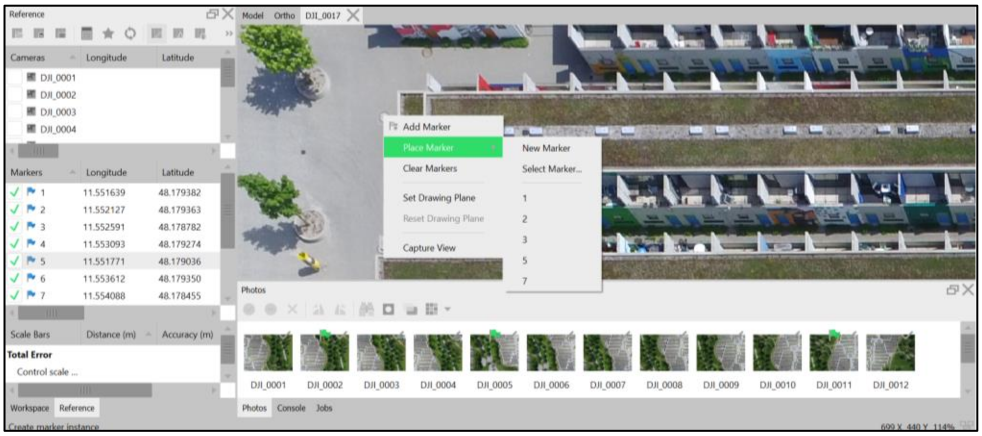


Figure 8: Assign Markers

After the assignment of marker error values were encountered due to the position of image alignment and the placement of marker not being in exact location.

Step 5: Optimizing camera alignment

To receive high degree of accuracy marker location on each image were rechecked and placed right at the center. The same procedure was followed for around all the images where the points could be visualized and were not blocked by any obstruction. The placement of the points in the images was done in almost every image by doing filter images by marker that displayed the most possible points in the image.

GCP marker number	Image ID
Marker 1	10, 11, 12, 13, 14
Marker 2	09, 10, 11, 12, 13, 14, 15, 16
Marker 3	01, 02, 03, 07, 08, 09, 10, 14, 15, 16
Marker 4	05, 06, 07, 15, 16, 17, 18, 19
Marker 5	01, 10, 11, 12, 13, 14
Marker 6	17, 18, 19, 20
Marker 7	05, 06
Marker 8	17, 18, 19, 20

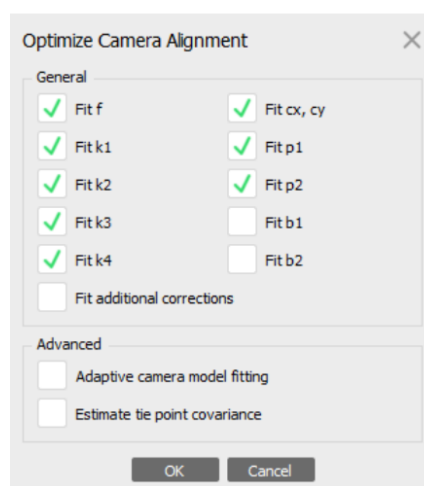


Figure 9: Camera Optimization

Once the manual process of placement was done reference was updated the camera optimization button was clicked. This process helped in removing the possible deformation caused due to various factors by optimizing the estimated point cloud and camera parameters based on the known reference coordinates. In this algorithm estimated point were adjusted with the reference coordinates and camera parameters minimizing the sum of reprojection error and reference coordinate misalignment error.

As a result of the entire process an accuracy was 0.062914 m was obtained as a positional error.

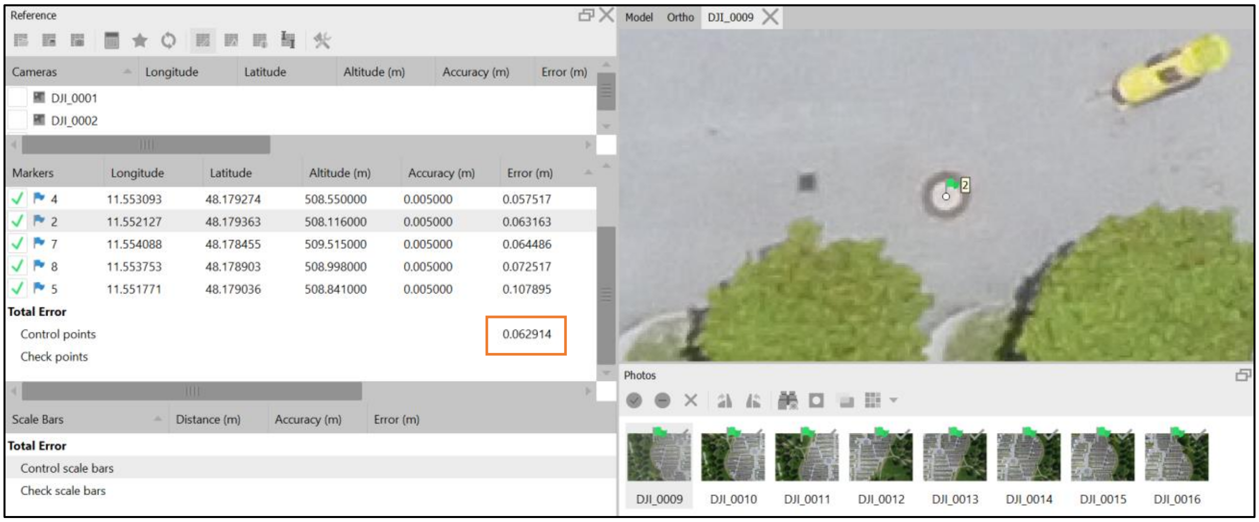


Figure 10: Accuracy Obtained

Step 6: Building dense point cloud

For the generation of DEM, a dense cloud of points was generated under this workflow. Quality was defined as medium and depth filtering as Aggressive as the geometry in the images were complex with numerous small details.

[Note: Dense point cloud generation is based on depth maps calculated using dense stereo matching. Depth maps are calculated for the overlapping image pairs considering their relative exterior and interior orientation parameters estimated with bundle adjustment.]

Figure 11: Dense Cloud of Points

Step 7: Building mesh model

A mesh model of the point is not mandatory for the generation of DEM or Orthomosaic Image but to visualize the output obtained from the mesh model created with dense cloud, the algorithm was run. Mesh model is connected points usually represented with TIN. So, it's a polygon representing closed 3D model

Figure 12: Mesh Model Output

Step 9: Building digital elevation model (DEM)

As well-known DEM gives the elevation information of a location and can be acquired with the help of dense point cloud generated from the UAV images after preprocessing. Though the spare dense cloud using for the DEM generation is least accurate method, it was adopted here to avoid the processing complexity. In the software Build Dem option can be chosen from the workflow that pops up a box as shown in the figure. The environment setting is used as default.

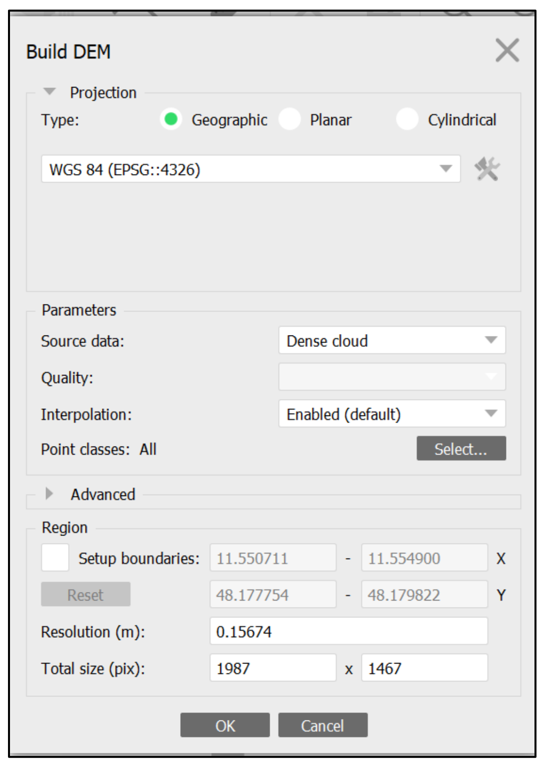


Figure 13: DEM generation

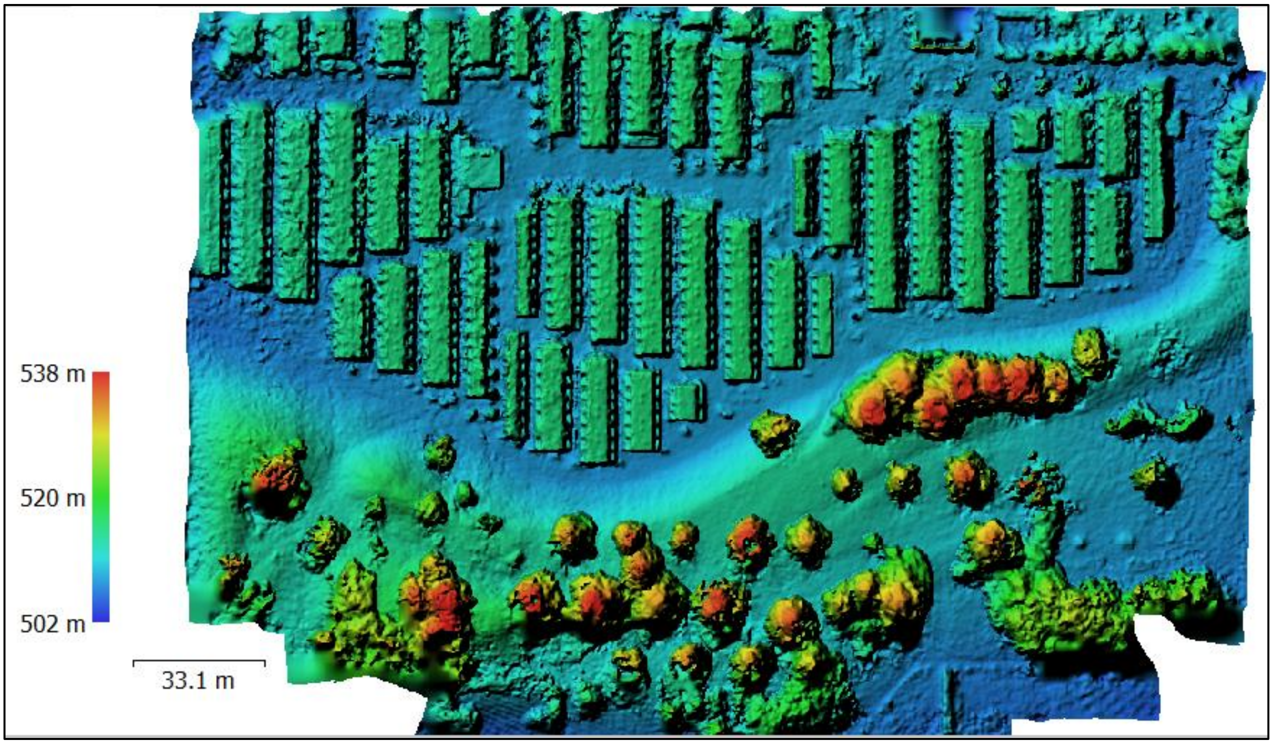


Figure 14: DEM generated

Step 10: Building orthomosaic

Orthomosaic is obtained by orthorectification of the original images and is generated for better visualization of information. Similar to DEM generation Build Orthomosaic option is available under workflow tool. Here Dem was provided as the surface parameter for the generation of Ortho mosaic and rest were set as default.

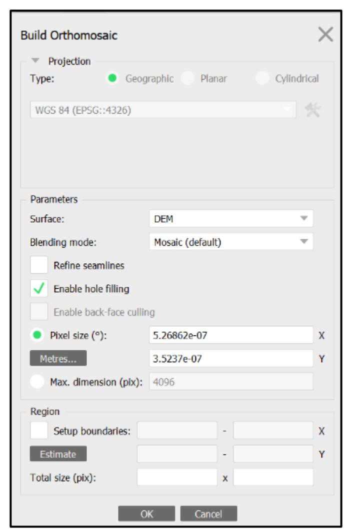


Figure 15: Orthomosaic generation

Figure 16: Orthomosaic generated

Step 11: Export DEM, orthomosaic

For the further comparison these models were exported as .tiff files and WGS 84 was taken as the reference system.

Observation

When the orthomosaic was visualized with created DEM as an elevation surface in the local scene of ArcGIS pro, it could be observed that the generated ortho image has high positional accuracy.

Figure 17: 3D visualization

Conclusion

Hence with the use of Agisoft Metashape for the aerial images of the Olympic village in Munich a dense point cloud from your correctly referenced was prepared. With this dense cloud a DEM and Orthomosaic and was observed that it is positionally accurate by comparing with ArcGIS pro local scene.