Universität Stuttgart
Germany

Institut für Photogrammetrie

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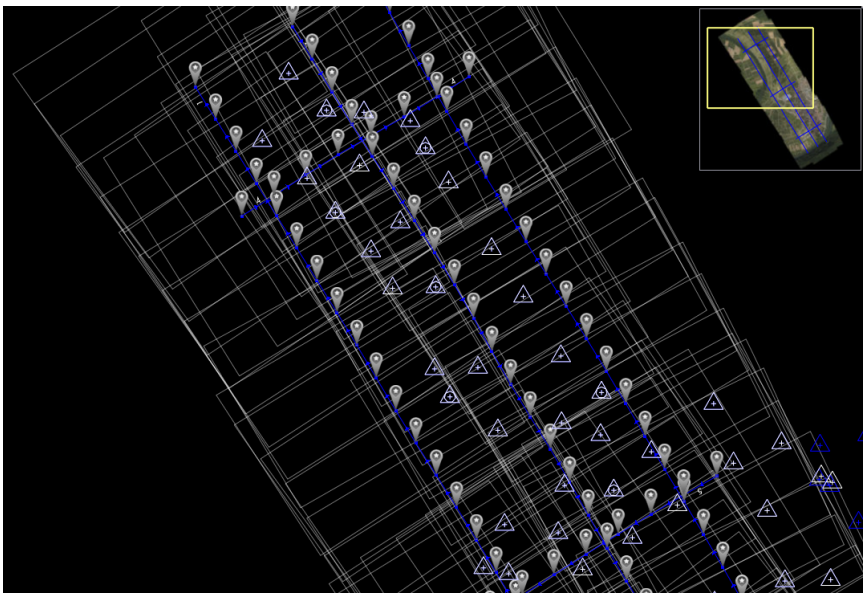
Geomatics Engineering GeoEngine
Airborne Data Acquisition

Lab 2: Image Orientation – Automatic Aerial Triangulation AAT (Summer 2019)

Deadline: **Friday, June 28, 2019**

The orientation of images, i.e. georeferencing, is the essential step within the photogrammetric data processing chain. Image orientation typically is not done within a single image procedure (like spatial resection, see lab 1) but all images forming the image block are considered simultaneously. This so-called aerial triangulation often is solved via bundle adjustment, i.e. the image observations are directly related to their corresponding object points via collinearity equations. Additional observations like GNSS or GNSS/inertial direct exterior orientation measurements or additional parameters for the self-calibration of the camera system can also be considered within this step. These topics will be analysed in the following lab now. Please start with the project, you already have established for the Spatial Resection in Lab 1.

Each group (2 students per group) will process its own photogrammetric sub-block, formed from a sub-set of 2x5 images flown in the Hessigheim test site. Data was taken by a Gyrocopter platform using a digital mid format camera with 50 MPix (IGI DigiCAM 50 with 50mm lens) and a nominal GSD of around 5-8cm (because of terrain variations) and 80/60 image overlaps. The overall block geometry of the whole image flight is depicted here, only smaller subsets will considered within the lab.



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USt-ID/VAT-ID: DE14779196

All data (and additional guidelines) are available from the CIP-Pool directory **\users\uebungen\AirborneDataAcquisition\Lab-AerialTriangulation** .

Working groups

The students groups will deal with the following individual photo IDs:

Group	Images	Students
1	250-246, 197-201	Bingqing Xu, Yi Wei
2	248-244, 199-203	Yimeng Chen, Yi Wang, Xiaou Tan
3	246-242, 201-205	Ruwei Nie, Meijie Xiang
4	244-240, 203-207	Yifei Zheng, Ariane Miseke
5	242-238, 205-209	Zhenqiao Wang, Tianqi Xiao
6	197-201, 184-180	Thomas Daud Gisiri, Casimir Naangmenkuu
7	199-203, 182-178	Huang Yu, Pascal Kößler

Action & Questions: Manual measurement of ground control points (GCP) and check points (ChP)

- Perform manual measurement of image points. All control points (GCP) per block should be measured. Make sure that all selected control points are measured in all available / üossible images of your block, i.e. in all neighbouring images within the strip and across the strip. Results of manual point measurement are stored in the *project_name.prj* file.
- Please document the number of control points per image and also illustrate their distribution.

Action & Questions : Automatic tie point measurement and transfer

- The ApplicationsMaster automatic tie point matching is done by using image pyramids (how to create pyramids is specified in the document). An internal bundle adjustment is used to obtain refined exterior orientation elements for each image and adjusted object coordinate of tie points. Based on this the connection between the neighbouring image strips can be refined.
- Results of matching process (and included AAT) are documented in the `AAT.txt` file and in `AAT.html` respectively. How many points have been automatically measured per image?
- Illustrate the distribution of automatically matched points by using the Analyzer Tool described in the manual. Are there any regions where tie points are matched with less density? Why?

Aerial triangulation via bundle adjustment method

As already mentioned the tie point matching is based on an internal AT already. Within this section of the lab the AT is more deeply analysed.

Action & Questions: AT with all Ground Control Points (GCP) only

The first adjustment is based on all GCPs, this does not allow to perform external accuracy evaluation because of the lack of check points. Thus only precision of the AT is analysed here. From the AAT_log file and View Statistics please analyse the following. Please also consider the Analyzer Tool again:

- Sigma naught value. Compare and comment to original pixel size of images.
- Image measurement residuals (RMS). Compare residuals from automatic tie points to manual measured points. Is there any difference?
- Control point residuals (RMS). Is there any big residual indicating a measurement error?
- Precision of adjusted terrain points. Does this accuracy match your expectations?
- Precision of adjusted exterior orientation elements. Are there any differences between horizontal and vertical precision?
- Also add meaningful illustrations from the report file document.

Action & Questions: AT with additional Check Points (CHP)

Now please introduce additional check points by changing the status from control to check point. Make sure you have still sufficient number of control points available. Then redo the Adjustment (post-processing only).

- Compare the result of this run to the previous one.
- Especially have a look on the residuals (value?) from check point analysis, which now reflect the exterior accuracy of your adjustment. Compare this to the precision of adjusted terrain points.
- Also add meaningful illustrations from the report file document.

Action & Questions: GNSS-supported AT (with CHP)

Start from the previous configuration (AT with additional CHPS) and now please introduce additional GNSS observations. The weighting of GNSS-observations has to be changed. Within the first run, we assume a standard deviation of 5 m for GNSS perspective center coordinates. With that, the observations will almost not influence the adjustment, i.e. they are considered as initial values only. In the second run, we will change the standard deviations to more realistic numbers. We assume to have 10 cm standard deviation here, as the trajectory is obtained from a differential phase processing. Furthermore, the additional offset and drift unknowns have to be considered separately.

- How does the weighting of GNSS perspective centers influence the adjustment? Discuss.

- Is there any need to use additional offset and drift corrections, when GNSS std.dev. is selected with 10 cm? Why? In order to answer this carefully analyse the GNSS observation residuals. Discuss need / influence of offset / drift parameters in adjustment.
- Finally try to reduce your number of GCPs to an absolute minimum of just 1 GCP located in the center of the block. GNSS observations are weighted with 10 cm std.dev. Discuss the result!

Action & Questions: AT with additional parameters for camera self-calibration

Within this final run we would like to add additional self-calibration parameters (12 Ebner, 44 Grün) into the bundle adjustment process. We will not use GNSS perspective center observations here. Thus, please select start from the previous version, i.e. the configuration which considers a certain number of check points in addition to GCPs only.

- Compare the result of this run to the previous one.
- Discuss need / influence of this additional parameters in adjustment.

Within your report please describe your main processing steps and illustrate with meaningful screen-shots. ***Only one report for each group is requested here****! Submit reports in digital form only by uploading in the ILIAS course. One PDF document for each group. Please use the following naming convention: ADA-Lab2-Grp#-LastName1-LastName2.pdf (# has to be exchanged by group number).*