MOSAiC helicopter image data - Onshore processing workflow

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For further information please refer to Georeferencing-Report-MOSAiC (Fuchs,2021)

Version control:

Date	Author	Changes
21.12.2020	N.Fuchs	first version
21.12.2002	N.Fuchs	Add generate report and additional meta data in excel sheet
21.12.2020	N.Fuchs	Specify use of cpulimit and initial camera removal
15.01.2021	N.Fuchs	Specify reference data delimiter and clarify conversion script file structure handling
26.01.2021	N.Fuchs	Correct raw data link

Preface

This workflow handbook explains the photogrammetric evaluation of AWI helicopter measurements recorded during the one year long MOSAiC drift expedition. From the aerial photographs taken nadir with consumer-grade CANON DSLRs, panoramas of the ice surface, so-called orthomosaics and digital elevation models are calculated.

I assume a basic understanding of command line and text editor usage as well as prior knowledge in the use of Agisoft Metashape. For all questions regarding the use of the AWI computer infrastructure and useful clients, please refer to the data center page in the intranet *www2.awi.de* , for doubts with Metashape, read the manual accessible via the *Agisoft.com* webpage.

This workflow is developed to process MOSAiC aerial image data on the AWI server: *bkli05l009.dmawi.de* . The server can be accessed from outside the institute via *linsrv1.dmawi.de* using X2Go client and from there ssh –X . For other systems it may need to be adapted.

Command line commands are highlighted in gray, settings in Metashape in cyan.

Successful processing should be logged to the Excel sheet *MOSAiC_processing_Metashape.xlsx* (location: */isibhv/projects/SEAICE/nifuchs/MOSAiC/Processing_Workflow/Documentation/*)

Data handling

Long term data HSM storage

Raw data and final projects should be stored on the backup AWI tape storage system HSM. Copy and paste of data is only possible via rsync, ftp etc. Use file service clients like Filezilla or WinSCP to transfer data.

Image raw data is stored in:

/hs/csys/SEAICE/data-raw/PS122/PS122-{Leg}/RGB-Camera_WAL/{flight_number]/{YYYYMMDD_HHMMSS,SSS_COUNT}.CR2

Applanix INS/GNSS data is stored in

/hs/csys/SEAICE/data-raw/PS122/PS122-{Leg}/applanix-ap60av-9873/{flight_number}/ insgpps-mosaic2019-pospac_export_gnssprim_{flight_number].txt

Final projects should be stored in

/hs/csys/SEAICE/data-raw/PS122/PS122-{Leg}/Onshore_processing/{flight_number}/.

Prepare working directory

Data processing is not allowed on the AWI HSM system. Therefore, data needs to be copied to the AWI Isilon cluster to be processed flight by flight. On Ubuntu, use the ftp client filezilla to copy the data:

```
filezilla
```

Log in with your AWI login credentials (Host: hssrv1.awi.de, Port:22)

Set up the following working directory structure in your *local site* window using right click and create directory:

/isibhv/projects/SEAICE/{AWI_username}/{flight_number}/Data/RAW/

/isibhv/projects/SEAICE/{AWI_username}/{flight_number}/Data/JPG/

/isibhv/projects/SEAICE/{AWI_username}/{flight_number}/Project/

/isibhv/projects/SEAICE/{AWI_username}/{flight_number}/Results/

Drag and drop all images and the Applanix file from the *remote site* to */isibhv/projects/SEAICE/Data/RAW* opened in your *local site*.

Data preparation

1. Image data conversion

Image data needs to be converted to JPG for processing. Furthermore, a reference file should be compiled, which contains the recording position and orientation angle of each image.

Two scripts are prepared for preprocessing: convert_images.bash for the conversion, and Prepare_Image_Reference_P3.py for the merging of reference data (P3 notation for Python3 compatibility).

Copy all conversion scripts and meta files into the raw directory:

```
cp /isibhv/projects/SEAICE/nifuchs/MOSAiC/Processing_Workflow/bin/* /isibhv/projects/SEAICE/{AWI_username}/{flight_number}/Data/RAW/.
```

Make sure, that the directory

/isibhv/projects/SEAICE/{AWI_username}/{flight_number}/Data/JPG/

exists, only then run the script:

```
bash convert_images.bash
```

The conversion takes a while. If you want to log out in between, run the script using

```
nohup bash convert_images.bash &
```

File paths are fixed in the conversion script, which means that it only works if the above specified paths are strictly followed at least up to the directory level *{flight_number}.*

Check the image brightness in the JPG directory, if images are too dark or too bright, change the coefficient in convert_images.bash behind the *dcraw* flag *–b* (suggestion: Leg4: 1.0, Leg3&5: 2.0) using a text editor and run the script again.

2. Assimilation of position data

Rename the Applanix file to Applanix.txt with

```
mv insgpps_mosaic2019* Applanix.txt
```

Run:

```
/scratch/users/nifuchs/bin/anaconda3/bin/ipython Prepare_Image_Reference_P3.py
```

to create reference data according to Metashape requirements.

If more than a few percent of images are skipped, something went wrong with the input data. Make sure you use the correct Applanix file of the correct day.

Metashape project – sea ice surface reconstruction

1. Start Metashape project

Open Metashape

/usr/local/metashape-pro/metashape.sh

Change back to terminal, run top, search for Process ID of Metashape.

Run command cpulimit –l 400 –p {Process_ID} –z & , to limit the processing power Metashape is allowed to use to 4 of 8 available cores (4x 100%). Leave the terminal open. The cpulimit will stop automatically, when Metashape is closed, but also when you close the terminal manually.

Back in Metashape, save project to:

/isibhv/projects/SEAICE/{AWI_username}/{flight_number}/Project/{flight_number}.psx

Import folder:

/isibhv/projects/SEAICE/{AWI_username}/{flight_number}/Data/JPG/

Remove images recorded on the helipad.

2. Reference data

Load reference data

/isibhv/projects/SEAICE/{AWI_username}/{flight_number}/Data/RAW/Reference_file.txt

check column labels and set delimiter to 'semicolon' to load the data correctly.

Revise reference data, remove all cameras without reference position.

Check all orientation angle boxes and set reference settings to:

Coordinate system: WGS84 EPSG:4326

Rotation angles: Yaw,pitch,roll

Measurement accuracy: 500m (floe survey), 50m (straight flight), 10°

Marker accuracy: 0.5m, 2pix; scale bar: 0.1m

Capture distance: according to flight altitude (reference altitude minus 40m to compensate for ellipsoidal height).

3. Ice drift correction

Open model view and check the flight pattern given by the blue recording point dots. For floe surveys, make sure that flight pattern looks like a grid, if not, we need to correct for floe drift:

Search two images recorded above the same ice surface from the beginning and the end of the floe survey. Copy recording positions into a distance calculator like https://www.cqsrg.org/tools/GCDistance/ . Calculate ice drift velocity from the time difference between the recordings and the calculated distance. Enter velocity in m/s and the calculated azimuth angle into the Prepare_Image_Reference_P3.py script. Re-run the script and load the reference data again into Metashape, choose corrected values in the x-column for longitude and y-column for latitude.

4. Camera calibration

Open camera calibration window, enable reference and GPS/INS offset adjustment.

Set yaw angle reference offset to 180°. Load initial camera calibration from RAW directory:

Camera_calib_initial_values_14mm_MOSAiC.xml

Do not use fixed parameters. Calibration is only for 14mm lens and a rough initial guess from the June 30 floe survey.

5. **Separate L-site triangle legs into chunks**

For periphery measurement flights with straight flight lines as f.e. L-site triangles, divide flights into flight legs by separating straight lines into different chunks.

6. **Align images**

Run image alignment with highest precision, reference preselection: source and adaptive camera model fitting.

7. **Edit sparse cloud**

Remove outliers

Remove misaligned images (recognizable by non-natural orientation angles

If alignment is not successful and ice drift has not been corrected yet in the reference data, go back to step "ice drift correction"

8. **Set scale bar**

If available, select images containing Polarstern, create markers at the bow and the stern of the ship. Select both markers in the workspace and create scale bar. Set scale bar reference to 118m in the reference dialog and tick the box to use it as control bar (instead of check bar).

9. **Optimize alignment**

Run Optimize cameras with adaptive camera model fitting and fit additional corrections

If scale bar was set, check scale error.

10. **Run batch processing:**

Import and run batch script: batch_depthmaps_DEM_Orthomosaic.xml, save project after each steps

Metashape data output

Output coordinate reference systems

All compiled raster data recorded south of 84°N should be saved in UTM projection. Choose appropriate WGS84 UTM ??N grid according to the recording longitude (for example: WGS84 UTM 31N EPSG: 32631). Data recorded north of 84° is to be saved in WGS84 Arctic Polar Stereographic EPSG:3995.

Save DEM and Orthomosaics as GeoTiff in full resolution and a reduced resolution of 0.5m per pixel. Avoid file size >1GByte. If necessary, split raster into blocks.

1. **DEM output**

DEM nodata value -32767

Enable Write tiled tiff and Generate Tiff overviews

Filename:

Results/{Flight_number}_Metashape_DEM_quality_high_moderate_filtering_resolution_{resolution in m/pix}_m_[floe_grid or flightleg_{number of leg}].tiff

2. Orthomosaic output

Background: white, compression: LZW, quality: 90, enable overview and alpha channel.

Filename:

Results/{Flight_number}_Metashape_Ortho_JPGinput_resolution_{resolution in m/pix}_m_[floe_grid or flightleg_{number of leg}].tiff

3. Screenshots

Save screenshots of the DEM and Orthomosaic using right click -> capture view in the Ortho tab and save both as {flight_number}_DEM_preview.jpg and {flight_number}_Ortho_preview.jpg into the highest level of the project folder, disable transparent background.

4. Generate Report

Generate survey report and save it into the highest level of the project folder:
{flightnumber}/{flightnumber}_Metashape_survey_report_{Date YYYYMMDD}.pdf .
Title of the report "MOSAiC SIP Heli {flightnumber}",
Description:
"
Data processed by: {Your Name} (AWI)
Workflow development and support: Niels Fuchs (AWI)
SIP Heli PI + Measurements: Gerit Birnbaum (AWI)
"
Projection Top XY and enable page numbers.

If the flight was split into different legs, save one report per chunk and add the suffix "_flight_leg_{number of leg}" to the filename and the report title.

Supplement for floe grids of leg 4

Floe grids of leg 4 should additionally be reprojected on the position of the floe on June 30. This allows for studies of temporal evolution without losing data quality through subsequent reprojection in GIS applications. To do so, an additional Metashape project needs to be created out of a duplication of the June 30 project. All other floe grid projects are appended as additional chunks. Three recognizable points are chosen in the June 30 chunk and marked in the orthomosaics/DEMs of all other chunks. DEMs are often more useful to recognise surface structures than orthomosaics. Run chunk alignment with June 30 marked in bold as master chunk and align all others by method marker based without fix scale. Re-run DEM and Orthomosaic creation, store all products in WGS84 UTM31N EPSG:32631 with the suffix "_reprojected_to_June30.tiff" in addition to the previous filenames.

Clean up

Fill Excel sheet with meta information of the processed flight.

Processed: yes, when done
Date finalized: date of completion
Data scientist: your name
DEM resolution: value given in the workspace
File size DEM full resolution: File size of the DEM saved with full resolution. If DEM was split into blocks, give single file size + number of files
Orthomosaic resolution: value given in the workspace
File size Ortho full resolution: File size of the Orthomosaic saved with full resolution. If Ortho was split into blocks, give single file size + number of files
CRS EPSG code: EPSG code of the coordinate reference system used for raster data output
DEM quality: If the DEM is bended strongly on larger scale and/or shows many discontinuities, choose bad quality
Brightness enhancement: Brightness enhancement factor used in convert_images.bash -> flag -b
 # sub legs: Amount of flight legs into which the triangle flight was subdivided
Ice drift corrected: True if ice drift correction was applied in reference data
Estimated drift speed: Estimated value for drift correction or if not determined, position error of first image + position error of last image divided by the flight time.
Ice drift direction: Value used in drift correction, else leave it blank
Scale bar error: Error given in reference dialog for Polarstern scale bar divided by the length of Polarstern multiplied with 100 to get percent
Reprojected: True, if floe grid was already reprojected (only leg 4 data)
Notes: Free to pour out your heart about interesting features, data quality, data quantity, Corona etc. ;)

Move complete flight directory back on the HSM storage using filezilla and remove project on Isilon.

Thanks a lot