EuroSDR initiative on camera certification
September 2008

EuroDAC² Core Team Meeting at IGN Saint Mandé

Wednesday – Thursday, September 24 – 25, 2008

Meeting Notes (Status, Sep 26, 2008)

Attendees

- R. Alamus (ICC Barcelona, Spain)
- L.-E. Blankenberg (Blom Geomatics, Norway)
- M. Pierrot Desseilligny (IGN France)
- N. Paparoditis (IGN France, only Wednesday morning)
- S. Bovet (Swisstopo, Switzerland)
- M. Cramer (Universität Stuttgart, Germany)
- G. Grenzdörffer (Universität Rostock, Germany)
- E. Honkavaara (FGI Finland, Masaala)

Status of calibration protocols and processes

- Calibration protocols of all relevant manufacturers have been collected and are available to the EuroDAC² team:
  - Applanix DSS301 (16MP) and Applanix DSS322 (22 MP)
  - Vexcel Imaging Ultracam-X
  - Intergraph DMC
  - Leica Geosystems ADS40 (SH40) and ADS40 (SH52)
  - Rolleimetric AIC-x1[1]
  - IGI mbH DigiCAM H/39[2]
  - Jena-Optronik JAS-150[3]

[1] Typically the Rolleimetric systems are sold with two lenses and the camera is also calibrated with both lenses. In case one lens has to be ex-changed the stability and validity of calibration is guaranteed through a special fixing based on two screws. In principle the calibration can be validated at any time by in-situ techniques (personal correspondence Rolleimetric 2008).

[2] Calibration protocol only delivered on customer's request, calibration performed in cooperation with TU Dresden. IGI typically recommends the camera calibration from test site data, i.e. small blocks flown as part of the project. Recommendations for calibration block geometry and parameter sets are available.

[3] Layout of standard calibration protocol not yet fully defined, as mentioned from Jena-Optronik the protocol of JAS-150 may be compiled individually to the user's need (personal correspondence JenaOptronik 2008).

- Current protocols almost exclusively focus on geometry only. If additional information on radiometry (i.e. layout of filters for DMC for example) only nominal values are displayed.
- Information on MTF is not included, MTF also has impact on the geometrical accuracy, especially when looking on the detection of fine image details (i.e. for measurement purposes)
- In principle more information would be available (i.e. from chip manufacturers) but not documented in calibration report
- Absolute calibration typically not available (i.e. DMC only does relative calibration, to perform "nice looking" imagery)
- Absolute calibration might also be of help for photogrammetric purposes, besides remote sensing. Without absolute calibration the colour balancing is not objective but operator dependent (also affected by computer screen and graphic cards). This will become repeatable process with absolute calibration values. Also needed for the dodging process.

Layout of test sites and design of quality check process

Radiometry

- The check of radiometric quality and the radiometric calibration from test sites is currently not so deeply discussed in photogrammetric community. More competence should be expected in the classical remote sensing group, so far mostly dealing with satellite imagery. Processes there may also be of help for the airborne photogrammetry case and validation/certification.
- In principle radiometric (absolute) calibration is possible from test fields, but atmosphere has to be modelled or atmosphere behaviour has to be derived from other systems like irradiance measurement from hyperspectral scanners. Still the calibration might be influenced by the actual environmental conditions of the test flight. Even though calibration from targets in a test site at least will give an estimation on the homogeneity or stability during the flight.
- What is the best/optimal/most practical set up for test targets? What reference measurements are necessary? What is the best/most practical radiometric calibration procedure?
- In principle reference targets may be prepared as permanent or temporary/moveable targets. FGI prefers to use permanent targets based on different types of gravel. Gravel has to be proven to have fairly homogeneous spectral behaviour, and only needs relatively limited amount of maintenance. Alternatively targets (like Siemens star or alternative edge response targets) may also be painted on the ground. Still they need some maintenance, i.e. annual repainting. Use of natural surface for radiometric targets may be problematic at least to certain extent, because of the variable behaviour, like this was shown for asphalt surfaces already. Still from operational point of view such targets should be made available not only in test field, also close to the system flyers base stations as well.
- System checking has to be separated in (1) deep investigation on how the system is working and (2) an operational system checking.
- One question may be how many users currently are really interested in such radiometric calibration tasks? Obviously this currently is not such big market segment

and not pushed as much, although situation will quickly change when people become aware of the potential of new sensor systems. And close to that the new features (i.e. MTF, given for the whole image) will also be treated in the according software packages used for the processing of data.

Geometry

- Geometrical performance typically is estimated from signalized GCP/ChP. In order to serve as reference accuracy of points has to be superior to the sensor accuracy potential to be estimated. Typically point accuracy is within 1-2cm STD, which might become critical when looking for very high GSD requirements with the 5cm range and higher. Still question remains, if with GSD automatically the accuracy requirements increase or if users will only have more detailed visibility but with lower accuracy corresponding for example to GSD 10cm flights.
- The optimal size, shape and distribution not fully discussed. In order to go for automatic point measurements the target size should be fairly large. From close range Photogrammetry target sizes with diameters of 10-20pix are recommended. This does not seem to be realized for airborne test sites, at least for large GSD values. From practical point of view, target larger than 1m seem to be impracticable, most often the target size has to remain within the 20-60cm range.
- Automatic measurement of signalized points still has the advantages of (1) less labour intensive, (2) higher accuracy and (3) higher objectivity and repeatability
- What is the optimal layout for the test blocks (i.e. flight configuration)? What are the optimal/minimal test site extensions? What GSD should be covered with the test field validations, typically (range between 3-50cm GSD is proposed)? Should test features also be appropriate for the high resolution satellites? Nevertheless the analysis of geometrical performance is quite familiar within photogrammetric community, thus there are quite a lot of investigation around which may serve a base for the EuroDAC² process.
- Quite interesting to note, that system manufacturers themselves already recommending some test field set-up or block layout which has to be realized to perform re-calibration of system or at least validation from true flight data.

Practical issues on the later EuroDAC² certification process itself

- It is a common agreement within EuroDAC² team, that the certification body most likely will not be able to have man power, competence and maybe also software access to carefully realize the full process chain for each digital sensor, because of the fairly different sensor layouts. In order to set-up a practical process, the certification has to define certain outputs which have to be delivered from system/data provider and which then are analysed for certification. In order to have full traceability on how results have been obtained, the data generation process has to be documented, i.e. the submission of data has to be supported by an additional report following certain guidelines already pre-defined by certification. All input data (and potentially also the according software packages on request) had to be delivered in order to be able to re-compute the data processing at any time.

- Certification process has to be software independent. It would be nice to have as much automation as possible in the process in order to obtain highest objectiveness/repeatability.
- Certification process has to define certain benchmarks which than can be used by system users to decide whether the system is able to fulfil the specific user requirements. It is obvious that some different accuracy classes may have to be introduced to consider the maybe different sensor concepts. A just general certification "system is able to deliver mapping accuracy" seems not to be sufficient. Those benchmarks may follow already existing standards (i.e. ISO standards defining image sharpeness)
- It might be possible that final certification is done at just one single organization for whole Europe. Alternatively several organizations, one for each member country also might be possible. If the second situation is the case, the use of the same process for data certification has to be guaranteed. If the first option is chosen the data which might be acquired from different calibration sites. Those sites should offer similar layouts.
- Still the question remains, who will become the final institution who is giving the certification to a particular camera system? It has to be an independent organization, which has to be accepted within the community. Some of the national mapping organizations might come into conflicts, because they are representing the user side and in some cases also the data provider side if they do their own flight missions. Nevertheless, if a clear and transparent certification process is defined and accepted the above should not be such large problem. In general as soon the desired certification process becomes available the question for the certification organization should be able to solve more easily.
- Financial aspects not currently solved. When certification is already implemented this service has to be charged to the system owners/providers. The cost also should include a certain part which has to be spent for regularly test site maintenance. It is not yet clear whether there are financial resources which may be used to support the process of certification definition and the initial installation of such test sites. In principle there should be financial resources for example from EU or ESA. It has to be check if such funding also may be used to cover such services, or only focusing on pure research projects. There seem to be EU programs covering establishing of new infrastructures – such test sites may also be seen as necessary infrastructure for the airborne imaging community.

Development of national/international standards

- German standard DIN 18740-4 available in first English translated version. So far no other countries in Europe (at least to the knowledge of EuroDAC² group) have a comparable standard. DIN currently tries to establish the German standard on European level.
- German standard has some deficiencies, especially when looking at the camera validation from test flight analyses. Here EuroDAC² input is requested.
- Another option would be to support the DIN/EuroDAC² developments in ISO/TC211. From input W. Kresse a project in calibration/validation was recently discussed and raised in priority. It typically is most efficient to compile a new ISO standard from

already existing solution. In case the available DIN/EuroDAC² solution is not mature to become a standard directly, this first may become a technical specification from which then a standard is developed (after 3-6 years of further investigations/development).

- In some countries no standards are available but guidelines from national mapping are used as de facto standards. This for example was the case for the USGS calibration protocols: USGS never had authority to impose camera calibration requirements on other government agencies. Similar situation is in Finland where people rely on the FGI recommendations.
- German standard may be a starting point for new Finnish recommendations.

Next steps

- **EuroDAC² will compile recommendations/guidelines on optimal test procedures for radiometric and geometric system testing and test field layout** (i.e. target layout, corresponding processes, quality measures). Two groups have been formed each working on one of the following working packages (WP):
  - **WP Radiometry**
    - Eija Honkavaara
    - Marc Pierrot Desseilligny
    - Ralf Reulke
  - **WP Geometry**
    - Stephane Bovet
    - Leif Erik Blankenberg
    - Görres Grenzdörffer
- WP Radiometry will also establish contacts to remote sensing satellite people from IGN Espace, the ICC group in Barcelone, and the EuroSDR project dealing with Radiometric properties of digital photogrammtric cameras. It is obvious that outcomes from the radiometry project are closely linked to the progress in the development of radiometry guidelines.
- WP Geometry will also contact literature and other test field suppliers, like University of Pavia, to share their experience when deciding on layout of test field, size/distribution of points, accuracy analyses, …

- **Draft for guidelines/recommendations from both WPs is due to March 2009** and will be presented during the EuroSDR spring meeting. Progress is verfied through following status reports / milestones
  - Status update I: first half of November 2008
  - Status update II: mid of January 2009
  - Draft for guidelines: March 2009

- EuroDAC² also will **intensify contacts to the DIN/ISO standard groups**. If possible findings of the EuroDAC² investigations should directly be used for the compilation of new national/international standards. This will be in the scope of Michael Cramer.

- EuroDAC² will ask system manufacturers for their (maybe currently not yet officially defined) guidelines for the design of calibration blocks / test field:
  - Stephane Bovet: Leica for ADS fligths
  - Ramon Alamus: Intergraph for DMC flights
  - Leif Erik Blankenberg: Vexcel for UC-X flights, Applanix for DSS flights
  - Michael Cramer: IGI for DigiCAM, Rolleimetric for AIC flights

- Next meeting of EuroDAC² group:
  - April 1 – 2, 2009 at ICC Barcelona

  Meeting will be used to prepare the EuroSDR spring meeting and also to report on the most recent findings of the DGPF evaluation activities. Since meeting will take place at ICC the ICC members of the radiometry project group also will be able to participate and exchange experiences.

mc, September 26, 2008