EuroSDR project: Radiometric Aspects of Digital Photogrammetric Images

Phase 2: Empirical study

15.6.2009

EuroSDR launched a project on radiometric aspects of digital photogrammetric airborne images in May 2008. Details of the EuroSDR project as well as the project progress are given in the project Internet-pages that are available through http://www.fgi.fi/EuroSDR/ .

The first phase of the project was a review to the state-of-the-art and theoretical issues. It was performed in autumn 2008 and the results have been processed in spring 2009. The short version of the results can be found on the project Internet pages http://www.fgi.fi/EuroSDR/ . A manuscript is under preparation to publish the detailed results of the query.

In the second phase, empirical investigations on radiometric processing of the large-format photogrammetric imaging systems will be carried out. In 2008, radiometrically controlled test flights were conducted in Catalonia and Finland. Three data sets are available: one from Catalonia and two from Finland; they are described in Appendix 1. The principle in the data delivery is that, for each data set, the organization that has generated the data will discuss individually with the participant the appropriate data delivery. Contact information can be found in Appendix 1.

The procedure and schedule is the following:

1. Participant: Selects materials that are of interest for his organization. He sends a data request for the contact person(s) (pilot center) of the selected data set(s). This request should include the description of the research group and research objectives. June-July 2009
2. Pilot centers: Contact the participant, communicate the appropriate procedure for data delivery and submit the requested data to the participant. July-August 2009
3. Participant: Process the data with his approach and delivers the results (processed imagery, evaluation results, description of the process etc) to the pilot centers. August-November 2009
4. Pilot centers: Evaluate results of individual participants, combines the results of single data set, and combines the results of all data sets

General objectives of the empirical study are the following:

- Radiometric characterization of the cameras.
- Resolution studies by means of Siemens star and edge targets.
- Evaluation of influence of exposure and aperture settings.
- Evaluation of the BRF measurement potential.
- Camera absolute and relative radiometric calibration.
- Atmospheric correction of the camera images.
- Colour enhancement and calibration.
- Evaluation of performance and influence of various radiometric processing methods.
- Application of reflectance images to remote sensing studies.

All contributions are valuable. The processing can include the entire image processing chain of the participant, some specific operations (e.g. pansharpening), image quality evaluations, etc. The image processing lines can be the normal operational processing lines or empirical processing lines. The current operational processing lines present the state-of-the-art, while the research processing is related to future developments. It is important that as many organization as possible process the data to make the evaluations representative.

The materials, suggestions of possible evaluations, and the publication plan are described in Appendixes 1-3.

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Appendix 1: Comprehensive radiometric test flights in summer 2008

Material 1. Integrated DMC and CASI test flight in Catalonia

ICC executed extensive radiometric test flights with DMC and Compact Airborne Spectrographic Imager (CASI) in Banyoles in 15 July, 2008. The imagery was collected from 820, 1125, 2250 and 4500 m flying heights. Various manmade reflectance targets as well as several artificial and natural stable covers with spatial homogeneity and spectral reflectance range were available around the test field, including a lake (Figure 1). In addition, a Siemens star was installed in the test field. Two groups carried out the radiance and reflectance ground-truth data acquisition with spectroradiometers. Atmospheric state was directly measured by several groups, instruments and techniques. An atmospheric Lidar provided aerosol profiles and an automatic sun tracking photometer provided column integrated values of Aerosol Optical Thickness (AOT) for the optical spectrum. Meteorological data is available. Central objectives of these rigorous test flights are:

1. Radiometric calibration of DMC by the radiance and the reflectance methods. Validation with radiometric targets. Radiance method will be performed with the simultaneous acquisition of CASI.
2. Spectral characterization of CASI regarding bandwidth and smiling effect. Comparison with laboratory results.
3. Atmospheric correction of CASI imagery with aerosol distribution and load, and water vapour derivation by an inversion method. Validation with radiometric targets and atmospheric measurements.
4. Atmospheric correction of DMC images by using CASI derived atmosphere parameters. Validation with radiometric targets.
5. Colorimetric calibration of DMC sensor towards CIE standard colour space. Validation with radiometric targets.
6. Resolution studies by means of Siemens star and edge targets. Study of the relationship between atmosphere state and resolution. Comparison with computer radiative transfer simulations.
7. Application of DMC radiance and reflectance images to remote sensing studies such us land use and classification, change detection, water quality, forest and vegetation analysis, etc.

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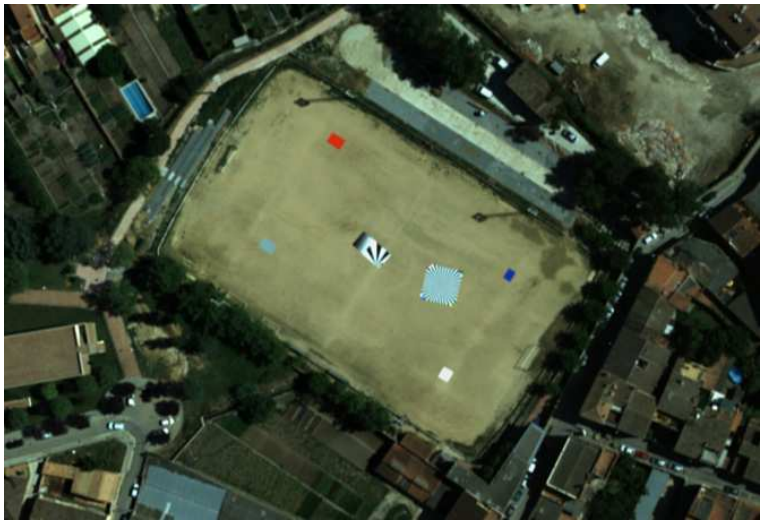

Figure 1. DMC image from Banyoles campaign of the ICC. Photo by ICC.

Material 2. DMC test flights with BRF targets in Sjökulla

The National Land Survey of Finland carried out acceptance testing of their new DMC in 1st September and 25th September 2008 at the Sjökulla test field of the FGI. The reflectance reference targets included the permanent BRF targets of gravel at the test field, several transportable BRF targets and several natural targets (Figure 2). Targets were monitored using an ASD field spectrometer during the flights. A Siemens star, edge target and line bar targets were available for the spatial resolution evaluations. Atmospheric observations were not collected at the test site. General objectives of this campaign were:

1. Absolute radiometric calibration of the DMC by the reflectance method.
2. Spatial resolution studies of the DMC using Siemens star, edge targets and resolution bar targets.
3. Evaluation of the influences of various exposure and aperture settings on the radiometric performance of the DMC.
4. Evaluation of the influences of various exposure and aperture settings on the spatial resolution of the DMC.
5. Evaluation of the BRF measurement potential of the DMC.
6. Geometric characterization of the DMC.

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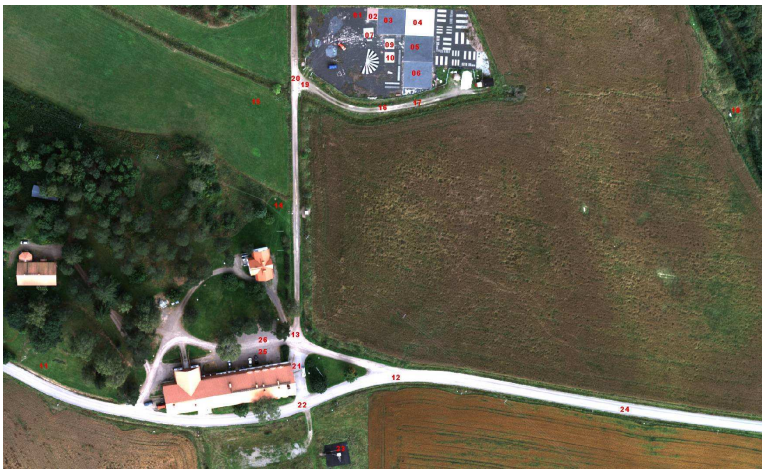

Figure 2. DMC image from the Sjökulla test field in 1.9.2008. Photo by NLS.

Material 3. ADS40 test flight with atmospheric observations in Hyytiälä in Finland

The test flight with ADS40 (SH 52) was carried out at the Hyytiälä forestry test field in co-operation with Leica Geosystems, Ilkka Korpela, University of Joensuu, Estonian Land Board and FGI. The test site is 3300 m x 8500 m in size and it contains more than 200 forest plots and over 15000 trees that have been measured for position and basic variables, in different forest conditions (density, age, species mixture, silvicultural history). A state-of-the-art weather station (atmospheric research) runs at the area of interest (SMEAR II). FGI's BRF calibrated reflectance targets and Siemens star were installed at the test field (Figure 3). The reflectance/radiance of the targets as well as various homogeneous land covers (asphalt, gravel, grass) were monitored by FGI and Leica Geosystems using field spectroradiometers during the flights. ADS40 data was collected with the uncompressed mode from 1000, 2000, 3000 and 4000 m flying altitudes providing 10 cm, 20 cm, 30 cm and 40 cm GSD.

General objectives of these flights included:

1. Absolute radiometric calibration of the ADS40 by the reflectance method and comparisons to laboratory calibration.
2. Evaluation of the performance of the semiempirical XPRO software of Leica Geosystems for the radiometric correction of the ADS40 imagery using the reflectance reference targets.
3. Correcting the imagery utilizing correction method based on radiative transfer modelling. Evaluating the performance with the reflectance reference targets.
4. Evaluation of the BRF measurement potential of the ADS40.
5. Spatial resolution studies of the ADS40 using Siemens star.
6. Geometric characterization of the ADS40.
7. Comparisons of the physical and semiempirical radiometric correction methods on the forestry applications.

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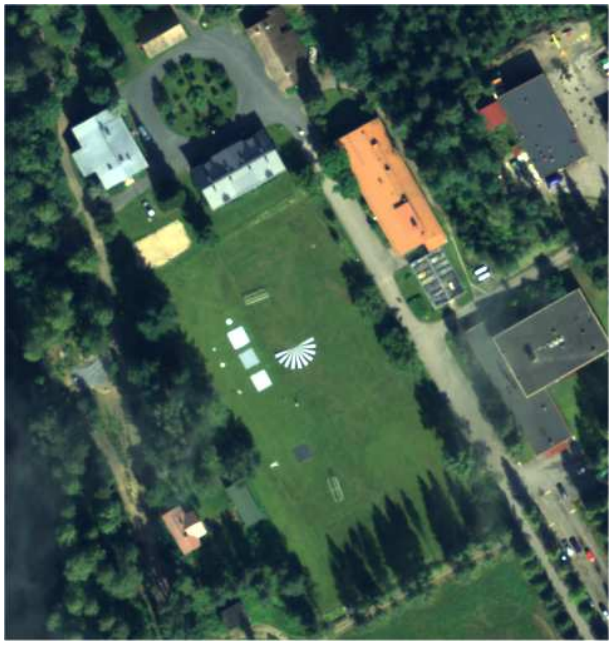

Figure 3. ADS40 image from the Hyytiälä test site 23.8.2008. Estonian Land Board, FGI, Ilkka Korpela, Leica GeosystemsUniversity of Joensuu. Photo by Estonian Land Board.

Appendix 2. Summary of the materials and suggestions about possible evaluations

Task	Banyoles DMC	Banyoles CASI	Sjökulla	Hyytiälä
Post-processing				
System correction (e.g. by manufacturers software)	×		×	×
Output product generation (participant)				
AT	×		×	×
DEM calculation	×		×	×
Orthorectification	×		×	×
Radiometric correction based on in-situ atmospheric observations	×			×
Radiometric correction: other methods	×		×	×
Pansharpening	×		×	×
Tonal enhancement	×		×	×
Color correction	×		×	×
Other operations	×		×	×
Atmospheric parameter estimation				
Sunphotometer	×			×
Atmospheric lidar	×			
CASI	×			
Calibration (participant)				
Absolute radiometric calibration, reflectance method	×		×	×
Absolute radiometric calibration, radiance method	×			
Colorimetric calibration	×			
Image quality evaluation (participant)				
Radiometry	×		×	×
Spatial resolution	×		×	×
Spectral characterization (bandwidth, smile)		×		
Evaluations by pilot centres				
Colorimetric accuracy	×			
Reflectance accuracy	×		×	×
BRF accuracy			×	×
Spatial resolution	×		×	×
Classification accuracy	×			×

Appendix 3. Publication plan

It is essential that the results of this investigation are presented widely to various interest groups of photogrammetric data collection. All the instances who have participated in the processing of a certain data set will be included as co-authors to the presentations and publications concerning the data set.

1. Presentations
    a. Pilot centers: In January/February 2010 present the preliminary results at the EuroCOW organized by the Institut Geomatic Catalonia. Appropriate presentations at ISPRS Symposiums in 2010.
    b. Participants: Presentations about the results and their methods in EuroCOW 2010 and other conferences.
2. Publications of combined results
    c. At least one scientific article of each processed dataset in co-operation with the participants
    d. At least one scientific article about the combined results in co-operation with the participants
    e. An EuroSDR report summarizing the results of the project
    f. Summary conference papers