EuroSDR project Radiometric Aspects of Digital Photogrammetric Images

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EuroSDR project porposal

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Summary

This paper describes a EuroSDR project proposal entitled “Radiometric aspects of digital photogrammetric images”. The project is realized in two phases. First, a review is made on the theory of image radiometry, radiometric processing methods and applications. Secondly, an empirical investigation is conducted to study the radiometric properties and correction of digital photogrammetric images and the potential of using the images in interpretation. The first phase is completed by the first quarter of 2009 and the second phase is completed by the end of 2010.

Background

Digital imaging is rapidly replacing the film imaging in the phtogrammetric data capture. The special advantage of the digital imaging in comparison to the film imaging is the excellent radiometric properties, including multispectral imagery, linear response, large dynamic range, great radiometric resolution and low noise level. These properties enable the use of the images in the classical photogrammetric tasks and improve the automation level and quality of these processes, and open new application areas (e.g. change detection, classification).

Many factors influence the digital numbers (DN) recorded by a sensor, including the scattering and absorption processes in the atmosphere, the spectral reflectance properties of the objects, and the system itself. The influences of the atmosphere and object are further dependent on the illumination and observation geometry. The important parameters of the imaging system influencing the DN are the spectral filters, PSF, CCD, gain and offset parameters, the dynamic range of the A/D conversion, and various radiometric processing; also the conditions (temperature, aperture, exposure time etc.) influence. The practical consequence of the above factors is that the same object provides different DN in different parts of a single image and in different images. It is necessary to perform radiometric corrections in order utilize the image radiometry.

New methods are needed in photogrammetric production lines to process the radiometry in a controlled way. Central features of the photogrammetric data capture are: a huge amount of data is collected yearly, in photogrammetric missions often hundreds of images are collected, airborne image data sets (mainly orthophotos) are collected over entire countries every few years as a repeat cycle, the images are typically arranged in image blocks with 20-80% side and forward overlaps, there is a great variability of systems available in the photogrammetric markets, and the field of view of photogrammetric sensors is large. Photogrammetric images can be utilized in different applications, including visual

applications, classical remote sensing applications that utilize normalized image data, and future remote sensing applications that utilize the anisotropic reflectance properties of the objects (bidirectional reflectance distribution function, BRDF); various applications require different processing. The above features make the radiometric correction task challenging. Efficient processing methods are needed to process huge data volumes. An interesting option is to utilize the overlapping imagery in determining the radiometric correction, i.e. to perform a sort of radiometric block adjustment; this is a new research area. When image radiometry is accurately processed, great advantages can be expected in many application areas, such as photogrammetric image product generation, interpretation, GIS updating and environmental monitoring.

Objectives

- Improve knowledge on radiometric aspects of digital photogrammetric cameras
- Review existing methods and procedures for radiometric image processing
- Compare and share operative solutions through a comparison of these techniques on a same test data set
- Analyse the benefit of radiometric calibration and correction in different applications (classification, quantitative remote sensing, change detection etc.)

Project Stages

Phase 1 – Review

Focus on the methodology itself. Report will be compiled based on literature research and query to sensor manufacturers, image providers, and image users. The following topics are focused:

- Definitions
- Radiometric calibration
- Radiometric correction of images
- Radiometric quality indicators
- Central problems related to the image radiometry
- Exemplarily radiometric processing chains
- Utilization of image radiometry in different applications

Phase 2 – Empirical study

Based on the results from phase 1, the empirical phase 2 investigations will focus on the processing of real data by test participants. The acquisition of empirical data sets will become necessary, i.e. strong image blocks preferable flown in different flying altitudes and covering several acquisition days to improve robustness of results. Additional equipment like spatial resolution and reflectance reference targets are needed. To enable absolute radiometric calibration, either airborne hyperspectral data by e.g. CASI or AISA (radiance based method) or field radiance and atmospheric data (reflectance based method) should be collected simultaneously during flights.

The later empirical studies by test participants can focus on many issues. All the tests are not performed with all the data sets and all the participants. Rather large number of participants making some processing, i.e.

- Sensor radiometric calibration
- Image radiometric correction: restoration, pan-sharpening, tonal transformations, enhancement
- Radiometric processing chains: default processes of sensor post-processing software and methods of the test participants
- Applications (e.g. automatic classification)

Final analysis by FGI and ICC will then work on the radiometric image quality and the adaptability of processed data to various applications (visual, classification).

Timetable

The planned schedules of the phases 1 and 2 are the following

Phase 1 – Review

- Questionnaires to sensor manufacturers, data providers and data users: 6/2008
- Answers: 9/2008
- Final report: 3/2009

Phase 2 – Empirical investigation

- Data set creation/acquisition: 6-12/2008
- Decision about the research objectives of the Phase 2: 1/2009
- Data delivery: 2/2009
- Results back: 9/2009
- Preliminary analysis: 12/2009
- Workshop 1/2010 (e.g. EuroCOW)
- Final report: 12/2010

Proposed project conduct

NMAs, camera manufacturers, software developers, mapping companies and research organisations are all welcomed to participate the phases 1 and 2. The FGI and the ICC will analyse the obtained results and compile the reports on the activities.

Project leadership

The project will be headed by Eija Honkavaara and Lauri Markelin, Finnish Geodetic Institute (FGI) and Roman Arbiol, Institut Cartogràfic de Catalunya (ICC).

All activities in the project are also aligned with the EuroSDR project "Medium Format Digital Cameras" under leadership of Görres Grenzdörffer, University of Rostock and the EuroDAC initiative on digital camera certification, headed by Michael Cramer.

Budget and Financing

FGI and ICC will do the coordination and analysis with their own funding. 6000 euros are asked from EuroSDR to cover the following travel costs.

- Phase 1: Travel support for one of the project leaders to participate in 113rd and 114th meetings to present results of Phase 1.
- Phase 2: Travel support for one of the project leaders to participate in 115th, 116th and 117th meetings to present results of Phase 2. Travel support for project leaders to camera manufacturers and/or test facilities.

Deliverables

The deliverables of the projects are presentations and project reports at EuroSDR Science and Steering Committee Meetings and corresponding presentations at IPSRS meetings. At least three joint refereed papers and three conference papers will be written about the results.