ICC
Institut Cartogràfic
de Catalunya

Generalitat de Catalunya
Departament de Política
Territorial i Obres Públiques

Newsletter 33

Orthophoto and orthophotomap of Catalonia 1:5 000, v.5.0

Since 1986, when the ICC published the first orthophotomaps in black and white, there have been various methodological changes both in how the aerial images are obtained and in how they are processed. As a result of these changes, the specifications of the orthophoto (image product) and orthophotomap (image product with toponymy and map formation) at 1:5 000 scale have evolved and a total of five different versions have appeared.

The most recent of these versions, version 5.0 (v.5.0), is the first to have been produced using photographs taken with a large format digital aerial camera.

▲ AVE train station in Lleida.

THE ORTHO PRODUCT IS OBTAINED WITH TOTALLY DIGITAL PROCESSES

The flight for v.5.0 was made at an altitude of 4 500 meters in order to obtain a pixel size of 45 cm on the ground. During the years 2005, 2006 and 2007 information about the entire territory of Catalonia has been captured. From 2009, the whole of Catalonia will be covered every year. In addition to the orthophoto in traditional color (RGB channels), an orthophoto in infrared color has also been generated from the green, red and near infrared channels of the digital camera.

One substantial difference with respect to the previous version (v.4), besides the use of digital cameras, is that a better radiometric (chromatic) continuity is achieved, which is necessary for the entire territory. It is also worth underlining the improvement in the geometric rectification process, which converts the aerial images into metric documents while maintaining the scale. For this version, use has been made of a digital elevations model (DEM) of triangles drawn from the vector information of the *Mapa topogràfic de Catalunya 1:5 000* v.2.0. This model has been complemented with information which has been specially plotted on some relevant territorial infrastructures, such as bridges and motorways. The DEM has also been used in the photograph mosaic process, so as to avoid, insofar as is possible, stretched image regions that correspond to very steep sloped areas of the territory observed obliquely by some photographs.

Furthermore, as a result of a generalization process of v.5.0 of the orthophoto of Catalonia 1:5 000 by merging groups of 5 x 5 pixels and grouping together the corresponding sheets, v.6.0 of the orthophoto of Catalonia 1:25 000 has been produced.

All these orthophotos (both version 5.0 at 1:5 000 scale and version 6.0 at 1:25 000 scale) are distributed free of charge as image products through the ICC website, either complemented with metadata on the standard section units or through the geoservices. The orthophotomaps are also available completed with toponymy and a cover sheet at the customer service centers.■

Contribution of the ICC at the XXI ISPRS Congress

On 3-11 July 2008 the XXI Congress of the International Society for Photogrammetry and Remote Sensing was held in Beijing (China). Below are summaries of the two papers presented by the ICC.

Analyzing DMC performance in a production environment

J. Talaya, W. Kornus, R. Alamús, E. Soler, M. Pla, A. Ruiz. Geodesy Unit. ICC

XXI ISPRS Congress

Since December 2004, the ICC has taken more than 135 000 digital aerial images with two Digital Mapping Cameras (DMC). After three years of experience and with the new, fully digital production lines well established, this paper analyzes the performance of the digital camera in a true production environment, with particular comparison to the older production lines based on digitized analog images.

135 000 IMAGES HAVE BEEN CAPTURED BY TWO DMC INSTALLED IN THE ICC'S AIRPLANES

The accuracy is assessed at every single stage of the mapping production line: aerial triangulation, DEM (digital elevation model) generation, stereoplotting and orthophoto quality (image resolution). DMC images of 45 cm and 7.5 cm pixel size from several production projects are analyzed and the results are compared to the respective results of analog workflows (with the same pixel size when scanned at 15 mm). For the aerial triangulation and stereoplotting, the accuracy is assessed with independent check points and with LIDAR data for the DEM evaluation. The analysis of the photointerpretation is based on the observations of experienced and well trained operators.

The conclusions are: DMC digital images show a considerable improvement in terms of image correlation, reaching a matching accuracy of 1/10th of a pixel. In aerial triangulation, check points showed that an accuracy of 1/2 pixel in the horizontal components and 2/3 of a pixel in the vertical component can be routinely achieved in production flights. In this study, however, the high accuracy in the correlation of digital images is not reflected in the horizontal accuracy, because the check points are measured manually without any automatic or semi-automatic support. In spite of the worse b/h factor, a small improvement in the vertical accuracy has been observed. This is due to the fact that most of the check points are measured on images from different strips (flown at 25% side lap), where the (larger) "side lap b/h ratio" compensates for the worse b/h in flight direction.

Automatically derived DEMs from digital and analog images result in more or less comparable accuracies, with slight advantages for the digital camera. Digital images also allow smaller grid spacing down to the size of 5 pixels. The comparison with LIDAR data yields a vertical accuracy of up to 1/2 pixel in flat areas without vegetation and buildings. In urban areas the accuracy is considerably inferior (approximately 2 pixels), because the DEM grid points do not correctly represent the height discontinuities at the edges of buildings or other man-made objects.

As far as stereoplotting is concerned, the conclusion is that the use of digital images means that more information can be digitized, the flight period can be extended and the stereoplotting process becomes easier. Although there is a slight loss of relief and there is a small decrease in height accuracy, this is not significant enough to affect the final products. Finally, more automatic tools are needed to optimize image display and management. Stereoplotting check points showed that an accuracy of 1.1 pixels in the horizontal components and about 1.5 pixels in the vertical component can also be routinely achieved in production projects.

With respect to the resolution of DMC digital images on paper, absolute resolution measurements have been generated from a Siemens star target of known dimensions. The FWHM (Full Width at Half Maximum) measurement, which is extracted from the LSF (Line Spread Function), provides a specific quantification of the resolution of the system, consistent with techniques of resolution evaluation, using USAF targets. This very same methodology can also be applied to analog images. The results then obtained showed the greater resolution power of the DMC compared to the film cameras.■

Aerial triangulation

Small scale flights: Analog vs. digital check point accuracies (45 cm GSD)

	RMS X (m)	RMS Y (m)	RMS H (m)	N. Checks
Analog cameras	0.22	0.20	0.28	90
Digital (DMC)	0.21	0.19	0.26	280

Large scale flights: Analog vs. digital check point accuracies (7.5 cm GSD)

	RMS X (m)	RMS Y (m)	RMS H (m)	N. Checks
Analog cameras	0.032	0.050	0.059	19
Digital (DMC)	0.035	0.041	0.058	117

Stereoplotting accuracy

BT-5M: Accuracy at 90% points (from 45 cm GSD)

	90% X (m)	90% Y (m)	90% height (m)
Analog cameras	0.80	0.83	1.17
Digital (DMC)	0.85	0.81	1.36
BT-5M specification	1.00	1.00	1.50

1:1 000 Urban map: Accuracy at 90% points (from 7.5 cm GSD)

	90% X (m)	90% Y (m)	90% height (m)
Analog cameras	0.173	0.160	0.102
Digital (DMC)	0.143	0.150	0.169
1:1 000 map specification	0.20	0.20	0.25

DMC virtual image characterization: Experiences at the ICC

R. Alamús, W. Kornus, J. Talaya. Geodesy Unit. ICC

XXI ISPRS Congress

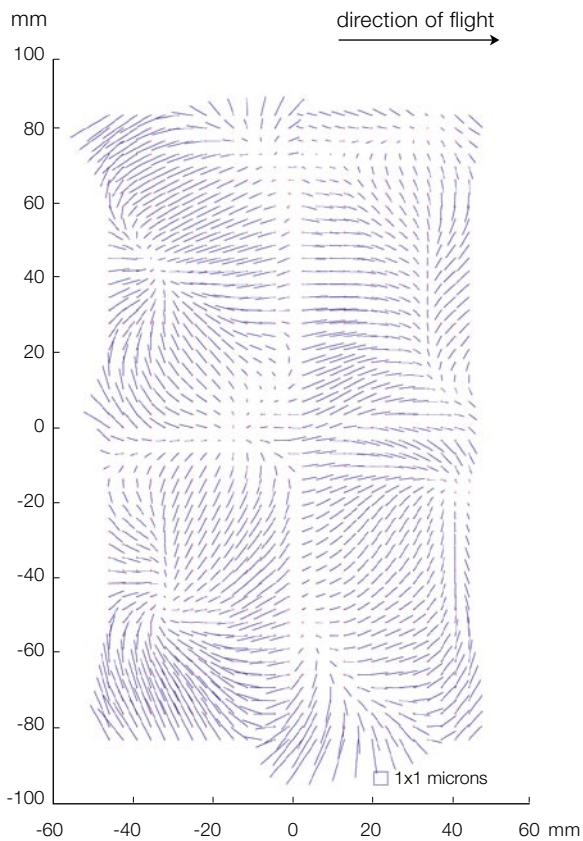
It has been proved that DMC images (like images of other digital aerial cameras) are not free of systematic errors in their virtual image space. If these errors are not properly modeled, the estimated exterior orientation can absorb propagated errors in the bundle block adjustment (from different error sources, such as image systematic errors, poor GPS/INS observations or an insufficient number of ground control points established) and may generate large and unwanted systematic errors in the object space, especially in height. To keep error propagation under control, two different approaches to bundle adjustment are considered:

i) an appropriate set of self-calibration parameters, and
ii) a calibration/characterization grid, compensating for image systematic errors in each virtual image. The calibration grid is derived from a calibration flight and should be valid for images acquired in other projects.

The paper has a twin focus: firstly, it makes a comparison between the performance of both approaches in aerial triangulation, and secondly, it evaluates the impact of these systematic errors on stereoplotting. The first analysis uses seven different data sets (including the calibration flight) and three bundle adjustment set ups:

i) not using any model at all,
ii) using a self-calibration parameter set, and
iii) using the calibration gird without using any self-calibration parameter set. Independent check points are used to assess the performance of both techniques in bundle adjustment. In the second analysis, object coordinates for points of single models are calculated, compensating and also not compensating for systematic errors in their image coordinates. Subsequently, these two sets of points are compared to the respective estimated object coordinates of the bundle adjustment.

In conclusion, this paper evaluates the performance of calibration grids (derived from a calibration flight and applied systematically to all data sets) in aerial triangulation and compares it to self-calibration in terms of the capacity of the grids to handle error propagation caused by non-modeled systematic errors in the virtual image space. Although systematic errors in image space from two different calib-ration data sets show the same trends, the error patterns and therefore the resulting calibration grids are different. This suggests that either the calibration grid is un-stable in time or that the method (presented in this paper) used to derive the calibration grid is unable to isolate image distortion patterns from errors of other sources involved in the bundle adjustment (e.g. GPS/INS, ground control, etc.).



▲ Distortion grid in focal plane derived from residuals in image space using the calibration data set: Salou 60% x 60%. GSD: 10 cm.

In aerial triangulation, self-calibration results are slightly superior to calibration grid results, independently of the flying height and of the time that has elapsed since the calibration flight. It has not been possible to prove the stability in time of calibration grid compensation: it is not clear whether the poorer results are caused by temporal effects, by effects related to the flying altitude over the terrain or by other block configuration aspects.

In stereoplotting, calibration grid compensation for systematic errors in the virtual image leads to slightly improved accuracies.

The influence of systematic errors in the virtual image space is much more pronounced in bundle block adjustment than in stereoplotting or DSM processes, where the exterior orientation is given and non-modeled error sources (in particular, systematic errors in image space) are not propagated through the block.■

Brief notes

The documentation generated by these Symposiums is in: **http://www.icc.cat/web/content/ca/common/icc/icc_publicacions_jornades_08_pro.html**

SYMPOSIUM: RADAR EARTH OBSERVATION SYSTEMS

This Symposium was held on 22 July 2008 at the headquarters of the ICC within the framework CSPCOT (see ICC Newsletter No. 32). The aim was to develop a platform of learning and debate about the needs and possibilities of radar Earth observation systems.

The Symposium was attended by 64 people.

SYMPOSIUM ON ORTHOPHOTOGRAPHIC SERIES

On 17 September 2008, the ICC staged this Symposium to offer a greater insight into the characteristics of the ortho product with reference to general coverage and urban coverage.

Papers were presented by advanced users of the orthophotos produced by the ICC: Department of Agriculture, Food and Rural Action, the Department of the Environment and Housing, the Catalan Water Agency, the Telecommunications and Information Technologies Centre, and Barcelona City Council.

The Symposium was attended by 88 people.

This newsletter is a free publication available in Catalan, Spanish and English.

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III International workshop: Digital approaches to cartographic heritage

On 26-27 June 2008, the III International workshop on digital technologies applied to cartographic heritage was held at the headquarters of the ICC (see ICC Newsletter No. 32). The two previous workshops were held in Thessaloniki and Athens, in 2006 and 2007 respectively.

30 papers were presented over the course of 6 working sessions:

- Cartographic heritage. Multidisciplinarity, sustainability, dissemination.
- Transformation into digital form.
- Information & communication technology web.
- Spatial data infrastructures and digital map libraries.
- Digital analysis and interpretation of historic maps.
- DIGMAP project.

The workshop included a round table which discussed the integration between map libraries and spatial data infrastructures, concluding that there is a need for greater understanding between those who produce the data and those who preserve it.

Although the main theme of the workshop was the publication of historical cartography on the Internet, there was also a presentation about the relationship between cartography and art; a session devoted entirely to DIGMAP, the European project for sourcing and viewing historical cartography; and a display of commercial products (large format scanners and digital content management systems).

The workshop was attended by 75 people from 14 European countries, the USA and Colombia. 30% of these participants came from Spain.

1st meeting of the Interdisciplinary Working Group: Cartographic Heritage of SDIs

The first meeting of this Working Group was held at the headquarters of the ICC on 25 June 2008.

Created as a subgroup of the NSDI Working Group of the National Geographic High Council, its thematic focus is the publication on the Internet of historical geographic data by means of SDI strategies.

The Map Library of the ICC belongs to this Working Group, together with the Documentation Center of the National Geographic Institute, the Cartographic Institute of Andalusia, the Polytechnical University of Madrid and the University of Zaragoza.