ACCURARY POTENTIAL OF POINT MEASUREMENTS IN MOMS-IMAGES USING A RIGOROUS MODEL AND A RATIONAL FUNCTION

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ABSTRACT

The motivation for the test originated from an ISPRS-WGII/7- initiative to establish a general purpose image-transfer standard for photogrammetric applications and remote sensing. While rigorous photogrammetric models guarantee a defined accuracy the rational functions approach allows only a more general statement about the expected accuracy of the points taken from the scene.

In order to select one if the either method as appropriate for a given application the effective point accuracy has been tested in a joint project between the ICC (Institut Cartogràfic de Catalunya) in Barcelona and Fachhochschule Neubrandenburg. MOMS-scenes of mountainous and of flat terrain have been used in the test, which has been conducted using various software packages from ZI-Imaging.

Given the orientation of images using a rigorous photogrammetric model there are two parameters to choose the rational functions that approximate the rigorous functions. The first one is the degree of the rational function. The second is the set of points, which coordinates are known through the rigorous model, used in the computation of the rational functions coefficients. In this paper a comparison between rational functions (changing the parameters that determine them) and the rigorous model has been done. In addition the dependency on terrain and sensor calibration parameters of the rational functions is discussed.

1 INTRODUCTION

In the past satellite images were usually georeferenced by approximative methods only, using polynomial functions and ratios of polynomials. The accuracy achieved using these methods was sufficient for monoscopic scenes and for pixel sizes of 30 m on the ground and upwards. Today's satellite images often have much smaller pixels or allow stereo viewing, requiring rigorous geometrical solutions. These collinearity equations have long been used in photogrammetry.

At the Fachhochschule Neubrandenburg the accuracy of both methods was to be investigated and compared based on 260 check points on the ground. Suggestions for the use of one method or the other in specific applications were to round out the study.

At ICC (Institut Cartographic de Catalunya) the accuracy of the approximation of the rational functions (implemented in the software of the ZI-imaging stations) against a rigorous model was compared based on 290 points identified in the images.

2 DATA USED

At the Fachhochschule Neubrandenburg the study was carried out using the MOMS-stereoscene T08FE/22, specifically channels ST6 and ST7, which are the panchromatic channels looking forward and backward with a ground pixel size of 18 m. The scene represents parts of Bavaria, Germany, with an image scale of approximately 1:1.700.000.

The Bavarian state survey administration supplied us with all permanent photogrammetric ground control points visible from the air within the scene of 100 km by 100 km. Out of the total of ca. 1400 ground control points only 260 points could be identified and were used for the analysis (Langner 99).
At ICC the study was carried out using images that were taken during the MOMS-02-D2 mission on the shuttle (1993). The data taken is the scene 4 of the orbit 115 in mode A (2 stereo plus a high resolution channel). The scene is covering an area of 120Km x 40Km over the Andes between Chile and Bolivia.

From Aerial photography there were identified about 50 ground points. A strict model of the camera and trajectory was adjusted using the GeoTeX-ACX (Colomina 92) ICC software. The mathematical model took into account position and attitude of the spaceborne platform (the Shuttle).

On the images there were over 1000 tie points matched (courtesy of Institute für Optoelectronic - DLR, Oberpfaffenhofen).

From the images an amount of 290 uniformly distributed points on the scene was selected. The coordinates (adjusted in the bundle adjustment using a strict model) has been compared against the coordinates of the points remeasured in the stereoplotter.

2 REALIZATION

The analysis was based on three software packages: PHODIS-ST Version 4.2.4 with MOMS-modul, Stereo-Softcopy-Kit (SSK, Version 2.3) with additional moduls for 3-line-camera-geometry and the MOMS-software of the DLR (Deutsches Zentrum für Luft- und Raumfahrt, German Aerospace Center). PHODIS and SSK are products of ZI-Imaging. The additional moduls for SSK are available from TRIFID-company.

PHODIS-ST incorporates a rigorous solution based on collinearity equations. The moduls of TRIFID use a rigorous model for SPOT, Landsat and IRS sensors. The results of these rigorous models are replaced by a rational function approach in the real-time loop. The MOMS-software of the DLR is based on a rigorous solution.

At the ICC the analysis has been carried out using the ISSD (ImageStation Stereo Display) Version 2.0.2.4 of Intergraph and an Intergraph software (β-version) developed under requirement of ICC, which allows the interpolation of a strict model by rational functions giving as result the rational function parameters in the format that ISSD needs. This software interpolates a strict model given a set of evaluated points by the strict model. The images used in the stereoplotter are the channels ST6 and ST7 of the scene 4 of the orbit 115, their pixel size is 13.5 meter. The steps which followed are:

1. adjustment of a strict model of orientation (in the adjustment the channels ST6, ST7 and the high resolution channel HR5 were used, respectively with pixel sizes 13.5m, 13.5m and 4.5m)
2. evaluation of the strict model in a set of points, which are used in the computation of the rational functions
3. computation of the rational functions
4. selection of a set of check points on the ground, coordinates are extracted from the bundle adjustment of the strict model (290 points were selected uniformly distributed in the MOMS scene)
5. measurement of selected check points using the digital stereoplotter (ISSD) by an operator
6. comparison of measured coordinates using the rational functions against the adjusted coordinates (in the bundle adjustment)

3 RESULTS

The MOMS-scene T08FE/22 was oriented using PHODIS-ST and SSK. The scene was also evaluated using the MOMS-software of the DLR. Initial results indicate a point measurement accuracy of ca. 10 m, or half a pixel.

The results of the comparison carried out at the ICC are summarised in the following table:

	Minimum	Mean	Maximum	R.M.S.	σ
X	-10.10	4.75	31.11	7.90	6.33
Y	-20.36	3.86	23.81	8.11	7.14
Z	-33.31	1.83	47.30	12.83	12.72

Table 1: Computed differences at 286 check points from 290 selected ones between the computed coordinates using a strict model and the measured coordinates using rational functions (units are in meters).

4 CONCLUSIONS

The study is going on. Final results and conclusions will be presented at the Amsterdam meeting.

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