

PERFORMANCE IMPROVEMENT FOR THE TRIANGULATION PROCESS ON LEICA ANALYTICAL WORKSTATIONS BY SEQUENTIAL ADJUSTMENT USED FOR CONTINUOUS QUALITY CONTROL AND DIGITAL POINT TRANSFER

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ABSTRACT:

After the successful introduction of the analytical workstations SD2000/3000 in 1991/92, Leica decided to completely modernise the orientation and triangulation software in order to increase the performance of the SD-line and respond to the change of user's demands for more quality control and modern graphical interface. A full integrated on line bundle triangulation module with statistical blunder detection is reducing drastically the time for detection and elimination of blunders. ORIMA (ORientation MAnagement software) was developed by Dr. Ludger Hinsken, Development & Consulting in close collaboration with Leica.

1. INTRODUCTION

Leica's solution in analytical photogrammetry, based on solid equipment, the well proven concept of distributed processing and a strong support network, is still a good investment into the future. The Analytical Workstations SD2000/3000 still represent state of the art in optics and high precision mechanics. Outdated electronics of early DSRs, AC1 and BCs can be easily upgraded to the latest electronics comparable to the SD-line of instruments, thus enabling owners of the older instruments to interface to the most recent computer platforms. With the ability to access state-of-the-art application software, which defines the functionality and productivity of the Analytical Workstation, every user of a Leica Analytical Workstation is a strong competitor in the photogrammetric market. Even in an age increasingly going „digital“ analytical photogrammetry is unsurpassed for numerous photogrammetric tasks, for example, whenever high resolution imagery need to be processed. Today analytical workstations are still effective for large scale mapping and medium size triangulation projects.

As the existing orientation software dates back to the early 80s, Leica decided to completely modernise the orientation software for the line of Analytical Workstations. Since the market introduction of those old packages user demands for orientation software have changed quite drastically. The new software should have a modern, easy to use graphical interface, it should be

PC-based, running under the Windows operating systems. The functionality should be extended to provide quality criteria for the orientation, and measuring errors should be detected by blunder detection methods.

The demande for the new aerial triangulation software are similar to the model orientation software. Additionally to the model orientation this software should handle an unlimited number of photographs. The results of a bundle adjustment should be used to load a model directly without repeated relative and absolute orientation.

2. ORIMA MODULAR CONCEPT

ORIMA (ORientation Management software) is a new orientation and triangulation software for all Leica analytical photogrammetric workstations based on the LMT (Leica Mapping Terminal) concept. ORIMA is a MS-Windows based modular software package for all orientation purposes required for aerial photogrammetry on Leica analytical photogrammetric workstations. The orientation procedures included are inner, relative and absolute orientation, as well as integrated on line bundle triangulation.

ORIMA consist of various modules such as:
ORIMA-B Simplified version for model orientation without sequential adjustment and on line

	quality control.
ORIMA-S	Standard version for model orientation with sequential adjustment, statistical blunder detection and on line quality control.
ORIMA-T	Same features as ORIMA-S, in addition triangulation measurement and digital point transfer.
ORIMA-TB	Same features as ORIMA-T, in addition full integrated bundle adjustment program (CAP-A). This version is limited to a block size of 100 images.
ORIMA-TE	Same features as ORIMA-TB but without limitations concerning the size of the block.

3. ORIMA WORKING PHILOSOPHY

The main characteristic of ORIMAs working philosophy is the sequential computation during measurement. This allows for an early detection of measuring errors. CAP-A in ORIMA-TB, ORIMA-TE is fully integrated into ORIMA. The same philosophy or sequential adjustment can be used for the bundle triangulation with CAP-A. It is not necessary to finish the measurement process for the whole block before the bundle adjustment is performed. As soon as a minimum of images were measured the bundle triangulation can be started already. The main purpose of the sequential bundle triangulation is to detect blunders as early as possible. This allows for easy correction of the blunder by remeasurement. Furthermore the sequential bundle adjustment allows for a high quality digital point transfer between strips. The sequential bundle triangulation can be limited to parts of the block. This is economical in terms of computation time and it is sufficient for blunder detection and digital point transfer. For ORIMA-TB, ORIMA-TE the sequential bundle triangulation is performed on the same PC in the background while the measuring process is continued in the foreground.

In order to obtain optimum results a final bundle triangulation including all images of the block must be carried out. Self-calibration parameters which are provided by CAP-A can be applied also during this final computation in order to eliminate systematic deformations.

4. ORIMA MAIN FEATURES

ORIMA is capable of managing all aspects necessary to perform a photogrammetric orientation of a single model as well as multi model orientation by block triangulation. The functionality covers the measurement of image and model coordinates, computation of orientation parameters, detection of measuring errors by statistical blunder detection, computation of quality criteria to judge the quality of the orientation of the model and block, and the download of model parameters into the analytical workstation. All measurements and computation results are based on sophisticated mathematical models and are presented in a simple graphical form. As an alternative to the graphical presentation, all results are also available in

the form of numerical listings. Output on paper is available for the graphical form and the numerical listing form. As ORIMA runs on MS-Windows, its user interface follows strictly the guidelines set up for Windows programs. ORIMAs working philosophy is the same used within other Windows based graphical programs. This ensures a short learning period.

The advantages of ORIMA are summarised:

- Modular software system (Upgrade is possible).
- Standard graphical user interface.
- Optional continuous quality control.
- Direct model orientation without repeated relative and absolute orientation after block triangulation in relation with supported triangulation software.
- Measurements for bundle adjustment are performed in comparator mode, but for ergonomically reasons searching of point is performed in model mode.
- Use of rigorous mathematical models:
 - Results of two-step model orientation is identical to one step bundle orientation with free adjustment.
 - Errors of control points are easily identified and cannot be transferred to the photogrammetric model.
- Compatibility to major mapping packages
- Integrated bundle program based on CAP:
 - Increased productivity
 - No input and output translation required
 - Easy to use
 - Interactive graphical analysis of results
 - Background processing, continuous quality control of the measurements
 - Digital point transfer between strips.
 - Direct model orientation without repeated relative and absolute orientation saves time and leads to absolutely consistent results across borders.
 - Additional parameters are transferred to the Leica LMT based analytical workstations, therefore no degradation of the bundle adjustment accuracy when a model is loaded after triangulation.

5. CONCLUSION

The combination of measurements and triangulation computation on the analytical workstation is increasing significantly the productivity in triangulation work.

The well known time consuming process for blunder detection is partly eliminated because errors can be detected much earlier during the measuring process. Owing to dedicated graphical display of the object points and tools like the specialized point editor and the ground control editor, the location of blunders in the block is very fast.

With ORIMA the new orientation management software for analytical workstations, Leica offers a state-of-the-art package in order to increase the efficiency of the mapping process.

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