THE G3/PC STEREOCORD - A SIMPLE ANALYTICAL PLOTTING INSTRUMENT ON A PC BASIS

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ABSTRACT

The Stereocord is a simple analytical plotting instrument for quantitative stereo interpretation, close-range photogrammetry and special photogrammetric applications. It comprises a measuring unit for stereoscopic viewing and digital measurement of image coordinates, an IBM-compatible PC with MS-DOS, a software package in BASIC and an optional plotter. The basic software includes programs for orientation, measurement and the derivation of geometric quantities. The G3 graphics package permits the digital acquisition, storage and output of graphic information. Special application programs enable the use of Stereocord in forestry, geo sciences, planning, environmental monitoring and close-range photogrammetry. The hardware and software are designed for the use with any IBM-compatible PC.

1. INTRODUCTION

The Stereocord is a simple analytical plotting instrument for quantitative photo interpretation and photogrammetric applications. The version G3 Stereocord was introduced by Carl Zeiss in 1982 on the basis of a software package developed by H. Mohl and W. Kresse for the HP85 and HP86 desk computers /1,2/. The G3 GRAPHIC package permits computer-controlled on-line mapping.

The wide use of IBM-compatible personal computers (PCs) and their favourable price/performance ratio have induced us to convert the G3 software to PC operation and to incorporate major improvements and extensions. The new version called G3/PC permits digital mapping with storage of the graphical information and offers a significantly increased performance and speed at a reduced price.

2. HARDWARE

As illustrated in Fig. 1, the hardware of the G3/PC Stereocord comprises:

- the opto-mechanical basic instrument for viewing and measurement of a stereo pair,
- a counter and interface board
- an IBM-compatible PC with MS-DOS operating system and
- optional graphical periphery.
The basic instrument with 4 components for measuring the photo coordinates x and y and the px and py parallaxes is connected to the new counter and interface board using a modified electric unit. This board is inserted into a free slot of the PC, a simple service procedure which basically can also be performed by the user.

The PC with the MS-DOS 3.2 operating system can either be operated with one or two floppy disk drives (5 1/4") or with a Winchester disk and floppy disk drive, and with a monochrome or colour display terminal. The following PCs can be used, for example:

- IBM - XT, IBM - AT
- IBM Personal System/2 Model 30
- Commodore AT-40

each with a 20 MB Winchester disk and printer.

As an optional plotter, the HP 7550 from Hewlett Packard or any compatible plotter can be employed.

Earlier Stereocord versions (G2, G3) can be upgraded into the G3/PC version by hardware and software updates.

Connections to other computers for data transmission can be implemented on the basis of Kermit.

3. SOFTWARE

The software of the G3/PC is written in BASIC (version A 3.31 or GW BASIC 3.2) and, as shown in Fig. 2, comprises:

- the basic software and
- optional software packages for digital mapping, close-range photogrammetry and applications in the earth sciences.

3.1 Basic software

The basic software includes programs for interior, relative and absolute orientation, for parameter orientation and for measuring points, distances, areas and volumes. A detailed description of the basic software is given in /1,2/. The control points used for absolute orientation can be digitized from existing maps using the new basic software.

A common feature of the G3 programs is the interactive operator guidance via the menu. Menus, recommendations for the menu choice, explanations, instructions, results and correction possibilities are displayed on the CRT terminal. This way the extensive capabilities of the Stereocord become easily accessible to users who are not familiar with photogrammetry. Examples for displays on the CRT terminal are given in Fig. 3.
The graphical representation of interpretation results in the form of a map is of great value for a wide range of applications, particularly in the earth sciences. So far, the G3 GRAPHIC program package has implemented computer-supported direct mapping with graphical output but without storage of the information. The new GRAPHIC package based on a PC enables the storage of the graphical information on the PC data media and the output in an identical or different form, as compared with data acquisition.

The scope and performance of G3 GRAPHIC are described in /2/, the software modules are shown in Fig. 4.

For the user's own programming, the standard program BOSS is available, permitting access of the user program to transformed ground coordinates, storage of the results in data files and calling of the program in the menu.

The graphic information is collected object by object with the programs LINE, AREA and TEXT and is written into a mapping file in records with identifiers and ground coordinates. Objects may include: points, point elevations, lines, areas and texts. The identifier (symbol number, comment) can be used for a kind of object coding, preparing the data for transmission to a system for further processing (e.g. Zeiss PHOCUS).

In data acquisition, the current element and the last point measured of a current object can be deleted and reactivated. Due to the storage in records and the display of the consecutive record numbers, there is the possibility of subsequent numerical editing of the stored information. The new program OFF-LINE DRAWING enables mapping of a digitally stored map on a plotter at different scales, with different symbols and with a freely definable cut-out area. The map contents can be fitted by affine transformation into an existing map frame traced with MAP, and can then be plotted.

As a result, the G3 GRAPHIC package permits

- the storage of graphical information in elements,
- on-line plotting during storage
- automatic off-line mapping of the stored data

This means that the valuable information is permanently available in the form of a digital map.
3.3 G3 TERRESTRIAL

The program G3 TERRESTRIAL is an enhanced version of the basic software making allowance for the special requirements of close-range photogrammetry. The relevant requirements are:

- plotting of metric and semi-metric photos
- the possibility of placing several photos on one photoholder
- introduction of additional conditions into the orientation
- high flexibility in numerical and graphical plotting

The G3 TERRESTRIAL software meets these requirements as follows:

Interior orientation:
Measurement of 4 or 6 fiducials or réseau crosses or points of the frame edges; input of distances or calibrated coordinates; allowance for distortion corrections; camera file for 4 cameras with 4 focussing positions.

Relative orientation:
Measurement of a maximum of 25 Y parallaxes; input of known relative orientation data and automatic weighting.

Absolute orientation:
Introduction of known exterior orientation data (base, coordinates of the camera position etc.) and of additional controlelements (distances, directions, planes, vertical lines) with weighting. Input of the approximate taking direction with respect to the object coordinate system and selection of the reference plane.

Plotting:
Selection of the plotting plane from xy/z, zx/y and yz/x for numerical and graphical plotting; circle measuring program; direct succession of measurements in different models (max. 9) on the same photoholder.

A plotting example with the programs G3 TERRESTRIAL and G3 GRAPHIC is shown in Fig. 5.
4. MAJOR FIELDS OF APPLICATION

The version G3/PC features a wide range of applications, a process which already started in the G2 Stereocord and was continued in the G3. The most important among them are:

- quantitative photo interpretation in the earth sciences, in planning and environmental monitoring,
- close-range photogrammetry in architecture, archeology, accident surveys and industrial surveys,
- photogrammetry with numerical and graphical plotting, measurement of digital elevation models,
- plotting for war material elimination
- training in numerical and analytical photogrammetry and for digital mapping.

The Stereocord is a simple, independent analytical plotting instrument. Due to the easy linkage of PCs to other computers, the G3/PC will be gaining increasing importance as a photogrammetric data acquisition station for further processing in land information systems.

REFERENCES

/1/ Mohl, H.: Das Stereocord G3 Bildmessung und Luftbildwesen (BuL) 50 (1982), pp. 7-15

Fig. 1: Hardware of the G3/PC Stereocord
Fig. 2: Program system of the G3/PC Stereocord
Fig. 3: Display examples

**STEREOCORD G3**

<table>
<thead>
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<th><strong>TERRESTRIAL PROGRAMS</strong></th>
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<tr>
<td><strong>INTERIOR ORIENTATION</strong></td>
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<tr>
<td>1 AERIAL CAMERA / MARKS ON THE MARGINS &lt;</td>
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<tr>
<td>2 AERIAL CAMERA / MARKS IN THE CORNERS</td>
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<tr>
<td>3 MEASURE MARKS ➔ LEFT PHOTOGRAPH</td>
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<tr>
<td>4 MEASURE MARKS ➔ RIGHT PHOTOGRAPH</td>
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<tr>
<td>5 SPECIAL CAMERA / WITHOUT FIDUCIAL MARKS</td>
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<tr>
<td>6 TERRESTRIAL</td>
</tr>
<tr>
<td>7 RESEAU CAMERA / FORMAT 24X36 OR 60X60</td>
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<td>☐ RESETTING COUNTERS - REFERENCE TEST</td>
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<td>+ PROGRAM SELECTION</td>
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TO FOLLOW THE STANDARD SEQUENCE ➔ [FOOTSWITCH]

**STEREOCORD G3**

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REFERENCE PLANE XY CAMERA AXES ➔ -Z

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Fig. 4: G3 Graphik - Overview

DRAW
Control Program

SYMBOL
Symbol Generation and Management

PROFILE
Contour Line Measurement and Plotting

MAP
Map Sheet Preparation and Readjustment

TEXT
Annotations, Generation of Legends

LINE
Acquisition and Mapping of Point and Line Objects

AREA
Acquisition and Mapping of Area Objects

OFF-LINE DRAWING
Off-line Mapping of the Stored Digital Map
Fig. 5: Plotting examples in architectural photogrammetry

Auswertung am STEREOCORD 6 3 mit HP 7580 B Trommelplotter
Massstab 1:50

IPO STUTTGART

Vertikalprofi

Horizontalprofile

Aufnahmerichtung