

New Developments in the Processing Software for P-Series Planicomp

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1. Introduction

The instruments of the Planicomp P-Series were presented to the public three years ago. The economy-priced P3 Planicomp has since become a standard instrument among analytical plotters, especially for jobs involving bulk data acquisition, i.e. in the fields of topographic mapping and DEM data acquisition. The top-of-the-line instrument P1 Planicomp is primarily used for applications where the special possibilities of optics switchover, optical interfacing and the large photocarriages are required, i.e. for triangulation measurements, terrestrial photogrammetry or if the connection of the VIDEOMAP stereo version would be of advantage. Both instruments feature the characteristic P-cursor for free-hand guidance of the floating mark and for command input. The P2 Planicomp, which was derived from the viewer of the C120 Planicomp and is therefore equipped with the traditional handwheels and foot disk, has also succeeded in holding its share of the market. Customers are now increasingly making use of the option to upgrade an existing C100 Planicomp to a P2 in order to be able to utilize the extensive capabilities of the PHOCUS program system. The three years since the market launch have shown that the three instruments with their different performance features effectively cover the users' requirements so that there has been no need for major changes or extensions of the hardware design. The flexibility of the instruments was also used to full advantage when it came to the connection of IBM-compatible computers featuring an MS-DOS operating system. The name P-CAP stands for the orientation software and the connection of CAD and GIS programs written for this computer category.

This paper deals with the capabilities and new features of PHOCUS and P-CAP, the emphasis being placed on object-oriented data acquisition and the measurement of digital terrain models.

2. PHOCUS

2.1 Object-oriented data acquisition in PHOCUS

MEOD (measure object data) is the central program for object-oriented data acquisition in PHOCUS. The objects to be measured are entered in an object code table, whose contents can be freely defined and therefore easily adapted to a wide variety of requirements.

During measurement, the collected data are stored in a structured form in the data base, but at the same time they can also be logged on several graphic output units. The VIDEOMAP and StereoVIDEOMAP are valuable aids here for the operator as they enable the direct comparison of the collected data with the aerial photo. A special feature of the graphic display terminal is the possibility of guiding the currently used display window along with the floating mark movement. This ensures that the current section of the field of view is always displayed, even with high magnifications.

The linking of elements to existing objects or object items is performed by the SNAP functions. This way, the topological relations between the objects are established and implemented in the data structure.

All editing functions are already available during data acquisition, permitting the immediate correction of detected errors. In particular the functions Snap, Delete last point/object etc., which are of special relevance for the operator, ensure the acquisition of a data base where the necessity of subsequent editing has been substantially reduced.

The results of additional, geodetic measurements - e.g. roof projections, completion of partly concealed objects etc. - can be integrated during or after the measuring process on the instrument.

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In the ongoing enhancement of this central measuring module of PHOCUS, we are incorporating user suggestions from their everyday practical work. Moreover, a programming interface enables each user to generate his own specific data acquisition functions. This means that the standard measuring program supplied with the equipment can be tailored to the customer's specific applications. PHOCUS thus meets the demand for an open-ended, flexible system.

For the acquisition of attribute data, the so-called object names and object item names are available at present. To meet the increasing demands that will be made in the future by photogrammetric users regarding the creation of geographic information systems, PHOCUS will be extended by the connection of a relational data base, permitting the definition and management of randomly structured attribute data. While the geometric data will continue to be stored in the PHOCUS data base, special data elements will be provided to form the connection with the relational data base.

2.2 PHOCUS PA Workstation

Customers have frequently expressed the wish to connect the analog stereo-plotters they are still using to the PHOCUS system, in order to be able to benefit from the advantages of object-oriented data acquisition also with the existing equipment.

The connection between the plotter and the PHOCUS computer is formed by the DIREC-P digitizing and interface unit. The inputs of the x, y, z encoders in the analog instrument are recorded and transformed by this unit and then transferred to the PHOCUS computer via a RS 232 standard interface. This ensures the connection to the different types of computers on which PHOCUS is implemented. Apart from the transformation of model into terrain coordinates, the software of the interface unit also performs the time-critical incremental recording procedures.

The absolute orientation of the stereomodel is supported within PHOCUS by an orientation program which computes the setting data for the orientation elements, while making allowance for the different types of terrain involved. If a model has already been oriented in Planicomp and stored in the stereomodel file, e.g. during a aerotriangulation measurement and adjustment process, this orientation data is used for the computation of the setting data. As a result, the speed of relative and absolute orientation of the stereomodel is considerably increased. After completion of the orientation process, the transformation parameters are transferred by a driver program to the digitizing and interface unit. The driver program also ensures that input data is correctly supplied to the internal PHOCUS interface. The data acquisition programs can therefore be used without modifications both in the Planicomp and the analog instrument.

The PHOCUS multi-workstation system permits the connection of several analog instruments to one computer, with the possibility of combining them with Planicomp, digitizing and editing stations.

2.3 PHOCUS DEM Measurement Program

2.3.1 MDTM

The standard measuring program for digital elevation models (MDTM) comprises the functions:

Measurement of single points

Manual positioning of the floating mark or
prepositioning using the input file, e.g.
for the determination of volumes

Measurement of a regular grid

Prepositioning of the floating mark to a
selectable, regular grid

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Measurement of parallel profiles

Guiding of the floating mark along defined profiles with variable travel speed, use of various incremental conditions for automatic point recording, e.g. profile measurement for orthophoto production

Measurement of longitudinal and cross profiles

Guiding of the floating mark along longitudinal or cross profiles defined by an input file. Use of manual or automatic recording data, e.g. for measuring terrain sections in road construction

These functions already cover most of the tasks arising in this field.

2.3.2 XSEC

The XSEC program (cross section) is a comprehensive package specially geared to route surveying in road construction.

The sequence of axis elements consisting of lines, circular arcs or clothoids is determined in a definition phase. The regular spacing of the stations can be supplemented by randomly positioned intermediate stations, with the input being performed either alphanumerically or by measurement. The length of the cross profiles can be randomly defined. However, the definition of the route may also be adopted from a different design program or read in via an interface. During the measurement process, the floating mark is guided along the longitudinal and cross profiles; the operator selects the movement speed, sets the height and triggers the measurements. The measurement progress is logged on the graphic display terminal. The route may extend over several models. The measurement can be interrupted at any time, and editing functions permit the immediate correction of measuring errors. After completion of all measurements, the data are output on an ASCII file and are available for further processing. XSEC currently supports nine formats commonly used in road construction today.

2.3.3 PROSA

The PROSA measuring program for digital elevation models was developed at the University of Munich and is also fully integrated into the PHOCUS environment. In line with the method of progressive sampling, a wide-meshed grid is first measured and is then locally densified depending on the terrain structure. The principal advantage of this approach is the reduction of the number of measuring points and, as a result, of the measuring time while retaining the desired degree of accuracy. The contour lines obtained by on-line computation can be displayed and assessed on the VIDEOMAP or Stereo-VIDEOMAP. The integration into PHOCUS also permits the use of other output instruments supported by PHOCUS such as graphic display terminals or plotters.

2.3.4 PROD

A further interesting program in the field of DEM is the PROD profile plotting program which permits the graphic representation of any type of terrain section. PROD enables the generation of a planimetric overview of all profiles. Each individual profile can be represented in vertical projection. The graphic output, including the desired lettering, is controlled by a wide range of parameters. If design data is available for the measured profiles, the cut and fill-up areas in road construction can be highlighted by selectable types of representation. The PROD program is a useful addition to the previously mentioned measuring programs.

3. P-CAP for P-Series Planicomp

3.1 Orientation and mapping

P-CAP is the overall name of the

- orientation software and the
 - driver for the connection of commercial CAD and GIS systems
- in IBM-compatible computers with a MS-DOS operating system.

The complete orientation software is implemented in the graphic user interface WINDOWS from Microsoft. Standardized elements such as menu bars, pull-down menus, list boxes and command buttons are used for calling up functions, for the entry of parameters and the output of lists. The input is made either with a mouse or the computer keyboard.

Apart from the known procedures for the orientation of a stereomodel, P-CAP also offers functions for project and model management. In addition, a configuration window enables the operator to assign the Planicom input elements (P-cursor, handwheels etc.) to the model movements in accordance with his particular working habits.

After completion of the model orientation, an ASCII data file of a defined format is generated for the orientation parameters (PHOREX format). This data file is used as an interface for the driver if the CAD and GIS programs are connected.

Opton Feintechnik has developed drivers for three of these systems, thus ensuring that the Planicom can be directly used as an input instrument. The systems concerned are:

- AutoCAD from Autodesk
- MicroStation from Intergraph
- pcARC/INFO from ESRI.

Another five program systems have been connected to P-Series Planicom by the customers and program suppliers.

The direct use of Planicom offers several major advantages:

- direct input of the terrain coordinates measured in the stereomodel, and therefore no need for conversion programs,
- all measuring and editing functions are directly available to the operator,

2.3.3 PHOSA

- the same system is used for data acquisition, editing and processing.

3.2 DEM measuring program within P-CAP

A special program has been developed for DEM measurement within P-CAP. It offers a similar scope of functions as the PHOCUS measuring program MDTM and includes for example:

- single point measurement
- grid measurement
- profile measurement with incremental recording

This PC version is characterized by a special feature. The area to be processed, which may extend over several models, is specified in the project definition, with the boundary line being defined by a polygon of any size. The same applies to the cut-out areas included (e.g. forests, builtup areas, water surfaces). The total area to be measured is covered by a bit map, in which each element represents the status of a measuring point, e.g.:

- point to be measured
- point not to be measured
- measured point
- point rejected by the operator as not being measurable

The bit map ensures that each point is checked during the measuring process. As a result, the grid points and profile points of the cut-out areas are skipped by the program from the outset and the measuring speed is increased. Moreover, the bit map enables checks across the model boundaries so that omissions or double measurements can be recognized and avoided right during the measuring process. Interrupted measurements can be resumed at any time. The graphic output of the bit map on the colour display terminal provides an overview of the current processing status of a DEM project.

When all measurements of a project have been completed, the measured data is output directly in the data formats of the most important programs for further processing. These are the DEM programs SCOP and HIFI and the input format for the Z2 Orthocomp orthoprojector. An ASCII file with a flexible format is also available as an interface for further programs.

4. Summary

With the use of the P-Series Planicomp as a data acquisition instrument for

- digital mapping systems
- geographic information systems
- special photogrammetric measuring techniques

a large variety of programs hitherto unparalleled in analytical plotters has now become available. This range of powerful, application-oriented software is continuously improved and extended by Opton Feintechnik GmbH. The outstanding hardware of the P-Series Planicomp with P-processor is also ideally suited for the generation of special processing programs and drivers by our customers for existing plotting systems. These features guarantee that the versatility of the P-Series instruments will also continue to be enhanced in the future.