THE SPECIAL FEATURES AND VERSATILE INTERFACES OF THE PLANICOMP P-SERIES

by J. Saile, Oberkochen

ABSTRACT

In spring 1987 Carl Zeiss Oberkochen presented the new analyticalstereo-plotters of the Planicomp P-Series. One of the differences between the P-Series and the C100 Planicomp family consists in the use of a micro-processor for LOOP computations and a standardized interface for the connection of the Host Computer. The resulting programming capabilities of the instruments are described. The paper also deals with the suitability of the P-Series for special applications in photogrammetry.

1. INTRODUCTION

The Planicomp P-Series /2/ is the new generation of analytical plotters from Carl Zeiss. A number of features, e.g. an improved ergonomic design and the new free-hand guiding with the P-Cursor /2/, distinguish these new instruments from the Planicomp C100 family which is successfully used worldwide.

In the C100 Planicomp, the viewer and the servo control system for the photocarriages are linked very closely to the control computer, a model of the HP 1000 series from Hewlett Packard. The data exchange between the computer and viewer takes place via a computer-specific 16 bit parallel interface. With a repetition rate of 50x per second, the model movements entered by the operator are transmitted to the computer, converted into photocarriage motions and retransmitted to the viewer as motion increments for the servo motors. All transformation parameters required for these computations are available in the system common area. The application programs use this common area for reading and further processing of the ground, model or photocarriage coordinates to be measured. Due to the type of interface used, the LOOP program written in Assembler and the use of the system commona area, the complete system is to a large extent dependent on the host computer.

In the Planicomp P-Series, on the other hand, the LOOP computation has been transferred to a microprocessor. Together with the four servo systems for the photocarriages, this processor constitutes the new intelligent control unit for this instrument line. The data exchange with the Host Computer takes place via a standardized I/O interface. As a result, the new analytical stereoplotters from Carl Zeiss have become independent of the computer.

2. PROGRAMMING CAPABILITIES OF THE PLANICOMP P-SERIES

2.1 CONNECTION TO A HOST COMPUTER

The Planicomp P-Series is connected to a computer via an interface bus conforming to the IEEE Standard 488 /6/, which is also called HP-IB or GP-IB bus. This interface bus is provided in a wide range of computers employed in the technical field of data processing. It is frequently used for the connection of measuring instruments, tracing tables and printers. Data are transferred via 8 data lines (8 bit parallel); in addition, 3 handshake and 5 command lines ensure the necessary control. Data transfer rates of approx. 500 Kbyte/s are attained here (as compared with approx. 1250 Kbyte/s with Ethernet and approx. 1.2 Kbyte/s with RS 232). The IEEE Standard 488 gives a very precise specification of the data lines, control lines, pin assignment and the mechanical dimensions of the plugs. This strict definition offers the considerable advantage that no problems arise in the linkage of the computer and peripheral equipment.

A special feature of this interface bus is the possibility of connecting up to 14 instruments, e.g. Planicomp, VIDEOMAP, plotters and printers, to the same computer interface, which reduces the interface costs for the connection of these peripherals. Moreover, the connection of several instruments to a computer with a limited number of I/O slots presents no problems.

2.2 INSTRUCTION SET OF THE P-PROCESSOR

The microprocessor of the Planicomp P-Series (P-Processor) performs the following major functions:

- retention of the stereomodel (LOOP computation)
- monitoring of the P-Cursor controls and foot switches
- transfer of point measurements to the Host Computer
- processing of the MOVE TO motions

For these operations the Host Computer must transmit the necessary parameters to the P-Processor and activate the relevant operating modes. An instruction set including approx. 50 commands is defined for this purpose. One command comprises two letters identifying the operator, a parameter string with one or more operands and a final character. Several commands may be combined into a data block which is then transmitted to the P-Processor. The total number of commands can be subdivided into several groups.

One of these groups ensures the transmission of the transformation parameters determined in the orientation programs. These parameters are needed in the LOOP computation for the conversion of the three-dimensional model coordinates into the movements of the left and right photocarriages. In a flexible input configuration, the different input elements such as the P-Cursor, handwheels and foot disk are assigned to the three model movements. This permits optimum adaptation of the floating mark guidance to the envisaged plotting task, for example by assigning one of the handwheels to the height adjustment in profile measurement or to the guiding of the floating mark in any model plane in terrestrial plotting. Allowance can also be made for the operator's usual working methods, e.g. by simulating the handwheel movement of a previously used analog instrument. This applies both to the assignment of the input elements to the model system and to the familiar transmission ratios. Switch-over instructions for the modes of the photocarriage motion and for the optical system permit the Planicomp to be used as a stereoplotter, a stereocomparator or a monocomparator.

To enable rapid changeover between several models, the parameter sets for up to 10 models can be stored in the P-Processor. For the changeover, only the relevant model number needs to be entered into the microprocessor.

A further group of commands is responsible for the configuration of the measurement conditions. Before the plotting process, it must be defined whether the coordinates of the model, image, photocarriage or tablet are to be measured. Any key of the P-Cursor or one of the foot switches can be defined as the trigger element for point measurement. As soon as the operator presses the defined key, a point record is generated in the data buffer of the P-Processor in the so-called single-point mode. Another type of record generation is the incremental mode where the processor automatically generates point records in line with the previously specified incremental conditions. These conditions are subdivided into primary and secondary increments, with time, travel, curvature or height increments being available as options for the primary increment. If a time increment has been selected, for example, the secondary increment "travel" prevents the remeasurement of identical points if the operator has to interrupt the measurement for a moment. With these options, the processor very effectively meets the requirements placed on dynamic measurement in photogrammetry.

When a previously specified number of point records has been stored in the data buffer, the P-Processor signals to the Host Computer via a SRQ (service request) interrupt /6/, and the measured points can then be transmitted. The interrupt mode offers the advantage that I/O activities are only initiated if data are actually available. If the computer does not feature this mode, it can call the number of records stored in the P-Processor by polling, i.e. by cyclic interrogation.

The instructions for measurement and record transmission are designed in such a way that the complete input concept of the graphical kernel system (GKS) /5/ can be handled by a driver program in the host computer. This applies to the GKS level 2c with the input categories LOCATOR and CHOICE and the input modes REQUEST, SAMPLE and EVENT for these input categories.

The execution of MOVE-TO operations is a major characteristic of analytical stereoplotters which considerably facilitates and speeds up photogrammetric measurement. The host computer is able to set computed target points in photocarriage or model coordinates, using a number of positioning instructions. The vector speed for this procedure can be specified beforehand. Profile measurements can also be performed at variable speeds which are selected by the operator with a knob. At the same time the operator can influence the floating mark movement by incremental inputs (e.g. height adjustment).

2.3 FORTRAN INTERFACE

A Fortran 77 subroutine has been generated for each command in order to simplify the control of the P-Processor in the application programs. These routines format the transferred parameters and transmit the resulting output buffer to the P-Processor via a central I/O routine. In the case of return messages, the response of the P-Processor is received and transmitted to the application programs in the form of parameters. Therefore, when the programs are transmitted to further computers, only the central I/O routine needs to be adapted to different I/O conditions. The application program itself can remain unchanged.

This Fortran interface is used by the device drivers of the PHOCUS system /1/, /4/ for the Planicomp P-Series.

3. PROGRAMMING OF SPECIAL APPLICATIONS

Generally speaking, the programming of the P-Processor and the relevant instruction set are designed for the classical photogrammetric tasks, i.e. for plotting central-perspective aerial photos of any inclination or photos taken with a terrestrial camera configuration. Due to the flexible assignment of the guiding elements, however, optimum guidance ofthe floating mark is ensured in all models.

To extend the field of use of the Planicomp P-Series to the plotting of photos and models in special photogrammetric applications, addition parameters have been included in the individual LOOP transformation steps. These addition parameters which are specified with zero in normal plotting, are taken into account in the computation of the model, image and photocarriage coordinates and can be set to any desired value. The computation of the corrections is carried out in the Host Computer.

One possible application is the performance of réseau corrections when plotting photos taken with a semi-metric camera. The actual coordinates of the réseau crosses are determined by a measuring program and are compared with the known nominal coordinates. The differences thus determined can be used as correction values. For this, a program cyclically reads the current photo coordinates, computes the correction values for these points, e.g. by bilinear interpolation in meshes, and transfers these data to the P-Processor.

In the plotting of SPOT models, the image coordinates are also changed continuously by a correction program, thus making allowance for the difference between the scanner geometry and central perspective /7/. This permits the use of all measuring and plotting programs (e.g. DTM programs such as PROSA) in their unchanged form as the P-Processor supplies the point measurements in the usual model or ground coordinate system. The floating mark is normally guided in a rectangular three-dimensional coordinate system which may have any orientation with respect to the model system. A nonlinear movement of the floating mark in the model can be achieved by means of the correction parameters relating to the model. For special applications in architectural or industrial photogrammetry, this permits changing the model height as a function of the X-Y movement and, as a result, guiding the floating mark for example on a sphere or an ellipsoid.

4. CONCLUSION

The experience gained by Carl Zeiss with the time-tested instruments of the C100 family has had a decisive influence on the development of the Planicomp P-Series. The now intelligent control electronics ensure the problem-free connection of these analytical plotters to any host computer. An extensive instruction set enables the simple generation of measuring and plotting programs. The programming of the instruments is supported and facilitated by the available subroutine libraries. Users who, for a whatever of reasons, do not wish to employ the high-performance PHOCUS system offered by Carl Zeiss are thus able to operate the instruments of the P-Series with their own programs.

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