FIRST EXPERIENCES ABOUT USER-PROGRAMMING OF THE PLANICOMP P3 AND DEVELOPMENT GOALS

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Abstract

The analytical plotters of the Planicomp P-Series are supplied with the external P-processor. Its instruction set is documented. This offers a potential for user-programming in order to extend the field of application. Development goals for classical use of P3 and use in digital off-line photogrammetry are described briefly. Applications will be focussed on data acquisition in close-range photogrammetry. An IBM PC-AT supported system configuration and user programming aspects are outlined.

1. Introduction

In spring 1987 ZEISS, Oberkochen FRG, presented PHOCUS, a new photogrammetric and cartographic software system, and the Planicomp P-Series, a new series of analytical plotters (Hobbie 1987, Leidel 1987, Saile 1987). The universal PHOCUS system serves for common needs in photogrammetry and cartography. For special applications (e.g. digital photogrammetry) of the new P-Series one is able to develop his own programs. This potential for user-programming is given through the concept of an external microprocessor, which is responsible for the basic tasks of an analytical plotter. This P-processor relieves the host computer beside others mainly from real-time tasks, thus reducing requirements of a host computer linked with the IEEE 488 interface of the P-processor.

In conjunction with the Gesellschaft für technische Photogrammetrie m.b.H., Stade FRG, and the support of the Ministry of Research and Technology,

Bonn FRG, the Institute decided to make advantage of Planicomp P-Series for digital off-line photogrammetry. The following content is focussed on considerations about software and hardware aspects. Development goals for use of P-Series are defined.

2. General objectives

As mentioned above for classical use the extensive PHOCUS system is already available. New software development that can't mean writing one's own PHOCUS, but using the potential of user-programming for applications not covered by PHOCUS. The general goal of the Institute is to make use of the P-Series for digital off-line photogrammetry. The realization of this task involves a development of an operation program including a wide range of tasks already realized in ZEISS software, but being a part of a complex program. Furtheron, with respect to the advantagous programming language C, it was decided to develop a new program written in C. This program should serve first for use of P-Series as analytical plotters and second as monocomparators in digital off-line photogrammetry. Cartographical tasks will not be taken into consideration. Program development is actually done for Planicomp P3.

2.1 Common use as analytical plotter

An extension in the field of application as an analytical plotter can be achieved through the concept of a fast exchange of parametersets in LOOP calculations and the kind of LOOP functions. As an example, the model plane described by the floating mark just moved by 2 degrees of freedom, may have any orientation in the model system. A third input coordinate may be easily achieved by any functional relation of the two coordinates controlled by the operator. A concept like this may be extended to write own LOOP positioning functions.

2.2 Use for digital off-line photogrammetry

Using analytical plotters in conjunction with CCD-cameras in digital photogrammetry is a well known new field of photogrammetry comming up over the last years (e.g. Pertl 1984, Schewe 1987). In this context the major field of

application is correlation of a stereo image pair. Concerning the P-Series ZEISS took these desirable adaption of CCD-cameras into consideration through predefined installation facilities.

For using a new Planicomp as a digital monocomparator for single point determination of artificial targeted points the concepts described by Luhmann in his yet unpublished dissertation (Luhmann 1988) are well suited and will be adapted. Estimation values for carrier/image coordinates may be easily derived, beside other ways, on the base of tablet coordinates of an orientated paper copy of the image. In this context, most of the concepts realized in the Rolleimetric RS-1, a new system for digital image processing are also applicable to a Planicomp (Luhmann and Wester-Ebbinghaus 1987).

Optical attributes of the CCD-camera, the size of the matrix-sensor and its pixel size, the effective pixel size in the carrier system must be chosen with respect mainly to the resolution limit of the comparators measuring system of 1 micron. Under condition of a known sensor location concerning the comparator system digitally determined coordinates can be transformed into the unique comparator system. In case of nonacceptable unflatness of film or glass plate, digital sensor measurement can be iteratively improved through a successive improvement of relative location of the optical CCD-camera axis until the sensor is centered over the target (see method of AutoSet-1, Brown 1987).

The optimal accuracy of digital point determination is expected to about 3 micron concerning the comparator system.

3. Hardware

As the host computer is free of real-time duties, a low cost and widespread model was chosen, just being able for running an editor and a C development software.

3.1 Actually available

- Planicomp P3 , resolution 1 micron
- digitizing tablet , resolution 25.4 micron
- IBM-AT 03 , 512 KB memory, Intel 80286/80287
- IEEE 488 bus
- ZIATECH ZT1488A IEEE 488 controller
  , maximum data rate 1 MB/sec

3.2 Future additional equipment

- CCD-Videocamera , e.g. Rollei VC-Metric with Valvo NXA 1010
- Video-processor , e.g. Imaging Technology Inc. FG-100-AT

4. Software

The software development is done with Microsoft C 5.0 and Quick C. For debugging highly developped debuggers are part of the software package. The linker allows for overlay linking and linking of different language moduls (FORTRAN,PASCAL,ASSEMBLER).

The decision for the language C was based on nowadays improved tools for personal computers with very high efficiency, economy and portability. Especially the by Microsoft delivered comprehensive run-time library with more than 200 routines including a graphic package must be pointed out. Additional libraries for different tasks are available at common software market. Furtheron, C is well suited for string processing, the main low level task in communication with the P-processor.

5. Programming aspects

The advantagous concept of the C language is described in detail elsewhere (e.g. Kernighan and Ritchie 1978), so that this chapter is limited to some short remarks for those who are thinking of self-programming of the new P-Series.

5.1 Communication concept with the P-processor

For self-programming ZEISS offers a manuel including:

a) Electronic and firmware
   - technical data
   - tasks and structure of firmware
   - photogrammetric calculations
   - absolute-positioning
   - configuration-parameters

b) Host computer interface IEEE 488

c) Instruction-set of P-firmware

This manuel and a documented set of driver routines (e.g. 40 "C" ZT-routines) for the bus communication with the host computer is sufficient to start programming. On low level that means string transfere between host and P-processor in both directions.

In the direction host to P-processor an ASCII-string consists in the given order of:

- two leading ASCII-signs as command identifier
- specified number of numerical data seperated by commas
- constant string terminator signs

With respect to the special transmitted command the P-processor expects to send an answere to the host before receiving the next command. Beside this, a communication free of errors must be garanteed through the valid parameter input range and actual device status.

Receiving a string from the P-processor one has to decode this ASCII-string, as numerical informations are lined up in the string, seperated by commas and terminated by an end mark.

Two further attributes of the P-processor for communication support must be mentioned. First, one is able to order status and error bytes of the processor containing the coded actual status and error situation. Second, event masks may be given to the processor. If an event holds true, one bit is set on a handshake chanal. The advantage is, getting quick information without sending and receiving/decoding strings on the bus.

For buffering data in the P-processor a 32 KB output-buffer (e.g. for dynamical measured coordinates) and a command input-buffer of 2000 ASCII-signs length is available.

5.2 Aspects for an operation program

Although most of the status informations needed for an operation program are available through ordering the informations from the P-processor, there are still remaining some, which are not recorded by the firmware. For example the actual moving mode of carriers or parameters for dynamical point registration. So in order to avoid operation error or to keep maximum operation control over the system the operation program should store at least these additional parameters or belonging to complex tasks also some of the P-processor recorded parameters.

In the context of C programming and memory aspects it must be mentioned that the needed length for floating point parameters send to P-processor is satisfied by "float"-variables of C. But as all floating point operations are done after conversion to "double" and float-parameters are sometimes (e.g. MSC 4.0) underlying a restricted program development concept a decision for float is not only dependend on memory aspects.

6. Actual development stage

The main commands of the instruction-set of 55 P-processor commands and basic routines for string processing (construction,decoding) are realized. A limited use of the P3 as a monocomparator with some user support (e.g. pre-positioning through tablet orientation) is possible. Further above mentioned tasks are under development.

7. Summary

The development direction for classical use in close-range photogrammetry and use in digital off-line photogrammetry, based on the Planicomp P3 are described. A low cost hardware configuration is introduced and programming aspects are outlined. As a first general experience it must be pointed out that even for functionally easy and stictly limited applications one has first

to solve the necessary basic communication with the P-processor, which means a not to underestimate time consuming task before receiving the first useful result.

8. Literature

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