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PHIPS - A NEW TOOL FOR DIGITAL PHOTOGRAMMETRY

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1. INTRODUCTION

PHIPS is the abbreviation for PHotogrammetric Image Processing System. It belongs to the line of products for digital photogrammetry from Carl Zeiss. While the transparency flatbett scanner PhotoScan PS1 is the data generating device, this new system represents the data processing part and is the central system of digital data manipulation.

Digital systems open new capabilities of data manipulation and integration. They enable the photogrammetric community to generate next to traditional products new ones. The base line of all digital photogrammetric work is the digitized image. This term will be equivalenced in the rest of this paper with the term 'digital image'. Also, the word scanning will be used for digitizing and vice versa.

Carl Zeiss presented together with Intergraph Corporation during the 42nd Photogrammetric Week 1989 the transparency flatbett scanner PhotoScan PS1. This instrument is capable to digitize either black and white or sequentially color transparencies in a user-definable coordinate system with high geometric reliability. Only region(s) of interest of an e.g. aerial image have to be scanned, and their positions are defined in the image coordinate system. This principle avoids unnecessary workload of the scanner and restricts the amount of data or the size of the digital image to a minimum.

PHIPS takes as part of its input digital imagery which may have been generated by a device such as PhotoScan PS1 or by a digitally recording device such as SPOT. One of the major purposes of this new system is the fully digital generation of orthophotos including all related tasks like image enhancement, orientation, derivation of digital terrain models (DTM), and much more. Another part of PHIPS covers applications based on either generated orthophotos or primary aerial/satellite imagery data. This involves digital image processing techniques casted to the needs of digital photogrammetry.

2. CONCEPT AND PHILOSOPHY OF PHIPS

There are two major goals for PHIPS. First, it is designed to digitally produce orthophotos of any scale, size, and orientation in a production environment. Second, it addresses a field of different applications primarily based on orthophotos or mosaiks of orthophotos which give the user a wide range of customer definable tasks.

It is designed to run on a whole family of graphics workstation computers and to comply for individual requirements. The operating system is UNIX in a multiuser and, optionally, multiprocessor environment. The software automatically recognizes the number of available or to PHIPS dedicated processors and accordingly distributes itself, but also under human control, over all or several processors. Multiprocessors are considered to be the appropriate mean to resolve for the high demands in computing power in a production environment of digital photogrammetry especially for large quantities of digital imagery. Color images are assumed as the default as well as a true color display. All interactive work is menu guided. This interface is based on OSF/Motif.

3. ORTHOPHOTOS BY PHIPS

The digital generation of orthophotos is a well known process /2/../6/, in academia. However, this task is not fully completed with the digital differential rectification. There are several prerequisites. Also, to exploit the advantages of digital orthophoto generation one can consider e.g. local and global image enhancement, mosaiks of orthophotos, annotation of invisible areas, and many other applications with digital orthophotos. PHIPS takes these aspects into account.

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3.1 Data requirements

In any case PHIPS needs at least one digital image and some information on the interior and exterior orientation of the image and a related DTM. The digital image with known interior orientation may be delivered by a scanning device, e.g. PhotoScan PS1, or the interior orientation may be measured either online interactively or offline automatically. Depending on the circumstances the exterior orientation may be introduced, e.g. as a result of an aerotriangulation. Other possibilities are either to perform a spatial resection, or if a stereomate is available to derive the exterior orientation of both images forming digitally a stereomodel.
In the latter case PHIPS derives automatically the DTM using TopoSURF which is an option to PHIPS. TopoSURF is a feature matching based DTM derivation program which evolved from MATCH-T of INPHO GmbH, Stuttgart, /1/. It may be used stand alone or as an option of PHIPS. If TopoSURF is not available the DTM has to be introduced from some definable database source or from a simple text (ASCII) or binary file.

3.2 Hardware requirements

Currently, PHIPS is running on Silicon Graphics workstations with 1, 2, 4, or 8 processors (CPUs). Every PHIPS workstation has the ability for a stereo display based on the liquid crystal shutter principle. This technique is not meant to be the adequate solution for permanent stereo work as with an analytical stereoplotter, but to be the appropriate tool for visual quality control via stereo-orthophotos.

Considering a color image as the standard the minimum amount of disk space is proposed to be 1 GB. The following table may give an overview on the disk space consumption of digital monochrome or color images with different pixel sizes and differently sized image areas scanned with PhotoScan PS1:

PIXEL SIZE	IMAGE AREA		
μm^2	10 x 10 cm^2	15 x 15 cm^2	23 x 23 cm^2
monochrome			
120 x 120	0.7	1.5	3.6
60 x 60	2.7	6.0	14.1
30 x 30	10.6	23.9	56.1
15 x 15	42.4	95.4	224.3
7.5 x 7.5	169.6	381.5	896.9
color			
120 x 120	2.1	4.5	10.8
60 x 60	8.1	18.0	42.3
30 x 30	31.8	127.2	168.3
15 x 15	127.2	286.2	672.9
7.5 x 7.5	508.8	1144.5	2690.7

TABLE OF DISK SPACE CONSUMPTION IN MEGABYTE [MB] OF SCANNED IMAGES

All workstations except the low end are equipped with a true color display for 8 bit in red, green, and blue each. By default all workstations come with SCSI (Small Computer System Interface) disks.

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The high end workstations may be delivered with IPI2 (Intelligent Periferal Interface) disks which are superior in their I/O response. Additionally, high end workstations may possess a logical volume system (LVS) and/or disk striping. LVS manages the distribution of big files over several disks and assures full usage of disk capacity. Disk striping performs I/O simultaneously on several dedicated disks. Beside the common network services under UNIX one can equip the workstations with FDDI (Fiber Distributed Data Interface) which is supposed to be 10 times faster than Ethernet, or with Ultranet which is an order of magnitude faster than FDDI.

3.3 Production

All jobs working on large images are designed to be offline or batch processes. One prepares a specific task with overview images and sets the big jobs into background, thus improving throughput. The user may run several, different processes at the same time, e.g. differential rectification (= orthophoto generation), rectification for epipolar images, and other filtering of full images. One has continous menu driven control over all processes and can schedule and prioritize arbitrarily down to the process-to-processor/s assignment level. Interactive work is reduced to preparation, plausibility checking, visualization, local image processing, job control, and data queueing.

Orthophotos are generated on an one-image-one-orthophoto or several-images-one-orthophoto basis. In the latter case regions of best visibility will be determined if appropriate geometric aerial images and DTM information are available. Another strength of PHIPS is the generation of mosaiks of orthophotos. This technique digitally merges adjacent and/or overlapping orthophotos to one new orthophoto. A radiometric fitting is included.

4. APPLICATIONS WITH PHIPS

4.1 Image processing

PHIPS is designed to comply with the proposed ANSI X3H3.8 Programmer's Imaging Kernel (PIK) standard. The imaging library will be continously increased towards this standard after the routines have been adopted to effectively run on large digital images.

There is an interactive interface which allows to perform all imaging tasks on loaded, i.e. displayed, or disk images. Local or global operations, e.g. neutralization or convolution, may be invoked interactively. The system decides itself if the task is preferably performed in batch or in foreground and either requests the user or applies the preset configuration parameters.

4.1.1 Measurement

The measurement is done either interactively, or semiautomatically, or even fully automatically. Interactive measurement may be supported by a digital magnification glass. In the semiautomatic mode one can point with the mouse to the region in the overview image where the marked point, e.g. fiducial, is supposed to be. Then a user definable and/or selectable point mask is run over the window. As the result one obtaines the measured point with subpixel accuracy. These floating point pixel coordinates are then transformed into image coordinates. A once oriented image keeps the orientation information and is this way always available for further image or object coordinate evaluation.

4.1.2 Image generation

Non image data can be converted into raster data and thus be displayed. A typical example is DTM information which is transformed into an elevation or slope image. Also, contour lines are converted from vector into raster data. Applying the proper scale these images may then be joined with orthophotos. This way many combinations of thematic data can be combined with orthophotos.

4.1.3 Data set joining

PHIPS may be used to join orthophotos with other raster data sets or with vector information in either transparent or opaque mode. The degree of transparency is selectable. Vector information, e.g. coming from PHOCUS or a HP-GL file, may be stored in text or binary coded files. This gives the user the possibility to combine orthophotos with any data set which has the proper data format the specification of which will be released. Thus, it is possible to produce any type of orthophoto maps.

4.2 Perspective views

Perspective views are generated with overlaid image or orthophoto/mosaik information. Again, vector information can be projected into these images giving planning departments new capabilities of not only photo-realistic but (photo-)true images. Also, perspective views can be generated for stereo viewing mode which gives the best impression for e.g. planned changes caused by a road reconstruction.

4.3 Service routines

An extensive library to faciliate I/O tasks is implemented. The functions access different storage media and allow im/export of several raster data formats and textual (ASCII) coordinate information. This includes data format conversions for different scanners and plotters. Networking capabilities are accessible under the control of PHIPS. For projections other than central according coordinate transformation packages are included, e.g. geodetic transforms for SPOT.

5. CONCLUSIONS

With this new system Carl Zeiss continues its line for digital photogrammetry. PHIPS processes and handles images primarily with the goal to generate orthophotos and to run applications based on them in a production environment. Due to the commitment to use standards wherever technically possible this is a comfortable system which may be adopted to existing systems or driven stand alone. With its capabilities to visualize mass data, generate DTMs, overviews, or full sized new constructed images, and convert raster data for im- and export PHIPS may be applied for many purposes.

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ABSTRACT

This contribution presents the concept, design, and contents of PHIPS, the next step towards digital photogrammetry at Carl Zeiss. A prototype version is demonstrated on the 43rd Photogrammetric Week, Stuttgart, September 9 to 14 1991. The system generates digitally orthophotos and exploits the advantages of processing all data digitally. This is being reflected by many possible applications of which only a few are addressed in this article and in the practical demonstration. In a later release this system will be able to generate near ideal orthophotos depending on the resolution of the digitized imagery and the degree of information contained in the DTM. Special algorithms will detect invisible object areas in images and search for visibility in images contained in an image data base. Arbitrarily sized orthophotos are possible by merging several orthophotos to a mosaik applying image processing algorithms. Automatic orientation of stereo pairs and derivation of DTMs via TopoSURF are optional parts of PHIPS.

PHIPS - EIN NEUES WERKZEUG FÜR DIE DIGITALE PHOTOGRAMMETRIE

ZUSAMMENFASSUNG

Dieser Beitrag stellt Konzept und Inhalt von PHIPS vor, welches als Softwaresystem den nächsten Schritt in Richtung digitale Photogrammetrie bei Carl Zeiss aufweist. Eine Prototyp-Version wird auf der 43. Photogrammetrischen Woche, Stuttgart, 9. bis 14. September 1991, vorgestellt.
Das System generiert digital Orthophotos, wobei alle Vorteile der Digitaltechnik zum Tragen kommen. Dies wird durch die vielen Anwendungsmöglichkeiten unterstrichen, von denen hier nur einige exemplarisch vorgestellt sind. In einer späteren Version kann das System nahezu ideale Orthophotos erzeugen, die lediglich durch die Auflösungen des digitalisierten Luftbildes und des Digitalen Geländemodells (DGM) begrenzt sind. Besondere Algorithmen suchen verdeckte Gebiete in einem Ausgangsbild und setzen automatisch ihre Suche nach Bildern fort, in denen die Verdeckungsgebiete sichtbar sind. Grundlage hierfür ist eine Bilddatenbasis. Orthophotos können zu beliebig großen Mosaiken zusammengesetzt werden, wobei gleichzeitig eine radiometrische Anpassung vorgenommen wird. Es bestehen in PHIPS weiterhin die optionalen Möglichkeiten, Bildpaare digital zu orientieren und daraus automatisch mit TopoSURF ein DGM abzuleiten, welches dann als Grundlage für die Orthophotoherstellung verwendet werden kann.

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