

Image Digitization Using PHODIS SC/SCAI

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ABSTRACT

With PHODIS SC Carl Zeiss is offering a system for scanning which fully integrates the high performance scanner SCAI in the digital photogrammetric workflow. High speed and a high degree of process automation are essential criteria for the efficiency of state-of-the-art, high-performance photogrammetric scanners. Only few manual operations are still required for single scans and the scanning of roll film.

1. INTRODUCTION

Digital photogrammetry has become an integral part of today's photogrammetric work processes. A major factor in this context is the work flow and handling of the instruments. The productivity and efficiency of photogrammetric scanners have significantly increased during the last few years, the decisive criteria being shorter scanning times and a high degree of process automation. Another aspect of increasing importance is the exchangeability of the collected data with other modules or software systems. It is also essential that systems of this type permit fast and easy familiarization by the user. Carl Zeiss as a manufacturer and vendor of hardware and software for the complete photogrammetric production chain meets these challenges by offering the PHODIS digital photogrammetric system.

2. PHODIS AND ITS STRUCTURE

PHODIS (Photogrammetric Digital Image Processing System) is the all-round photogrammetric digital image processing system from Carl Zeiss. It features a modular structure permitting users to tailor the system to their specific requirements.

The following modules are available:

PHODIS Base	Includes basic functions for image processing and photogrammetry and is required by all the following modules
PHODIS SC	Module for image scanning using the SCAI scanner
PHODIS AT	Module for fully automatic aerotriangulation
PHODIS ST	Digital stereoplotter
PHODIS TS	Automatic generation of digital terrain models
PHODIS OP	Module for orthophoto generation and mosaicking
PHODIS M	Monoplotting module

2.1 PHODIS Project Structure

PHODIS features a standard project structure which is used by all its modules. This primarily refers to the directory structure which is defined via so-called KEYWORDS pointing to the different directories. A directory path is assigned to each KEYWORD. These directory paths may include KEYWORDS previously defined by recursion. As a result, the actual data can be filed on different hard disks and in different computers and can be combined into a project using the project file. The project file used in PHODIS SC is then processed by the other modules.

All settings made within any of the modules are stored in a parameter file. It is therefore advisable, in PHODIS SC, to create several different parameter files for typical tasks, e.g. black-and-white negative-into-positive scans, color scans, infrared scans, etc. Such parameter files can be used as patterns and can be adapted as required for the specific application.

3. THE PHOTOGRAMMETRIC IMAGE AS A PART OF THE PHOTOGRAMMETRIC DATA

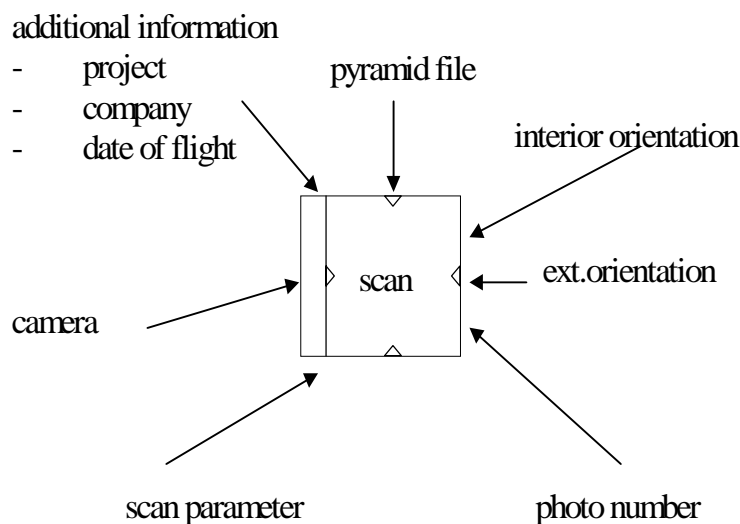


Figure 1: The photograph and additional data.

The scanned image cannot be considered in isolation, but must be seen as part of a complete set of photogrammetric data (Figure 1). This information comprises, for example, the camera with its calibration data used, the parameters of the interior orientation, the photo number and further data such as the date and location of the mission, the number of the film roll, the company flying the mission, etc. PHODIS SC automatically assigns this data to the image right during the scanning process, thus ensuring that the information is available to all PHODIS modules immediately after the scan. If, for example, aerotriangulation is to be subsequently performed by PHODIS AT, the photo numbers are already assigned to the correct image files at this early stage, and there is no longer any need for laborious and often error-prone manual editing.

4. PHODIS SC

PHODIS features an OSF-Motif user interface which ensures that the entry of parameters and the execution of actions are largely intuitive. All procedures have been combined in logical menus. Context-related on-line help supports the entry or selection of parameters. Figure 2 shows the PHODIS SC start menu.



Figure 2: Start menu of PHODIS SC.

In the scanning process with PHODIS SC, the following files are created:

image file (*.tiff, *.tld),

binary file containing the image data (grey levels)

scan information file (*.sin),

ASCII file containing the scan parameters

image information file (*.di).

binary file containing the orientation data, the logical photo number and other image parameters.

4.1 Scanning of Individual Photos

The scanning of individual photos involves the following procedures:

- Entry of the scan parameters
- Entry of the file parameters
- Definition of the photogrammetric functions
- Prescan
- Scan

4.1.1 Entry of the Scan Parameters (SETUP SCAN)

The following entries are made here: the **pixel size** (7μ , 14μ , 21μ , 28μ , 56μ , 112μ , 224μ), the size of the area to be scanned and its position of this area on the photoholder plate. The position of the scan area can be defined either numerically or interactively using the mouse. A prescan (see the relevant paragraph) is prerequisite for the precise interactive definition of this area.

A further scan parameter is the **selection of the color mode**, i.e. the specification whether a color photo should be scanned in black-and-white or color. For the derivation of a black-and-white image

from a color photo, the specific color weighting required can be entered. Following the selection of the color mode, the size of the image in bytes is immediately displayed.

The next menu section is used to set the parameters for **exposure, contrast, positive-negative conversion and color weighting**. The operator has the possibility of either using the default settings or of selecting user-defined imaging functions contained in a Look-Up-Table (LUT). For each color channel, the LUT permits the 12 internal bits (4096 grey levels) of SCAI to be imaged to the 8 bits (256 grey levels) of the output file via reference points or fixed functions.

The next entry is the **image position**. This enables on-line rotation and /or mirroring of the image in the image file, a process require for some digital aerotriangulation programs.

Finally, the so-called Scanscript can be executed. Scanscript corresponds to a command file (Shellscript) executed at the UNIX level. It is used to copy the created image files to another computer, to send a mail to another computer indicating that the scan has been completed, or to convert the image data into the customer's target format using an external conversion program.

4.1.2 Entry of File Parameters (SETUP IMAGE)

This procedure involves the assignment of a file name to the scan and the definition of the image file format (TIFF or TLD). In addition, the photo number can be assigned to the image at this stage. The number is stored in an image parameter file (extension .di) and is subsequently used, for example, in PHODIS AT (fully automatic aerotriangulation). Automatic incrementation of the image file name and / or photo number can be selected.

4.1.3 Definition of Photogrammetric Functions (SETUP P-ACTIONS)

This operation assigns, for example, the camera used for photography. It also also allows the specificatin that the associated pyramid file should be generated for each image after the scan, and that an automatic interior orientation should be performed.

4.1.4 Prescan (SCAN PRESCAN)

The prescan permits checking the selected scan parameters such as the position of the photo in SCAI and the brightness and contrast settings. If any of the scan parameters needs to be changed, SCAN SETUP can directly be called up from here. It is also possible to call up a histogram for the assessment of the scan. The prescan is performed with a resolution of 224 μm and takes about 1.5 min. for 230 x 230 mm. The scan area can be interactively varied using the mouse.

4.1.5 Scan (SCAN START)

Once all parameters have been set, the actual scan is started. An easy-to-read list of all major settings is once again displayed for checking and correction (Figure 3). The display also shows the estimated duration of the scan, depending on the parameters involved (e.g. 9 min 30 sec for 14 μm , 230 x 230 mm). The execution time of the scan is not only dependent on the selected exposure time, but also on the **SPEEDTABLE**. The latter determines the travel speed of the SCAI scanner, with allowance made for resolution and the specified on-line rotation and mirroring of the image. Needless to say, a further decisive factor is the performance of the computer platform used, which means that different SPEEDTABLES are available for different computer platforms.

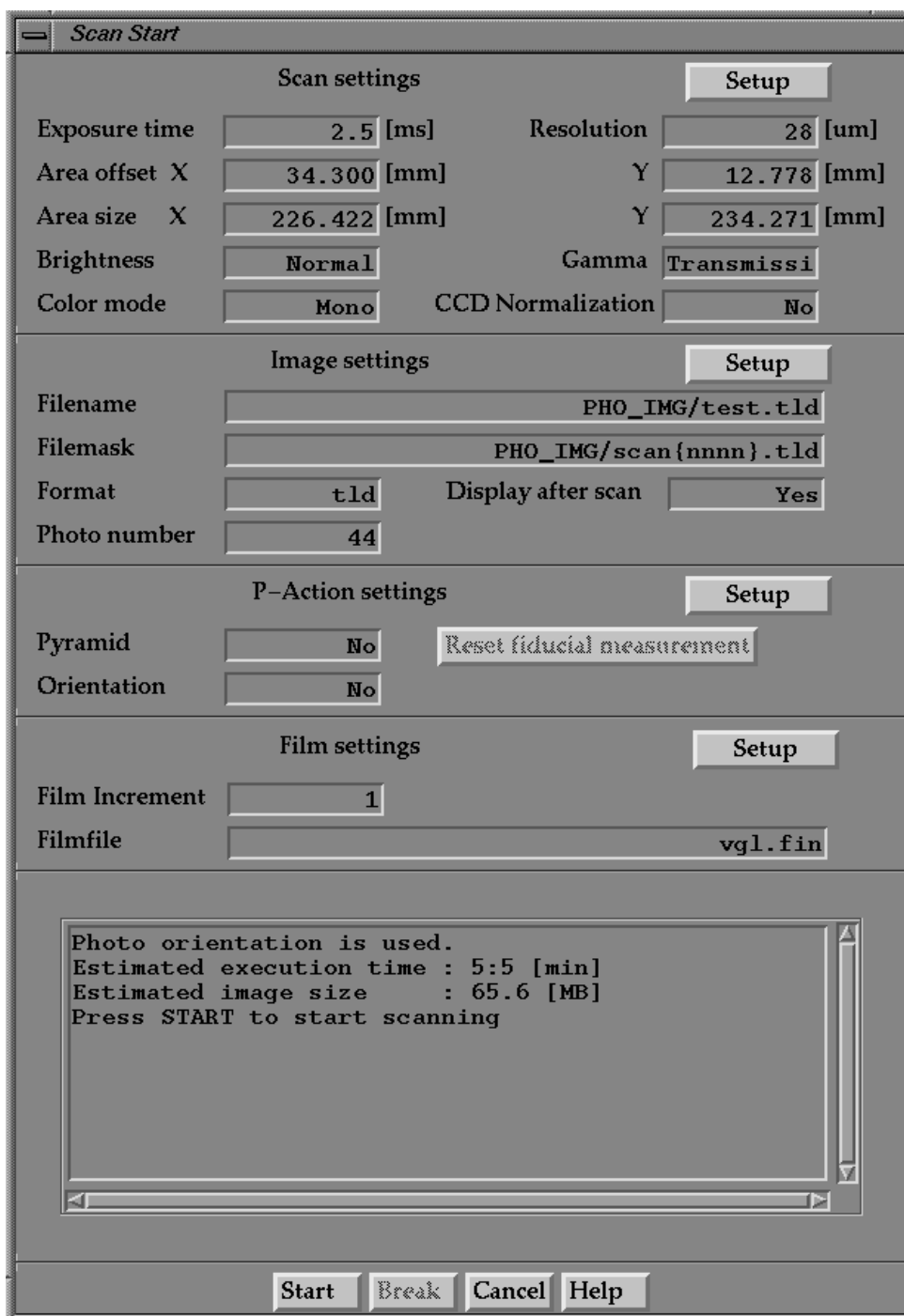


Figure 3: Parameter overview in the scan menu.

4.2 Scanning of Roll Film

PHODIS SC permits fully automatic scanning of roll film. For this purpose, the retrofittable AutoWinder attachment is available for SCAI. This permits scanning to be performed without the presence of an operator. Film transport and the recognition of the frame edges are fully automatic. The basic requirement for the scanning of roll film is the **film file** which is created for each roll film and contains all settings defined for the individual photos. SCAI uses the film file as a control file for sequential processing. The processing of a film file can be interrupted at any time and resumed later on, as long as SCAI remains actively connected with the control computer.

The scanning of roll film requires the following procedures:

- All procedures involved in single scans, except prescan and scan (see above)
- Creation of the film file
- Editing and execution of the film file

4.2.1 Creation of the Film File (SETUP ROLL FILM)

The film file allows the entry of explanatory comments, e.g. where the mission was flown, which project is involved, etc. The number of photos included in the film is entered. In addition to the previously mentioned files, an **overview file** can be created, containing the scanned overviews of all individual images. This overview file can then be archived together with the film file and considerably facilitates the *sampling* of the film. The size and resolution of the overview can be specified here.

The area to be scanned and the position of the left-hand frame edge on the photoholder plate are entered; likewise the area for automatic frame edge recognition (alignment). The AutoWinder always advances the film by a predefined distance per frame (e.g. 260 mm). Since the intervals of the frames are not always identical, it may happen that the left-hand frame edge does not precisely stop at the predefined position. The scan area is then adjusted within a certain tolerance. If the positioning accuracy exceeds this tolerance, the AutoWinder automatically corrects the position. During the entry, the default values can either be confirmed or edited. When the menu is ended, the film file is created.

4.2.2 Editing and Execution of the Film File (SCAN NEW ROLL FILM)

This menu is used for editing and execution of the film file. The following actions can be assigned to each photo: positioning (alignment), overview scan, scan, parameter setting.

The photos to be processed (e.g. 1-15) are entered, followed by the selection of the actions to be performed (Alignment, Overview Scan, Scan, P-Actions).

The default settings for image rotation, brightness, color, name and photo numbering are adopted from SETUP SCAN and SETUP IMAGE. These default values can be replaced by specific entries as required. If several frames are skipped (e.g. 10), it is advisable to perform a new alignment after every five frames, for example, to ensure that the frame edge continues to be reliably found. This method also permits automatic processing of composite roll film from which, for example, a section has been explicitly cut out. After editing of the film file has been completed, the roll film is loaded. The next procedure is the definition of the left-hand edge of the first frame (alignment).

Then the execution of the film file is started (EXECUTE FILMFILE), and the roll film is processed frame after frame. In this way, a complete film roll can be processed in overnight operation, with the images, inclusive of their interior orientation, being available on the next morning for further use. It should be emphasized that it takes the operator no more than about 1 or 2 hours to pre-prepare the image file of a complete roll film which requires several hours of scanning time.

5. OUTLOOK

Because of the outstanding performance the photogrammetric high performance scanner SCAI has reached it's worldwide acceptance in the market. With the AUTOWINDER as an rollfilm attachment for an interactive, but mainly automatic usage the efficiency and processing speed is raised.

PHODIS SC as the scanning functionality in PHODIS is using these abilities of the SCAI/autowinder for a seamless and complete integration of the images into the following PHODIS-workflow.

6. REFERENCES

- Dörstel, C. (1995): PHODIS Innovations, Photogrammetric Week 1995, Wichmann Verlag, Karlsruhe, pp. 5-10.
- Mehlo, H. (1995): Photogrammetric Scanners, Photogrammetric Week 1995, Wichmann Verlag, Karlsruhe, pp. 11-17.