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# SISCAM softcopy photogrammetric workstation

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**Abstract**

With this report we present SISCAM systems in digital photogrammetry field. Particularly are described the STEREODIGIT, a digital stereoplotter which presents some innovating solutions and MICRODIGIT, a portable stereoplotter which can be friendly used directly on the field.
SISCAM inherited the long experience of Officine Galileo in designing and manufacturing analytical and analogical stereoplotters.
In this report we describe the solutions to set the stereoscopic vision and the possibilities to extend the field of application of the photogrammetric techniques.

## Introduction

Digital images are used in photogrammetry in two different ways. The increasing power of inexpensive processing systems allows the realization of packages for geometrical and radiometrical image transformation.
This last possibility allows the fulfilment of softcopy systems for producing numerical orthoimages. The original image is not used directly for measuring but is drawn up for getting a new image geometrically correct.
The second method uses digital images for 3-D measurements in a fully similar way as images on film are used in an analytical stereoplotter, i.e. as primary source for generating pairs of plate coordinates which, suitably processed, are getting the 3-D coordinates of the material point.
Theoretically speaking a digital stereoplotter does not differ therefore from an analytical one.
Digital stereoplotters have had recently a large diffusion on the market for a better operative flexibility, for the possibility of extending the field of application of the photogrammetric restitution and finally because they can better integrate the photogrammetric plotters with geographical information systems.

## 1. Systems for monocompilation

In this category the systems which use the

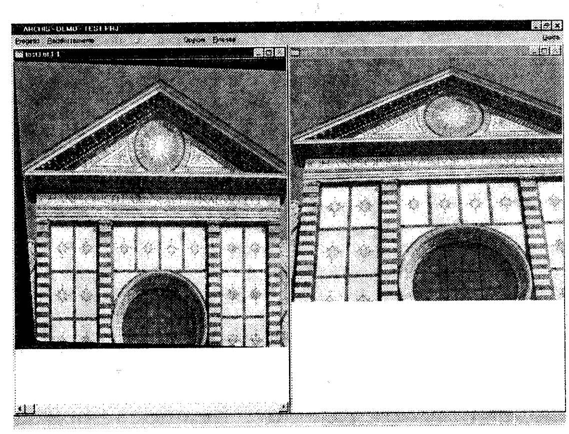

**Figure 1**

image for generating a successive one which is corrected for the perspective effects and the heights displacements are included.

When the object is near flat it is enough to eliminate the consequences of the perspective effects by means of a global transformation of homographic type. Our ARCHIS software, an user friendly package in Windows environment (see Fig. 1), allows the production of a photoplane of either aerial or terrestrial photos. When the objects to be treated are 3-D ones, ORTHOMAP package, is producing "orthoprojection" where the heights displacements are corrected pixel by pixel on the base of a digital model of the object: the relatively complex operation mode is addressing this software mainly to the cartographic production.

## 2. The systems for digital restitution

### 2.1 Stereodigit

A basic problem to solve in designing a system for digital restitution is to realize the stereoscopic vision; images correlation, an important feature in a digital stereoplotter, cannot be considered an alternative way to the human collimation: in many cases the automatism does not work or gives unsatisfactory results and is therefore required the supervision of the operator.
Numerous are the methods which allow the

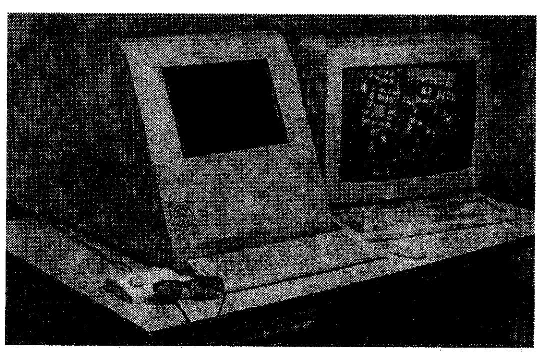

**Figure 2**

vision and the stereoscopic collimation of a digital stereopair: among these methods we can mention systems including traditional optical components (mirrors and lenses) for separating stereoscopic images. In other systems the stereoscopic vision is achieved electronically by an high frequency switching of the images concerning each eye.

We operate a designing choice realizing a stereovision with 'no alternate filtering': we get a more comfortable vision. This choice has important influence in defining the instrument architecture.

### 2.2 Stereovision in the Stereodigit plotter

The system we are using for getting the stereoscopic vision in the Stereodigit does not contemplate the use of optical systems inserted between the operator and the observed images.
We are using two high brightness flat monitors; in front of which are mounted two polarizing filters. The two displays are mounted at 90° each other; on the diagonal is positioned a beam splitter which has the task to optically merge the images and transmit them to the observer.
The images, filtered by the polarizing screens, merged by the beam splitter, arrive simultaneously to the operator's eyes. A pair of glasses with polarizing lenses oriented in the same way as the screens allows the separation of the images giving therefore a right

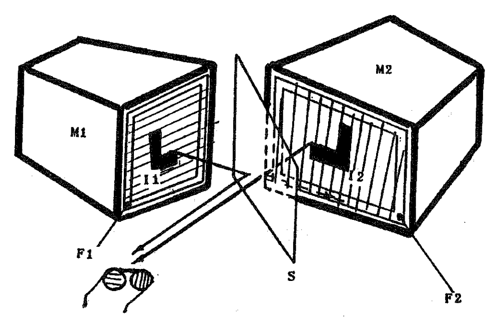


**Figure 3**

stereoscopic vision.(see Fig. 3).
The beam splitter must be realized in a way which cannot alter the polarization imposed by the filters in front of the monitors; moreover it must have a low energy absorption and a good balance between transmitted and reflected light.
The advantages of this kind of stereovision are mainly the following two ones:

- The vision is more comfortable and agreeable because of the absence of flickering phenomena due to a dynamic alternate polarization. We assume that this characteristic is very important considering that an operator is working for many hours at the stereoplotter.

- The image resolution is fully exploited: in fact it is not necessary to present the images in an interlaced mode.

### 2.3 Stereodigit architecture

The structure of Stereodigit is in principle very similar to that of an analytical stereoplotter. The devices for moving the frames are in this case substituted by two image processors (practically two PC), each one with its own magnetic storage, the relevant basic software and a graphic board for driving the monitors. The two units are linked together allowing therefore the exchange of the data in real time (position of the floating mark); one of them, (named master), is connected with an host computer which has the task of data collection and editing.
The two units are connected together and with the host computer in a local area network for the download of the images forming the stereopair.

### 2.4 Microdigit

The design of Stereodigit has allowed to

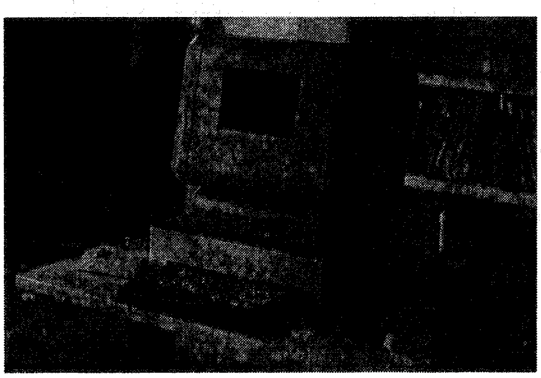

**Figure 4**

Siscam the manufacture of a portable version of the instrument named Microdigit (see Fig. 4). This instrument is using two 10" liquid crystal displays and two portable computers installed in a compact supporting structure. Siscam has to obtain a light instrument (less than 20 Kg) and a reduced shape (around 0.5 cm meter), powered also by battery, with the same characteristic of productivity of the Stereodigit. Microdigit can therefore be used directly on the field. Joint to a digital camera allows of testing stereoscopically the quality of the images immediately after they have been done.

### 2.5 The use

As we said, Stereodigit and Microdigit have all the functions of an analytical stereoplotter; in addition they have a set of possibilities that can be found only in the most sophisticated instruments:

- Zoom in and out practically unlimited
- Floating mark with shape, colour, and dimension selectable by the operator.
- 3-D superimposition
- Radiometric correction of the images
- Negative images can be transformed in positive ones and vice versa
- Automatic stereocollimation by means of images correlation

A set of function, typical of a digital system, can be joined to the above mentioned:

- Possibility to use the instrument as a "stereoscopic terminal" of a geographic information system if in the data bank were loaded the "oriented stereopairs".
- A block of oriented stereopairs can be treated as a single object for 3-D measurements and stereoscopic investigations: it can replace a traditional map or orthoimage.
- Fast updating of an existing map.
- Inquiry system for cadastrial purposes.

## 3. Digital images

Input data to the system are exclusively (if we don't consider the control points coordinates and pre-existing vector data) digital images to be used for the stereorestitution operations; such images are in many cases stored in files of considerable dimension specially when aerial photos are used. Therefore is very important the connection of the digital stereoplotter in a local area network for data exchange.
Moreover, if we think that a digital stereoplotter has not mechanical devices

involved in the image coordinates measurements, we can deduce that the accuracy of the restitution depends only on the quality of the input data.
In other words, the digital stereoplotter does not bring any kind of errors in the stereorestitution process.
Digital images used for stereorestitution can have two different origin:

- images coming from digital cameras
- images coming from scanning devices

In the first case, the good quality of the photo camera either from mechanical or optical point of view, guaranties the goodness of generated images; in the second case the image created on the traditional film, will be transformed in numerical data by an optical-mechanical device that can introduce errors in the geometry of the image: the problem of accuracy change from the stereoplotter to the scanner device.

### 3.1 Images from digital cameras

In the recent past have been marketed world-wide many models of cameras able to output directly a digital image in the most used formats.
Generally these cameras (e.g. Nikon E2, Kodak DCS 420 or 460) are used by photo-reporters and therefore they are producing images not suitable for photogrammetric purposes, where high precision are commonly required. However, considering that the image coming from a digital camera are usually affected only by deformations due to optical aberrations of geometrical type (are absent, for instance, the deformation due to the not perfect flattening of the film), we realized an auto-calibration procedure of the camera based on a shot of a tridimensional target and an automatic processing of the image.
The procedure, based on auto-calibration techniques, is easily done and can be repeated on images taken at different distances from the target giving information on the distortion and principal point position in all conditions of focusing of the lens.

### 3.2 Images from scanners

To use pictures on film in a digital system it is necessary to transform them in numerical images by means of scanners.
The accuracy of the data collected by a digital system depends mainly on the precision of the scanner that should be realized with the same quality of an analytical stereoplotter.
We can classify the scanners in two categories:

- High precision photogrammetric devices
- Commercial scanners for publishing

Photogrammetric scanners are characterised by high geometric accuracy, high resolution (over 2500 dpi) and the possibility to choose the scanning direction to align it with the one identified by the fiducial marks. These devices are very expensive and also the working costs are elevated.
The costs of the scanners can reduce the diffusion of the digital systems, therefore we elaborate a calibration procedure so that even the image scanned with a publishing devices can be used for photogrammetric application with good accuracy results.
For the calibration we use a high precision grid, the same used to calibrate an analytical stereoplotter. Such a system, similar to that used on the reseau cameras (those without the film flatness devices), increases considerably the accuracy.
The procedure performs the following steps:
1. Scanning of the grid superimposed on the film.
2. Automatic search of the grid nodes and calculation of the homographic correction parameters.
3. Interior orientation of the photo.
4. Digital image resampling for scanner distortion and lenses aberration correction.

## 4. Image correlation

The well known procedure can perform the collimation automatically demanding to a processing system the identification of the homologous points.
It is easy implemented in the digital systems. Besides the help to the operator in the measuring job it can increase the precision of

the altimetric collimation because it can work with sub pixel facility; the homologous points are identified with an accuracy of approximately one third of a pixel.

The main application of the image correlator is the automatic Digital Elevation Model collection. This task is very annoying and slow if done by an human operator, but for its relatively simplicity, no photointerpretation is required, can be done by a software. There is a large request of DEM for the increasing diffusion of digital orthoprojector.

The image correlation procedure is not completely deterministic because the homologous points are identified using same similarity criteria that can fail in particular conditions. Therefore it is necessary to join it with a digital stereoplotter for the control, done by an human operator, of the points the calculation has classified as dubious.

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