

# DIGITAL PHOTOGRAMMETRIC STATION "DELTA"

Malov V.	SPL "Geosystem"	Ukraine
Oleynik S.	SPL "Geosystem"	Ukraine
Gajda V.	SPL "Geosystem"	Ukraine
Zotov G.	CSRIGSM	Russia

## Commission II, Working Group 2

**KEY WORDS:** Photogrammetry, Space, Mapping, Orthoimage, Stereoscopic, Digital, Scanner, DEM/DTM.

### ABSTRACT

This poster describes structure, features and principle of functioning the digital photogrammetric station "Delta". It serve to digital mapping and making of orthoimages from airphotoes and spacephotoes. Source materials is scanning by high precision photogrammetric scanner. The Scanner is the general part of whole complex and allow to scan images with pixel size 14,28,56 mkm and 256 grey levels, so accuracy of positioning is 3 mkm. Then operator works with a digital images of photoes which store in files on server. The software provide inner, relative (auto with correlation) and absolute orientation of photoes on computer's monitor using lens stereoscopic unit or stereo-eye-glasses. After model has been oriented operator makes vector digital plans and maps in stereo data collections software which include many service functions. All processes are similar an analytical photogrammetrical station works but have some advanced possibilities. Such as stereoscopic visualisation both vecor map and bitmap photoes and automatizing relative orientation.

### 1. INTRODUCTION

Scientific-production laboratory "Geosystem" attached to the Main Administration of Geodesy, Cartography and Cadastre at the Cabinet of Ministers of the Ukraine and specialized in design of

analitical photogrammetric instruments, "Stereoanagraph" by name, presents its latest product - digital photogrammetric station (DPS) "Delta". Its apperance is adduced on Figure 1. Digital technology replaces analitical one because this tendency is known to

be observed in adjacent to photogrammetry fields of knowledge, in science and technology on the whole. The greatest contribution to realization of the main idea has been made by the producers of computing techniques. Photogrammetrists have had an opportunity to use external memory of 1-10 Gb hard disks for storing digital photographs and multiaperture photoelectric sensors on CCD-lines.

The main feature of digital stations is usage of a digital image allowing to realize some additional possibilities when photogrammetric processing the photographs, for example:

- ◆ automatization of stereo-indefication of points on photographs;
- ◆ possibility for superimposition of vector- and raster-images.
- ◆ fast manipulation with images;

## 2. DPS STRUCTURE

DPS "Delta" includes:

- ◆ Precise photogrammetric scanner.
- ◆ File-server.
- ◆ CD-Recorder for long-term storage of data.
- ◆ Network equipment.
- ◆ Working places for stereomaking and orthophototransforming.

The parts of the system interact in the following way. A chosen file-server joins scanner, working places and additional peripheral equipment in a common system. It also assures optimal distribution of resources, storage and transmission of data. For the purpose of heightening the speed of data communication the server is bound up with working places through network equipment 100Mb-ETHERNET.

Computer modifications for scanner and working places have to be not less than PENTIUM 100/16 Mb with disk memory - 1 Gb. Not less than 17" monitors with the resolution of 1024\*786 elements under 256 gradation of grey in graphic mode are used for stereomaking. Either eye-glasses providing with control shutters or prismatic stereoscopic nozzles are used for stereoviewing.

Proceeding from the range of settled tasks, the number of working places can be changed. However, it is optimal to use not less than 4 working places for stereomaking and orthophototransforming. Such configuration will allow to distribute the cost of scanner and output devices for collective use and to reduce their own specific cost.

### 3. SCANNER WORKING PLACE

Digitizing working place has been organized on the base of a photogrammetric scanner designed for DPS. Fundamental distinction of the scanner in comparison with well-known non-photogrammetric scanners is high resolution and positioning precision of each element of raster.

#### General Technical Data:

- \* Maximum size of photographs 30\*30 sm
- \* Resolution of observing system 1 micron
- \* Mean-square error of positioning less than 3 micron
- \* Minimum resolution element of digital photograph 14\*14 micron
- \* Sensor type CCD-line
- \* Number of elements in the line 2048
- \* Number of levels for brightness quantization 256
- \* Photochannel performance 1 Mb/sec
- \* Dimensions 80\*80\*40 sm
- \* Weight 50 kg

Meaning constructive design, the scanner is an automatic monocomparator which has fixed axis of sight and mobile in two directions photograph. Scanning is accomplished in automatic mode by strips along one of the sides of photograph. The width of the

strip is equal to the width of the image of an active CCD-line part. High accuracy of coordinating is assured by means of direct current servosystems with precision transducer of the type "position encode" in feedback circuit. Metrological calibration of the scanner allows to take into account all the main systematic errors of design: eliminate scale errors of digital image and unperpendicularity of axes of the instrument. Prior photometric correction of phototone is realized during scanning. Total time required for digitizing one photograph with size 23\*23 sm with the highest resolution is equal to 35 minutes.

### 4. STEREO-MAKER'S WORKING PLACE

As compared with analytical photogrammetric station, work with DPS has got a number of considerable features, such as:

- ◆ stereo-viewing terrain model onto display screen through eye-glasses;
- ◆ possibility for layer by layer superimposition of a vector-image on a raster-one;
- ◆ automatization of photographs orientation by using correlation method of identification of the same points;

- ◆ automatic obtaining digital geographical model (DGM) for use in orthophototransforming process.

High speed of image regeneration regardless of the size of stereopair file allows to gain an efficiency in raster-image processing. All that allows to pass from one part of stereopair to another practically in a moment and to change the image scale on the monitor screen. Changing the scale of an initial digital image is realized in a discrete way with coefficient 2 in the direction of both reduction and enlargement. In the last case screen image is formed from the points which are the result of interpolation of an initial matrix. Images like that allows to be processed with subpixel accuracy.

Correlational processing digital images is realized in two modifications:

1. two-dimensional correlation for points identification during relative orientation of photographs;
2. one-dimensional correlation for creating a digital geographical model (DGM).

In the first case operator only picks out some zone for the points of relative orientation, but precise identification is realized automatically. In the second case transformation of an initial digital

photograph onto a surface parallel to the survey base is accomplished at the beginning. Only then there will be no vertical parallax along all the stereopair area regardless of terrain relief. It allows to use fast algorithm of one-dimensional correlation. Raising the accuracy of identification is achieved by reduction of pixel - element of resolution - at the expense of dynamic interstepper division up to 1/8 of pixel.

Authenticity of restoring relief is checked automatically according to the correlation coefficient of each point. When the coefficient is coming down below a definite level this point is either struck off the list or identified by operator.

Throughput of used algorithm is illustrated by the following data: DGM with 1 mm-step in the photograph scale (about 17.000 points) is restored for 20 minutes and, by the way, all errors satisfy the demand for making orthophotoplans for unbuilt territories.

DPS software has been created for two operating systems: *MS DOS* and *Windows NT/Windows 95*.

(*MS DOS* and *Windows* are registered trademarks of MicroSoft Corp.)

## 5. TECHNOLOGICAL SOFTWARE

DPS "Delta" is used for the solution of the following technological tasks:

- ◆ making and revising digital maps for all the scale series;
- ◆ making plans for terrain cadastre;
- ◆ making architectural and mine-surveying plans on the basis of ground phototheodolite photographs;
- ◆ geodetic network densification by analytical photogrammetric triangulation.

DPS technological software supports all the principal procedures of stereoscopic processing which is used in analytical station "Stereoanagraph", such as: automatic orientation of model, collecting topographic data, semantic encoding of entity, etc. Technology of making digital maps by means of DPS is based on stereoscopic sight of digital image of stereopair on display screen. A library of functions automatizing accomplishment of several processes, such as: restoring circles, arcs, parallel lines, orthogonizing outlines of buildings, smoothing any horizontals out, etc., has been developed for reduction of laboriousness of obtaining digital terrain model (DTM).

Densification is accomplished by the method of analytical photogrammetric triangulation in two modes: traditional, e.g. artificial marking of tie points and digital marking. The second mode is supposed to be more prospective as it allows to avoid some instrumental errors during marking. This method provides for making a project of works with determination of the tie points centres through all the block. The project is created by digitizer upon contact pictures. According to the project data management with DPS work and making file of tie points coordinates through all the block with posterior checking the results of measurements is accomplished. Program interface accomplishes the attachment of the data with different adjusting programmes being in user's disposal.

Collecting programme allows to divide topographic data into layers; their content is fixed by user. This technology gives an opportunity for convenient manipulation with data. Also it is allows to represent any combination of subject layers in different colours with operator's wish.

DTM creating is possible to realize in two versions of setting coordinate-systems: in a given cartographic projection for small-scale satellite surveying and in a local orthogonal coordinate-

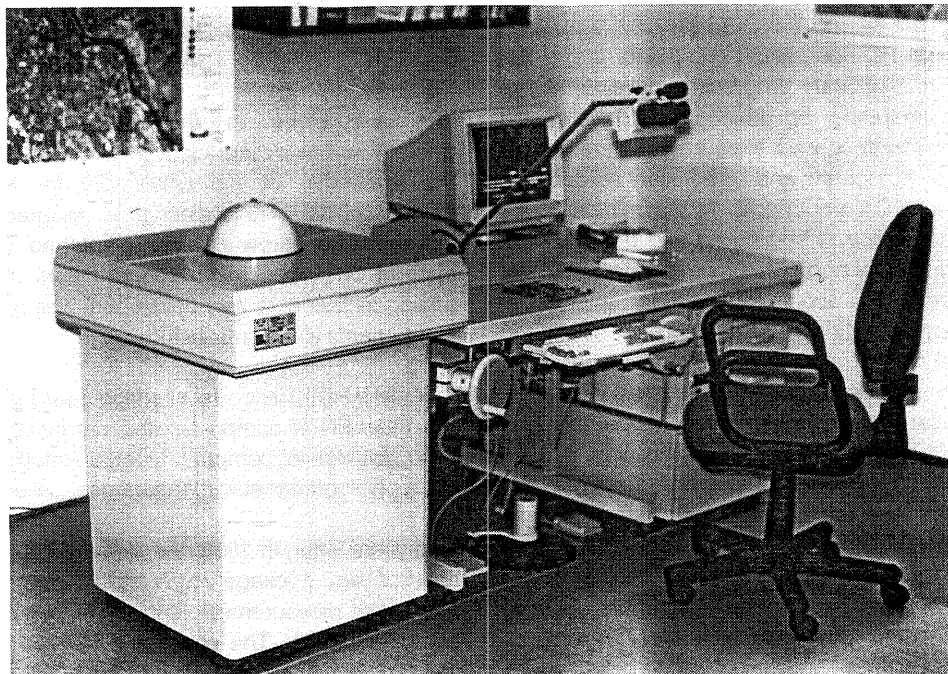
system for large-scale aerial surveying.

A great number of functions for creating digital DPS "Delta" has a convenient human-computer interface accomplishes superimposition of vector- and raster-images, realizes fast screen regeneration on passing from one part of stereopair to another, allows to work in interactive mode with a large number of entities.

DTM transformation into a digital map is accomplished in graphic mapping editor, which allows to correct committed errors, add conventional signs and captions to DTM, make subject colouration of geographical entities. When the graphical image is connected with

individual features of an entity, cadastre basedata used during preparation of standard data for land tenure inventory making is being filled. According to the basedata structure all the characteristic fields can be modified by user in compliance with requirements to the kind of task.

Information system has a wide range of subject requirements which are directed toward interaction with terrain cadastre basedata, assures obtaining reports tied up to the graphic image of an entity on display screen. Thus it allows to make a number of such standard documents as plan of setting land-tenure boundaries and to search information by given criterion, etc.



*Figure 1*