ASPECTS REGARDING THE STEREOSCOPIC EDITING OF DIGITAL PHOTOGRAMS IN UPDATING THE TOPOGRAPHIC PLANS

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Summary: *This article includes some aspects regarding the use of digital aerial photos during the process of updating the topographic plans. The basic principles and the characteristics of digital stereo image editing process are hereby presented. Also, the features of the case study made in Turnişor neighborhood, the south-western part of Sibiu city are hereby exposed.*

Keywords*: digital image, stereoscopic editing, vectorization, cartographic database.*

1. General notions about the stereoscopic editing of digital photograms

The topographic plans are graphical documents of a great accuracy, used in a variety of economical papers, in projection and research, as well as in different construction works. Due to the economical and social dynamics that is permanently taking place on the entire Romanian territory, their informational content is always out-of-date.

The satellite or aerial images are the most updated and complete information source regarding the territory registered on the topographic plans, which can be taken right at the moment of updating and can be succesfully used during the process of update, creation and editing the informational graphic content. Very often, during the process of updating or creating the topographic plans, digital aerial images are better prefered instead of satellite images, due to lower costs and the large scale they can be obtained at.

The development and improvement of both the photogrammetric equipment and capture and recording technology led to a higher chance of obtaining aerial and satellite images of the ground very quickly, in a high resolution, providing the optimal cartographic accuracy. Nowadays, in recording the aerial images, digital photogrammetric cameras with digital, optical, high resolution, advanced sensors are frequently used.

Editing the digital images taken during a photogrammetric flight can be made either *monoscopically,* by georeference or orthorectification and vectorization, or *stereoscopically*, by means of a special software.

The stereoscopic editing of the digital aerial images involves, by means of a *stereogram* (two succesive, double coverage, digital images) to create a virtual *stereoscopic model* (stereomodel) of the recorded ground, on a precise scale, in a photogrammetric coordinates system, oriented in the geodetic coordinate system and the spatial vectorization of the topographic details along this stereoscopic model created.

The creation of the digital stereo model is based on stereoscopic view principle (binocular) to perceive the objects in space. The stereoscopy is that part of applied physics that deals with the study of the features that lay base for the image embossing process.

Throughout the stereoscopic editing of the digital photograms, the errors, caused by differences in registered ground level in the planimetric position of the vectorized topograhic details are eliminated.

Whereas the greatest part of the Romanian territory is represented by hills and mountains, during the update process of the topographic plans, the stereoscopic editing of digital photograms is rathered prefered.

Updating the digital topograhic plans entails updating the geographical database where these are generated from.

2. Stereoscopic editing on digital photograms

This paper presents the aspects of digital stereo editing on digital photograms of Sibiu area.

In fact, the case study of this paper includes the areal of ***Turnişor*** neighbourhood of ***Sibiu Municipality***, located in the south-western part of the city.

In order to update the topographic plan inside this areal, digital images have been used from two arrays of photograms of the digital photogrammetric block, recorded in 2009, that covers the whole territory of this city (Fig. 2.1).

On stereoscopic editing the ***Stereo Analyst*** model, for ***Erdas Imagine 9.1***. software was used. This is a modern, high-performance working tool, conceived to create a stereoscopic model based on the principle of *anaglyphs* of combining the complementary colors, enabled with high-performance measurement and vectorization tools.

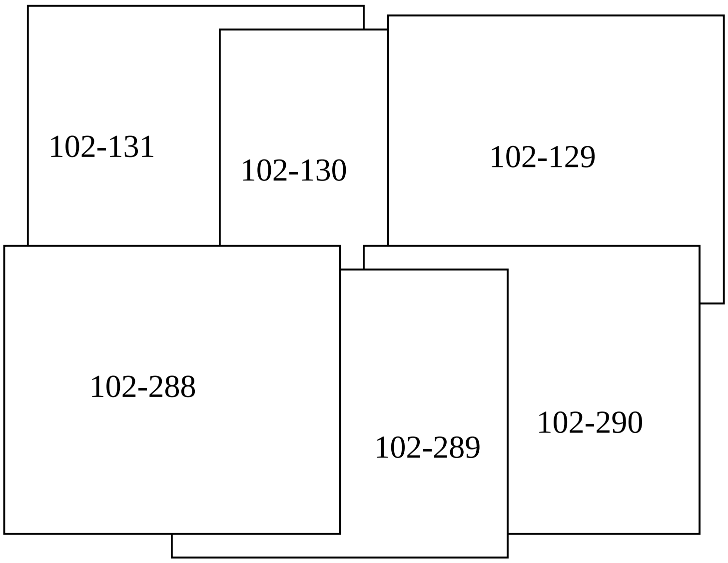


Fig. 1. Disposal of digital images that cover a part of the Turnişor neighbourhood of Sibiu Municipality

The anaglyphs method, used through the Stereo Analyst software is based on combining the complementary colors in order to create a 3D space model, and on the binocular view of the stereogram images, which consists of showing almost superposed stereogram images, in complementary colors on the computer screen (a red image and a green-blue one).

The spatial perception principle of the stereogram image consists of displaying the two digital photograms of the stereogram on the computer screen and its visualisation through the anaglyph glasses with coloured lenses having the same complementary colours as the stereogram images and therefore, each eye will see the complementary color of the filter it is looking through. So, the eye that will see the red coloured image is looking through the green-blue filter and the eye that will see the green-blue colored image is looking through the red filter. Therefore, each eye will see one uncoloured image of the two coloured images of the stereogram (the color of the image displayed on the screen is annihilated).

At the intersection of the spatial rays, separated by the two filters, the stereoscopic model is displayed as a virtual, spatial, uncoloured image, that appears inside the software's icon, on the screen and can be viewed by the operator through the anaglyph glasses.

The most accurate and complex method is the the stereoscopic editing of the satellite images and involves the following substeps:

- Selecting and opening the stereogram's digital images inside the software window;
- Adjusting the image and screen resolution, as well as the image contrast;
- Creating the stereoscopic model;
- Exploiting the stereoscopic model (vectorizing planimetric details on the stereoscopic model and recording in a cartographic database).

The Stereo Analyst software's window has 4 sections (Fig. 2) for displaying the stereogram, displaying the stereoscopic model, called workspace and displaying each stereo photogram.

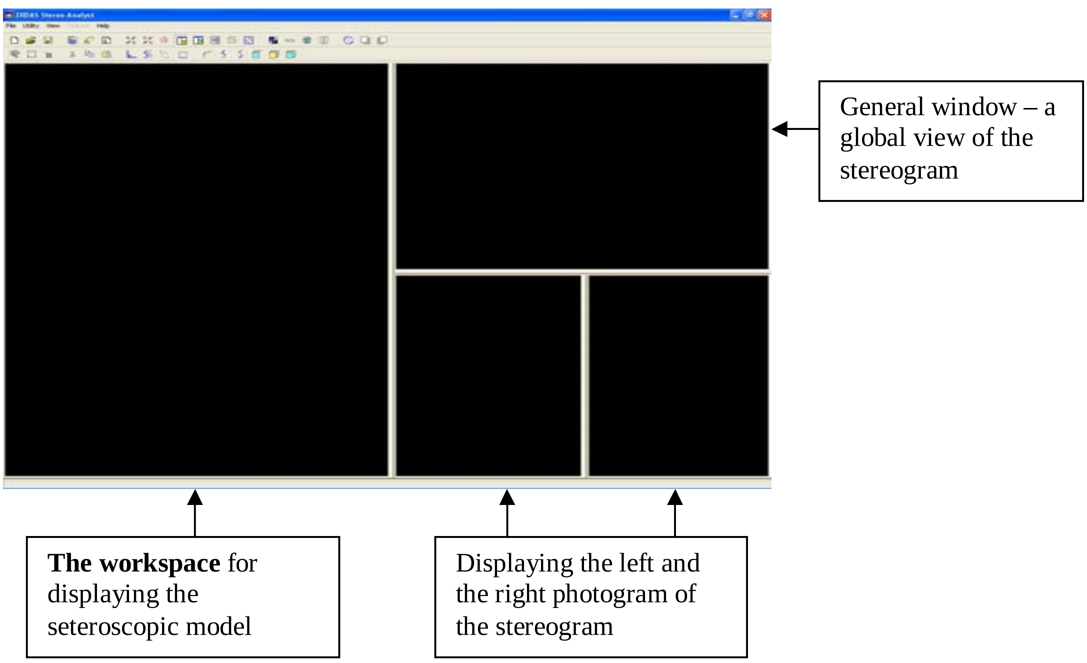


Fig. 2. The window of the Stereo Analyst software

The first operation within the creation of the stereo model is to select and open the stereo images on the software workspace, from the folder which they are stored in.(Fig. 3). Stereo digital photogrammetry must be saved as **.img** or **.tiff** format or one of the formats recognized by the Stereo Analyst software.

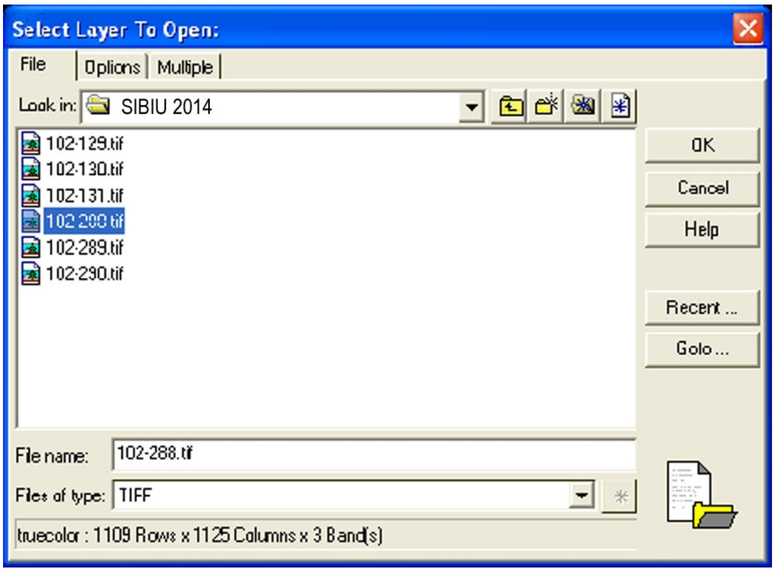


Fig. 3. Selecting and opening the image 102-27280

The left stereo image is selected and opened by choosing the **Open**  button, on the software toolbar, and the right stereo image is selected and opened from **File** menu and by activating the options **Open** > **Add a Second image for Stereo** (Fig. 4).

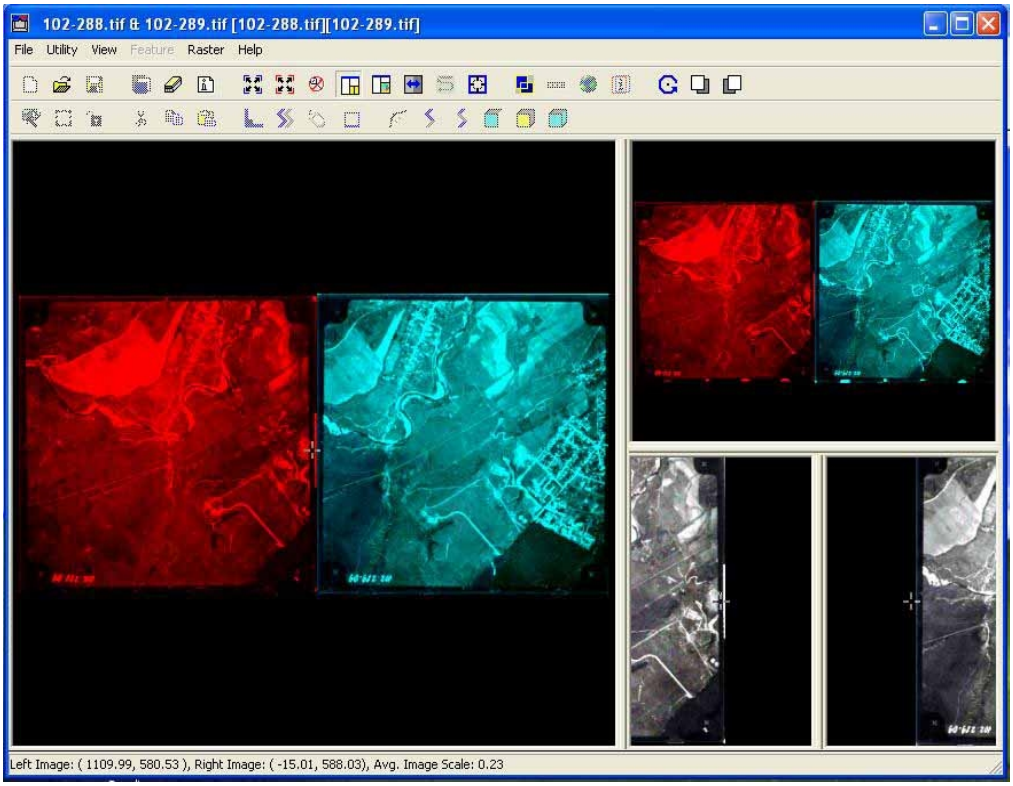


Fig. 4. Images 102-288 and 102-289 of the stereogram

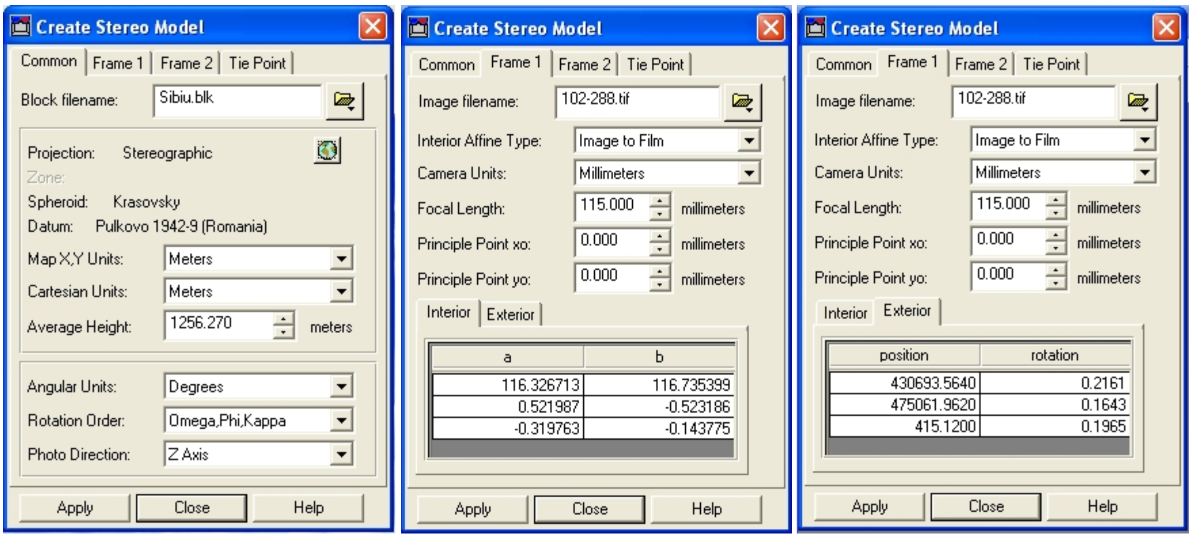
After opening the stereo images, the process of resolution and contrast adjustment is applied. Also, the screen resolution will be adjusted to correspond to the one of the images.

The process of creating the DSM – Digital Stereo Model is further displayed. In this regard, the window used for creating the digital stereo model will open, to configure and introduce the photogrammetric camera parameters that have been used, as well as the interior and relative orientation elements for each stereo photogram and the coordinations for the photogrammetric landmarks and the tie points, and the absolute orientation of the stereo model.

The creation window of the stereo digital model will open from the icon Create Stereo Model on the toolbar.

In the window named **common** (Fig. 5.a) the common parameters values of the stereogram are entered (units of measurement for coordinates and and the average height value of photogrpahy) and the cartographic projection is selected. If the cartographic projection cannot be found on the implemented projections listed, then it can be configured from the configuration window (Projection Choser), by entering its parameters and therefore, they will be saved on the list.

In the window **Frame 1** the parameters of the stereo photogram 102-288 are introduced as follows: the values of interior orientation elements will be entered in the window ***Interior*** (Fig. 5.b), and the values of exterior orientation elements will be entered in the window ***Exterior*** (Fig. 5.c).



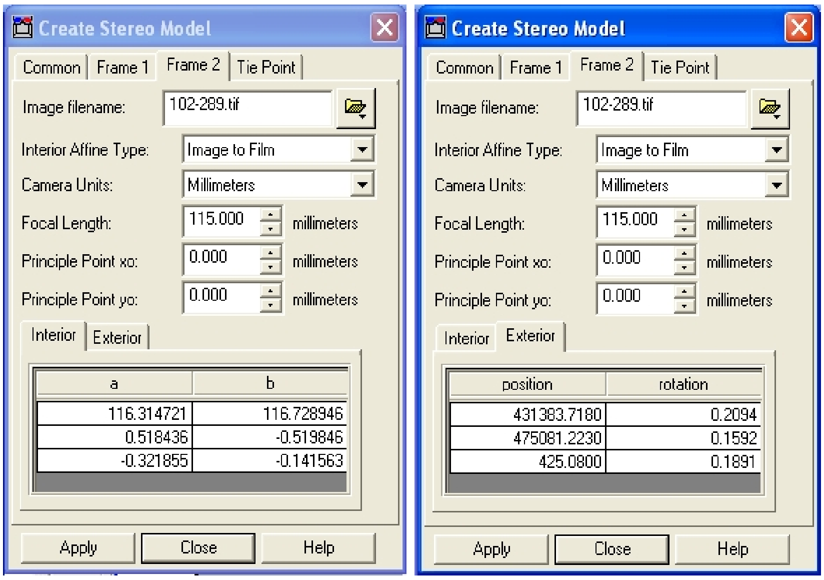
a b c

Fig. 5. Windows for entering the common parameters and the exterior orientation of the photogram on the left side of the stereogram

In the window **Frame 2** the parameters of the stereo photogram 102-289 are entered as follows: the values of interior orientation elements will be entered in the window ***Interior*** (Fig. 6.a), and the values of exterior orientation elements will be entered in the window ***Exterior*** (Fig. 6.b).

These exterior and interior orientation parameters of the photograms are extracted from the photogram parameteres file, delivered on the photogrammetric flight and are used on the relative orientation process of the stereo photograms. A compelling orientation of the stereo photograms can be made by using the tie points, usually selected on standard positions, and the stereo images' dual coverage.

The next operation excuted after entering the values of the stereo photograms' orientation elements is adjusting parallaxes on standard points.



a b

Fig. 6. Windows for entering the exterior orientation parameters of the photogram on the right side of the stereogram

In order to eliminate the necessity of adjusting the parallax on the axis X each time the block file with the stereogram parameters opens, on the **Tie Point** frame the coordination values of the tie points will be entered (Fig. 7).

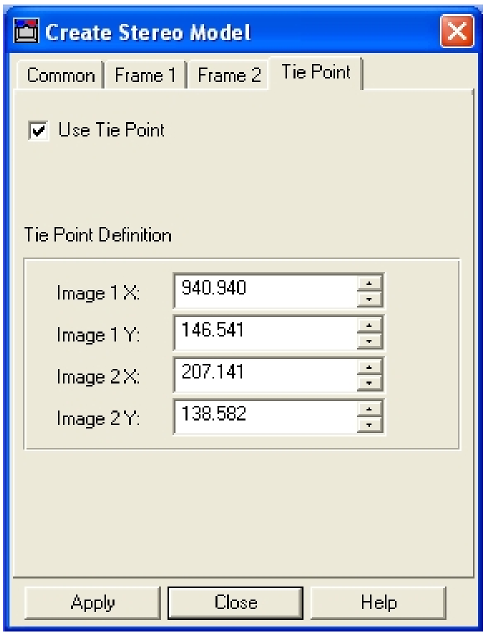


Fig. 7. Window for entering the tie points coordinates

After entering all the parameters of the stereogram images the **Apply** button will be activated (Fig. 7) in order to create the block file with the registered stereo parameters, the result of these operations being the Digital Stereo Model (DSM), that can be displayed on the digital stereo workspace of the software (Fig. 8).

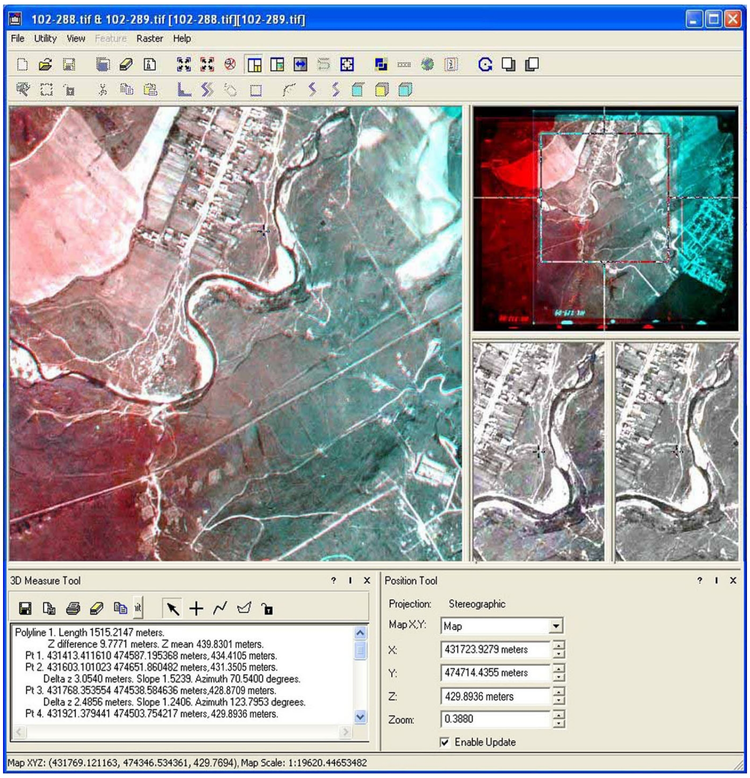


Fig. 8. Window with the stereo model created
(can be viewed with anaglyph lens glasses)

3. Vectorizing the topographic details following the stereo model and updating the cartographic database

First, inside the database, layers were created, for the topographic details that were vectorized for the update.

Then, the stereo digitizing was made on the stereo model created, selecting for this purpose the spatial cursor (the floating cursor) from the icon .

Afterwards, all the topographic details used for updating the digital topograhic plan were vectorized, constantly keeping the spatial cursor in contact with the virtual terrain stereo model.

The coordination points of the vector entities resulted from the digitizing process are included in the coordinate systerm of the cartographic projection *Stereo 1970* and refers to the vertical located on the digital stereo model.

The vector entities captured from the stereo model were recorded on the layers established prior to digitization.

4. Conclusions

The digital stereo editing of the digital photograms is a modern, efficient and accurate method of updating the topographic plans, due to the fact that the digital photograms are the most actual source of information, that serve to extract topograhic details and can be generated on high resolutions that assure the necessary precision for the photogrammetric exploitation.

In the technological process of the digital stereo editing, a great importance must be given to the quality, contrast and resolution fo the digital images, as these parameters can negatively or positively affect the quality and precision of extraction and digital representation of the topographic details.

Precision in calculating and performing the relative orientation of the stereo images depends on selecting, identifying and marking the tie points and the monument points on the stereo images, in order to measure their coordinates.

As we can notice from the above data, although the technological process of digital photograms' stereo editing is complex, the Stereo Analyst software, through its performance, makes this method very efficient and strict for mapping hill or mountain areals.

The vectorization precision on the stereoscopic image depends on the resolution of the stereo images, as well as on the pointing precision on the stereo model during vectorization.

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