Photomod in pipeline industry. Cartographic database creation for Ukrainian trunk pipelines GIS using photogrammetric methodology

Anatoly Mikhailenko, GIS center Head
Svetlana Dorofeeva, Head of photogrammetry group,
VNIPITRANSGAS
20 Esplanadna str., Kiev, Ukraine
Phone: (380 44) 227-54-46
E-mail: gis@vtg.com.ua

During last year International Photomod User's Conference in St.-Petersburg we had a presentation on cartographical database creation methodology for Ukrainian trunk pipelines GIS. We discuss there the whole multifunctional complex of geodetic survey processes for trunk pipelines construction considering their infrastructure, features of natural landscapes, object's data systematization as well as cadastre data collecting for pipelines geoinformational systems.

VNIPITRANSGAS is working intensively in this direction since 1995. We always used photogrammetric methods for topographical data obtaining. And since 1997 VNIPITRANSGAS became a licensed user of RACURS Company software. While improving PHOTOMOD system our institute tested different versions of the software on exact objects. We are usually using PHOTOMOD integrating it with "Bentley Systems" GIS technologies (USA), which serves as the inner standard for our customers and us.

In 2002 have been done the whole set of works on certification of 327 km of trunk pipelines of Kievtransgas Company. Most of data was obtained using PHOTOMOD software, version 3.11.54. The software worked effectively with this object data, especially on sites where the field survey was unavailable due to considerable bogging and over-watering of the territory or relief ruggedness (where relief height differences reached 45 m).

We would like to present in details main steps of our work, based mostly on photogrammetrical methods and PHOTOMOD software.

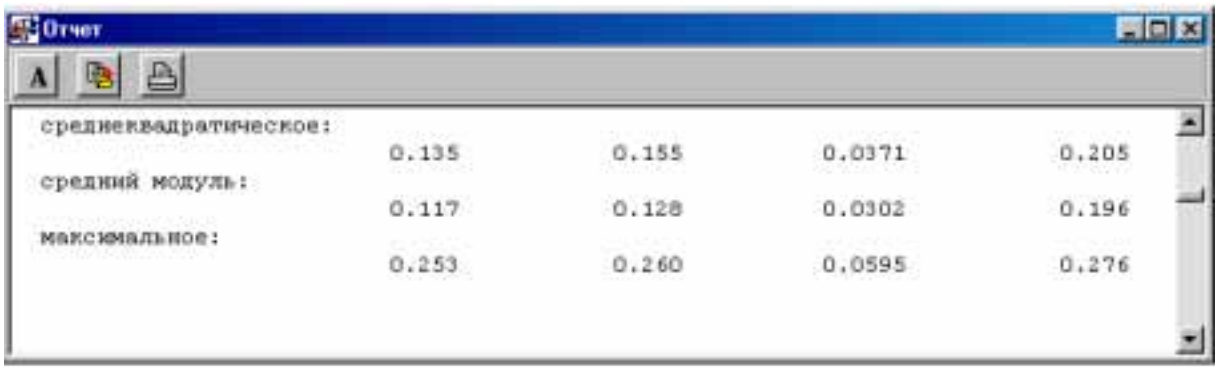
1) Firstly were provided airborne survey with Zeiss LMK-1520 camera and color film Agfa. The survey was mainly in single strips with scale 1:8,000 considering the linearity of our object – corridor of trunk pipeline.
2) Afterwards the densening of geodetic network was executed used high-accurate satellite methods and 2-frequency GPS-receivers Carl Zeiss.
3) Also there was field survey with connection to GPS-stations for network creation. At that we used the following equipment: electronic tachymeter GTS-601 by TOPCON (Japan) and Elta S-20 by Carl Zeiss (Germany).
4) At the same time we made geodetic work on localization and coordination of trunk pipelines. The pipelines themselves were surveyed, obtaining the depth of pipes and cables deposition and also under-ground and on-ground communications intersections surveyed. The survey accuracy was 0,01m and depth detection error was less than 3%.
5) Photogrammetric processing of the air-survey results was executed fragmentary due to the specificity of field topographic survey. 21 parts of

pipelines were selected, where field survey was over-labored - 16 marches over the ravines with great height difference and 5 marches over waterlogged river valleys. Total length of marches was 47.3 km. We chose well-recognized terrain objects as landmarks (power lines columns, pipelines objects). Landmarks survey accuracy not less than 0.05 m.

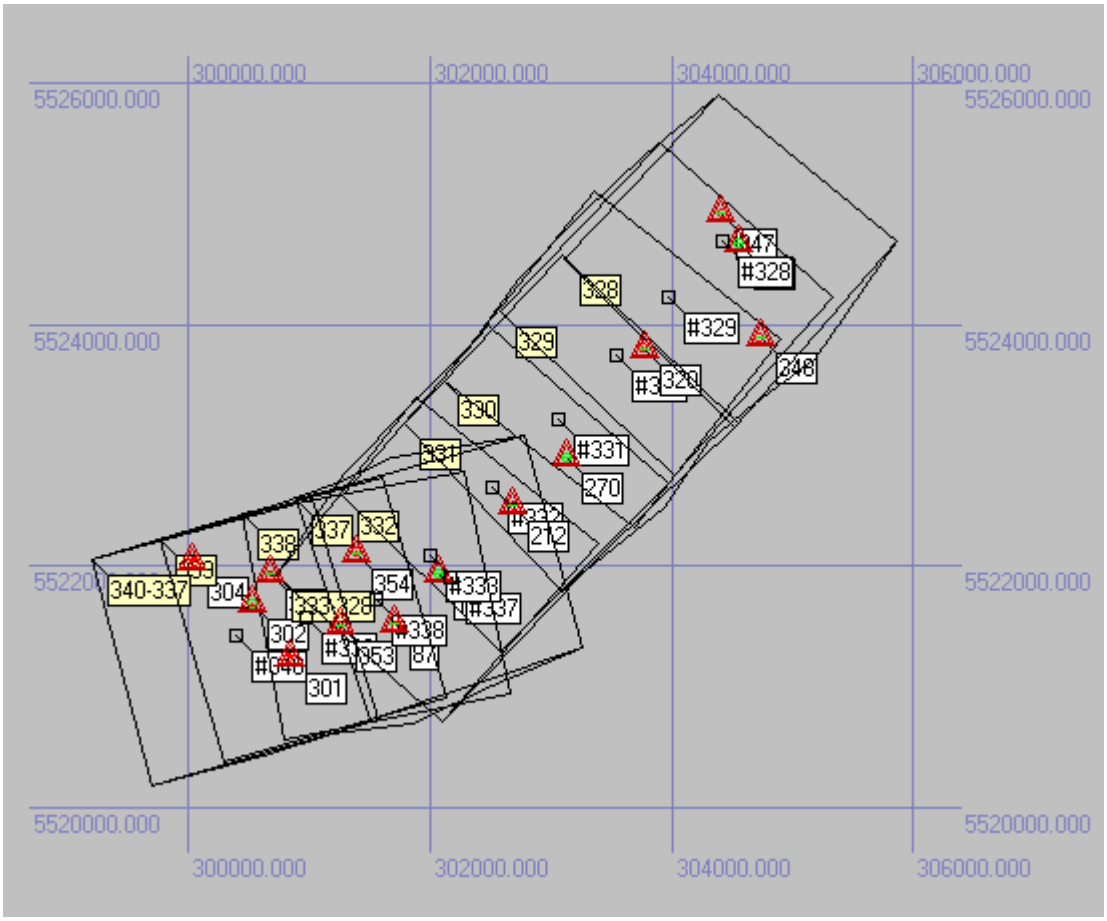
6) Then we start photogrammetrical works using geo-referenced images and PHOTOMOD modules in the following order:

6.1. Aerial triangulation was executed in PHOTOMOD AT module. Each march over the natural barriers we considered as a separate PHOTOMOD project, so we dealt with 21 project.

6.2. On the next stage we have executed block adjustment and calculated exterior orientation parameters in PHOTOMOD Solver module, using independent strips method. The customer required the accuracy was for X, У = 0.3 m, for Z = 0.4 m. If the results were out of the tolerance, we re-calculated ground control points in stereo mode in PHOTOMOD AT.

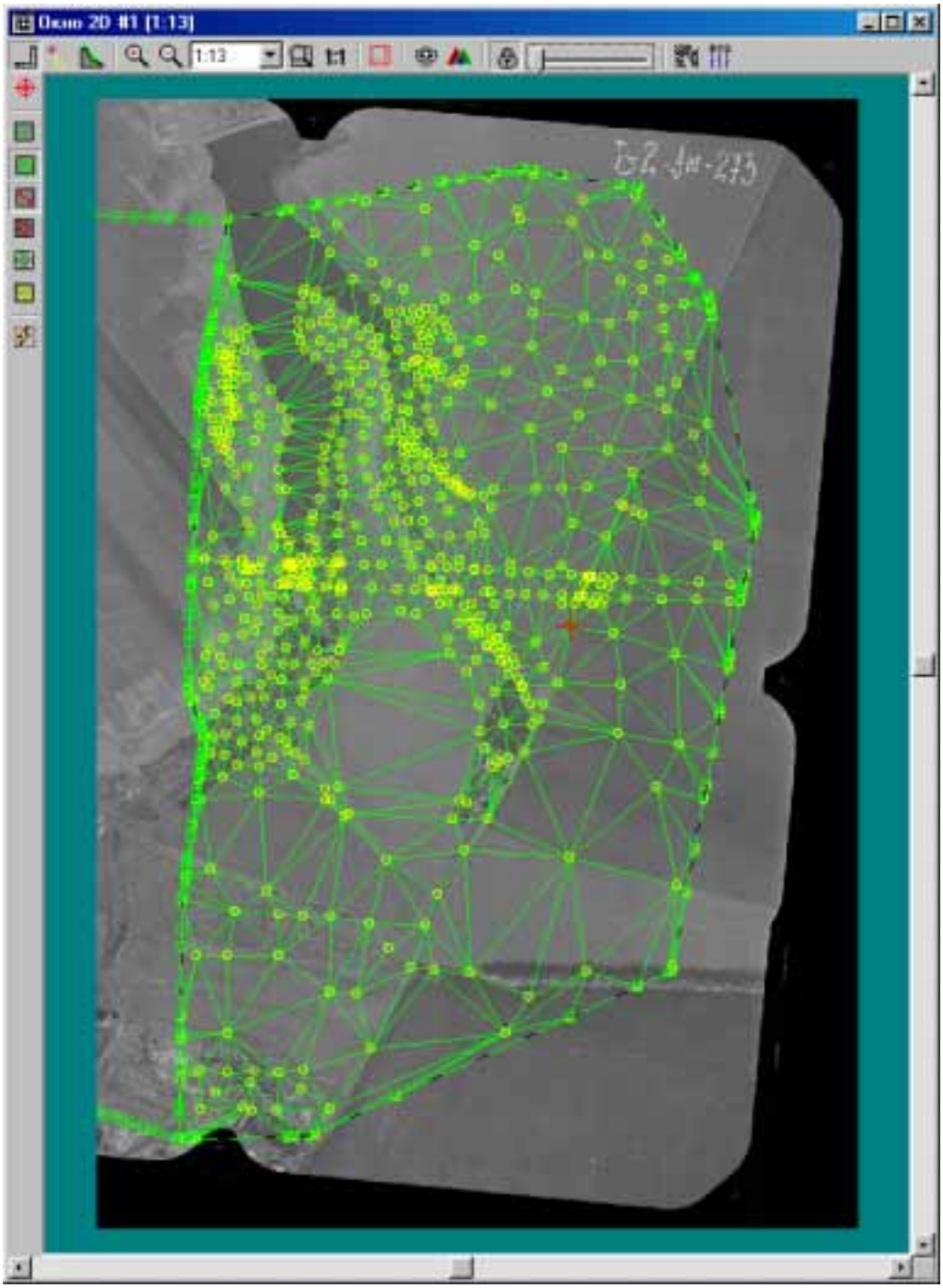


After adjustment in Solver the block adjustment scheme was built, where images and control points with the errors occurred visualized.



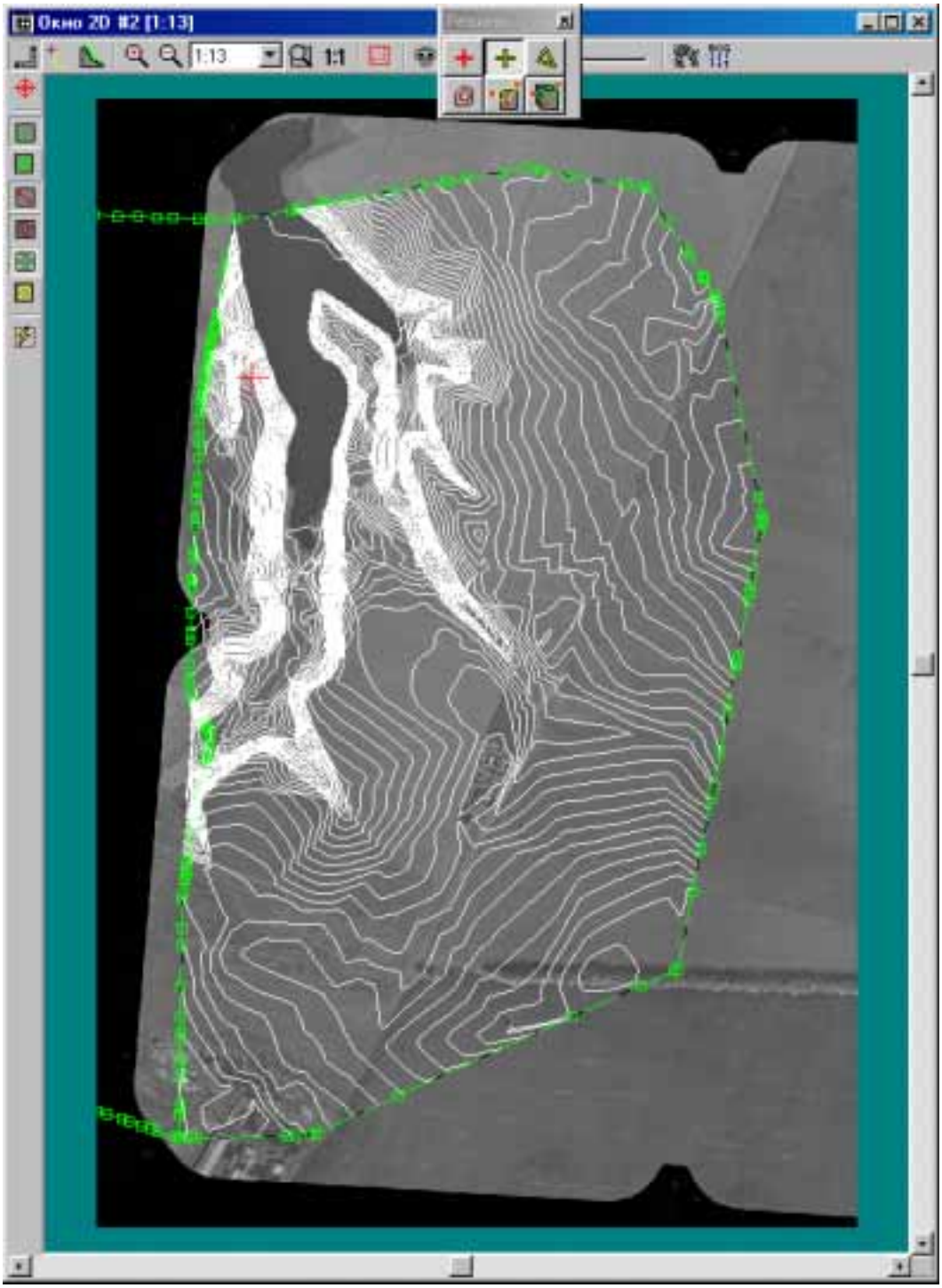
6.3. Important step – import vector objects to Photomod StereoDraw. In our work all field survey pickets (over pipelines, cable communications and their infrastructure) were intended as vector objects. StereoDraw module allows to control in stereo mode the data height relatively model surface immediately. The control show quite acceptable results: almost all pickets were located on the model surface in tolerance.

6.4. In Photomod DTM module for each stereo pair TIN was built and edited on adaptive model with imported vector objects.



6.5. Using the TINs the contours with 0.5 m height step were drawn. It is necessary to note that if the TIN was built quite accurate on previous stage, the contour lines might be not edited. You can see on the picture below, how the contour lines lay down on the model.

6.6. Next important stage – TIN and contour lines fragments selecting by the regions boundaries. Stereo pairs and contour lines merging quality depended correspondingly on reliability of global regions creation. As our object was linear extended, we need some corridor along the trunk pipelines, so we tried to create the global regions with central line coinciding with pipeline.

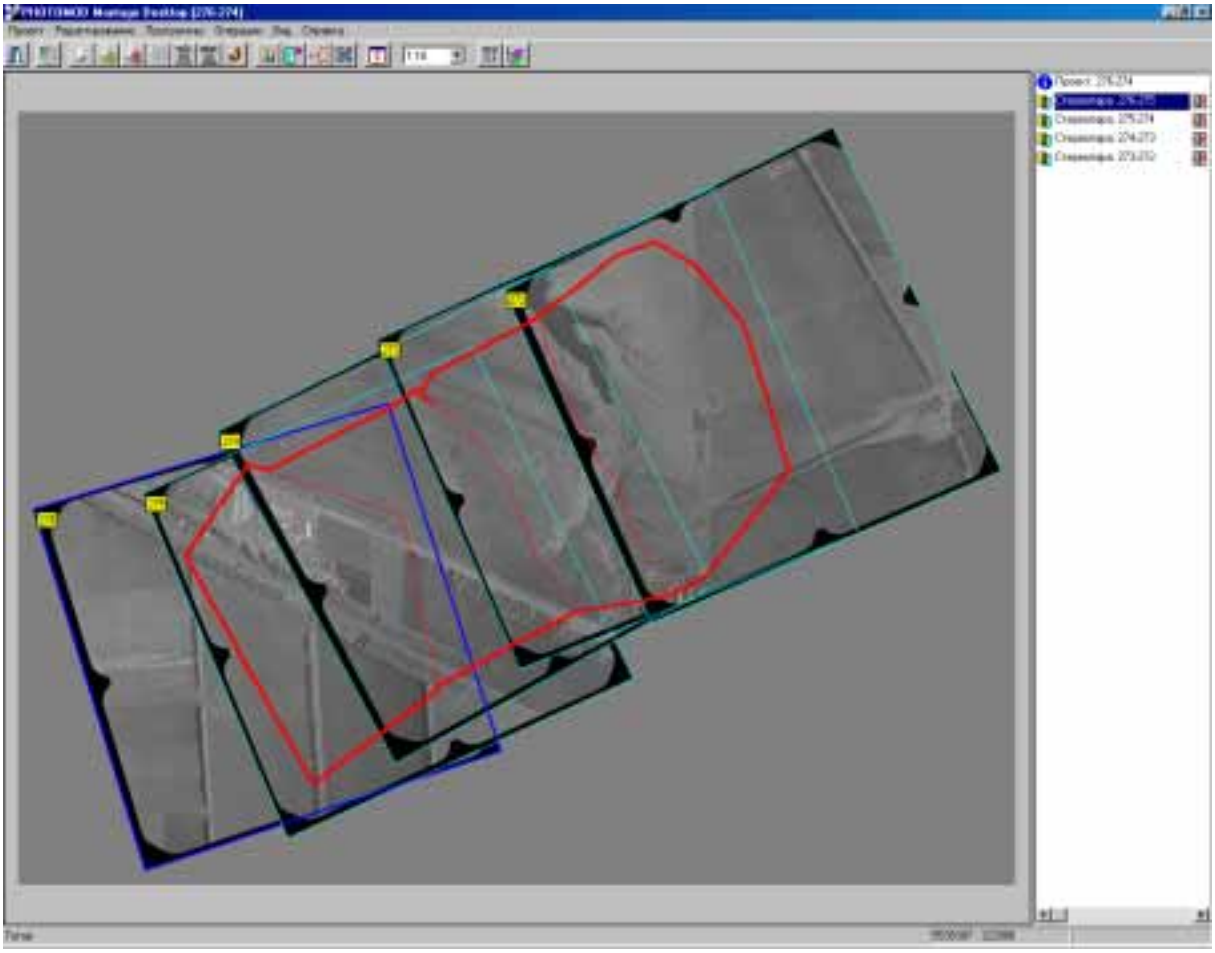


6.7. We would like to note some suitable option in the current version – automatic DEM creation on the entire block in Photomod Montage Desktop (merging of TIN fragments for each stereo pair using global regions). Previously we have to spend a lot of time to join the local TINs into common one in MicroStation software.

6.8. Automated contour lines building on the entire images block in the same module was our next stage. And here we have faced with one disadvantage – when merging contour lines on strips with more than 10 images, some part of contour lines was lost. We resolved the

issue by dividing of merged contours unit into two parts but the question still exists.

6.9. Orthophotoplan creation on the entire images block in PHOTOMOD Mosaic module – the last operation in our procedure.



7) Afterwards we export ortho's and DEM's into Bentley Systems modules and edit our materials in MicroStation to meet customers requirements: final design of large scale topo-maps and ortho-maps of trunk pipelines corridors. The current stage procedure includes overlapping the ortho-map and entire set of the objects digitized from 1:10,000 scale topographic maps (with updating them) and pipelines objects, surveyed in field.

Thus, we suggest aero-photogrammetrical methodology using PHOTOMOD software for large-scale topographic mapmaking of the following phenomena:

- damages of conservation zone of trunk pipelines in 1:2,000 scale;
- marches over the natural barriers (river valleys, ravines, swamps) in 1:1,000 scale.

At that field survey is necessary only for pipelines, their technological objects and underground infrastructure.

The methodology described is the completed procedure allowing to produce and update variety of large-scale maps, GIS and derived products beneficially both for the customers and for the end users.