Production of map materials for automated system of state land cadastre on testing area of Megin-Kangalass ulus of Sakha Republic (Yakutia)

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Russian government has approved state programs on land cadastre management and state registration of real estate objects. For these programs realization it is necessary to have up-to-date cartographic data. However in many cases, particularly in little-inhabited areas, there are only outdated initial materials in different scales, created in different coordinate systems.

Our organization had an order from Real Estate authority of Sakha Republic on digital maps production in 1:10,000 scale with height step 5 m on territory of Megin-Kangalass ulus with area of 8,700 sq.km in GIS "Map 2005" format.

The initial data was aerial survey materials of 2000 in 1:10,000 scale, interpretation templates, topographic maps in 1:25,000 scale as the source of semantic information and additional interpretation data.

Analysis of aerial survey data acquired in 2000 shows number of the following disadvantages, which do not allow to obtain high-quality production.
Selected survey scale of 1:10,000 is not good for mapmaking in 1:10,000 and 1:25,000 scales due to time and financial expenses for photogrammetric processing and referencing of aerial survey data.

Big number of images (more than 12,000) and strips (more than 100) on the testing territory forced to divide survey materials on several photogrammetric blocks, further merging of which causes errors accumulation during measurement and adjustment, and they will influence considerably on the production accuracy. Considering such huge work on relative orientation we have applied to Racurs company specialists - developers of PHOTOMOD system – and asked them to speed up the release of new module on automatic relative orientation. Images blocks acquired in 2000 were taken

as test data for module testing. This module is now part of PHOTOMOD system of 4.0 version.

In some places was insufficient photogrammetric quality of imagery acquired in 2000 (small vertical and horizontal overlap), big water area (Lena river) surveyed on several images of the strip and in sub-blocks, that do not allow to perform photogrammetric processing according to the requirements of national photogrammetric works standard. Survey data of 2000 became outdated during 5 years and the imagery needs significant field updating.

All the above reasons brought us to decision to perform new aerial survey in 1:40,000 scale to provide quality and actuality of production.

New survey was done in September 2005 using camera RC-30 with 153.44 mm focus. There were 530 images in 27 strips.

Phototriangulation and adjustment were performed in digital photogrammetric system (DPS) PHOTOMOD, versions 3.8 and 4.0 by usual digital photogrammetric technology and were completed in 2.5 months. Old survey data processing may take 1.5-2 years of work by the same technology.

First, we compiled the project using “Instruction on topographic survey in 1:10,000 and 1:25,000 scale”. Then GCP on aerial images were recognized and referenced. GCP heights were obtained from topographic maps of 1:25,000 scale. In total 81 plain-height and 151 height points were measured. Tested terrain is densely forested and has highly developed river network.

Adjustment results are as follows:

RMS errors:

Ex, Ey, Ez, Exy (m)

Ground control

0.629 , 0.492 , 0.531 , 0.796

Tie

0.219 , 0.148 , 0.314 , 0.264

Tie – projection centers

Maximal errors:

Ex, Ey, Ez, Exy (m)

Ground control

2.388*, 1.739 , 1.998*, 2.388*

Tie

1.980 , 1.231 , 2.924*, 2.116*

Tie – projection centers

According to requirements of “Instruction on photogrammetric works” the adjustment results allow to suppose that we can reach the accuracy of 1:5,000 scale in plain and accuracy of 5-meter relief step in height.

To find out an optimal mapping technology we tried two workflows:
1. Objects stereo vectorization in PHOTOMOD system (using interpretation materials) using code table with completeness and accuracy of 1:10,000 scale with further data conversion and editing in GIS “Map 2005”.
In this workflow Racurs company specialists performed stereo vectorization in PHOTOMOD StereoDraw module of territory fragment (about 30 sq.km. area) using classifier imported from GIS “Map 2005”.
Then models created for each stereopair were exported to GIS “Map 2005”, where some edition was done: merging of stereopairs fragments into common map, names input, topology verifying, etc.
On this map all objects are three-dimensional that could be used for various design tasks.
2. Creation of orthophotomap in PHOTOMOD system as a raster layer and map vectorization in GIS “Map 2005” (using interpretation materials).
For this workflow we used terrain relief from topographic maps of 1:25,000 scale. After vectorization of contours and height points and further transformation of semantic data to metrics by GIS “Map 2005” tools, the 3D relief model was built and used then for DEM creation.
Using this DEM the orthophotomap with 0.6 m resolution in RSW format for the whole territory was created. The orthophotomap accuracy satisfies the accuracy of 1:10,000 scale:

	X	Y	XY
RMS:	2.978	2.768	4.061
Maximal "+":	7.262	6.962	10.060
Minimal "-":	-7.666	-7.035	-

Orthophotomap was verified by GCP and objects vectorized over stereo model. Discrepancies were from 0.4 to 5 meters. Mapmaking was done in GIS “Map 2005” using orthophotos as raster background for vectorization.

Both workflows allowed to obtain necessary result, however, stereo vectorization is more labor-intensive process.

So the research and analysis shows that for mapmaking in 1:10,000 scale the most optimal technology in accuracy and expenses is vectorization of orthophotomaps, which were produced using existing topographic maps in 1:25,000 scale and other auxiliary materials. This choice is the best also because there is no need to create a relief over stereo model, that reduces time expenses significantly.

Landmarks cameral referencing, cameral interpretation using 1:25,000 scale maps and interpretation etalons allow to omit almost all field works. This is especially important in little-inhabited almost impassable regions with poor infrastructure.