

HIGH RESOLUTION SOVIET SPACE PHOTOGRAPHS FOR TOPOGRAPHIC MAPPING

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Abstract

The results of evaluation of high resolution panchromatic photographs acquired from Cosmos satellite and multispectral space photographs taken by the MKF-6 camera installed on Salyut space station are discussed.

High resolution space photographs taken from 220 km orbit have been evaluated on analytical plotters and orthophotoprojectors. The achieved accuracy is satisfactory for topographic mapping in the scale 1:50 000 and map revision up to the scale 1:25 000.

Introduction

The paper describes some results of evaluation of satellite panchromatic and multispectral photographs taken from the Soviet spacecraft. It also includes the cartometric analysis of the high resolution space photographs. The types of the stereophotographs under consideration are:

- 1/ multispectral photographs taken from the SALYUT-6 orbital station at the scale of 1:2 652 000 from the orbit of 338 km,
- 2/ panchromatic photographs taken from the COSMOS satellites at the scale of approx. 1:1 050 000 from the orbit of 210 km,
- 3/ panchromatic photographs taken from the COSMOS satellites at the scale of approx. 1:220 000 from the orbit of 220 km.

The photographs have been elaborated by using analytical methods including DTM for orthophotomaps elaboration. The achieved results have been compared with the existing topographic maps at the scales from 1:200 000 up to 1:10 000.

1. Space multispectral photographs at the scale of 1:2,6 mln.

The multispectral photographs have been taken by the MKF-6M camera with FMC in 6 channels /0.48 - 0.84 μm /. Two stereogrammes of band No 4 /0.66 μm / have been selected for analytical elaboration using the steconometer C Jena. About 40 control points in each stereogramme have been measured for the investigation of cartometric analysis. These points were the topographic details identified on the photographs and on the existing topographic maps at the scale 1:200 000. To reduce the influence of the Earth's curvature the geocentric coordinate system was applied. The accuracy of coordinates of topographic details /points/ identified and measured on the two stereogrammes was checked by comparison of the some points which coordinates were determined from the topographic maps. The results are listed below:

$$\text{RMS}_x = \pm 46 \text{ m}$$

$$\text{RMS}_y = \pm 54 \text{ m}$$

$$\text{RMS}_z = \pm 75 \text{ m.}$$

The investigation of these photographs proved their satisfactory accuracy for updating topographic maps at the scale 1:200 000 or smaller.

2. Space panchromatic 18 x 18 cm photographs at the scale of 1:1 mln.

The photographs have been taken with the metric camera, equipped with reseau grid of the focal length $c_k = 200,622$ mm from the COSMOS satellite with the orbit of 220 km. For the evaluation a part of strip consisting of 4 photographs at the scale approx. 1:1 050 000 with 60% end lap was chosen. The base ratio $\frac{B}{H} = 1$. About 35 GCPs on each photographs, clearly identified on the existing topographic maps at the scale 1:50 000 were selected with the accuracy of $\text{RMS}_{x,y} = \pm 15\text{m}$, $\text{RMS}_z = \pm 5,0$ m. From the total of 140 GCP, 14 x,y points have been used for strip adjustment, 126 points were used as reference /check/ points. The achieved accuracy is shown in the table 1.

Table 1

	RMS in the terrain	RMS in the photoscale 1:1 050 000	No of check points
X	± 20 m	0.02 mm	126
Y	± 22 m	0.02 mm	126
Z	± 25 m	0.12% H	126

The strip adjustment was completed using the "OTR COSMOS" triangulation program.

These photographs can be used for elaboration and updating of topographic maps at the scale up to 1:50 000.

3. Space panchromatic photographs 30 x 30 cm at the scale of 1:220 000.

The original photographs 30 x 30 cm have been taken on the board of COSMOS satellite with the photographic camera of focal distance 1012,83 mm, from the orbit of 220 km.

The obtained photographs are vertical or oblique $\angle \Omega$ approx. 19°. The end lap of the photographs is 60% and the base ratio $\frac{B}{H} = 1:8,5$.

In the experiment on analytical plotter planicomp P1 the originals 30 x 30 cm have been used. In the planicomp c-120 and orthocomp Z-2, the original size was reduced to 24 x 24 cm. The new, reduced scale of the 24 x 24 photograph is approx. 1:284 000. The data of the photographs are given in the table No 2.

Table 2

Data	24 x 24 cm	30 x 30 cm
scale approx.	1:284 000	1:226 000
c_k /mm/	785.040	1012.82
omega	$-18^{\text{g}}.80^{\text{c}}$	$-18^{\text{g}}.40^{\text{c}}$
fi	$0^{\text{g}}22^{\text{c}}$	$4^{\text{g}}22^{\text{c}}$
H approx.	214 km	220 km
Planicomp	c -120	P- 1
Software	PAT M	BINGO
Mean parallaxe mq /mm/	0.001	0.001
No of points for absolute orientation	7	7

The GCP_S have been identified as topographic details, from the maps at the scale 1:50.000 and 1:10.000, as well as from the aerial triangulation of photographs in the scale 1:26.000. The RMS of the coordinates XYZ from the above mentioned sources are shown in table 3.

Table 3

Source	RMS		
	X	Y	Z
map 1:50 000	± 15 m	± 15 m	
map 1:10 000	± 4 m	± 4 m	± 2 m
aerial triangulation 1:26 000 better then	± 1 m	± 1 m	± 1mm

The interior accuracy on the Planicomp c - 120 with the PAT-M programme is shown in table 4.

Table 4

	control points from the map 1:10 000	points from the map 1:50 000
RMS _X	± 2.5 m	± 49 m
RMS _Y	± 2.1 m	± 55 m
RMS _Z	± 1.7 m	± 53 m

DTM has been created on the c -120 Planicomp. Three orthophotomaps at the scales 1:100 000, 1:50 000, 1:25 000 were produced on the Zeiss Orthocomp Z-2 analytical orthoprojector. Film Agfa Gevaert Gevatone N 31 P was used. Scan speed 50 mm/s, slit 8 and 7, 4 control points were used. The accuracy of the orthophotomaps were checked by the comparison of 50 points which coordinates were digitized in the orthophoto and in maps at the scale of 1:10 000. The results are given in table 5.

Table 5

Accuracy of the rectified 24 x 24 reduced space photographs

control points taken from:	1:100 000		1:50 000		1:25 000	
	m _x	m _y	m _x	m _y	m _x	m _y
1. Coordinates from aerial triangulation. Photos in the scale of 1:26 000, N = 48	7.9	7.0m	8.0 m	7.1	6.9m	7.0m
2. Coordinates taken from maps 1:10 000 N = 19	8.4m	10.3m	7.8.m	7.9	8.9m	4.2m

Conclusions

Satellite photographs can help to generate accurate topographic maps such quicker and cheaper which is very important for the developing countries.

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