Satellite image maps of warsaw in the scale 1:25,000

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ABSTRACT

IGiK OPOLiS in Warsaw and SURFACES Laboratory of the University in Liege have developed methods for combining digitally high resolution (2 m) Russian space photographs KVR-1000 and KFA-1000 with SPOT multispectral data and topographic maps.

This new generation of space data offers several advantages over traditional SPOT XS + P data specially for topographic mapping and map revision up to the scale 1:25,000. One of the satellite maps of Warsaw has been printed in the scale 1:25,000 with the pixel size 5.8 m as the combination of KVR-1000 B/W photograph with 2 m spatial resolution and multispectral SPOT XS data with 20 m spatial resolution. A second satellite map has been printed also in the scale 1:25,000 with topographics information superimposed on the satellite image map. The methodology has been developed on the I²S system 600 and on the Intergraph Image Station Imager using also Fast Fourier Transform techniques in the preprocessing stage. The final printed maps in the scale 1:25,000 are presented. The maps have been found ideal for urban planning and monitoring change detection in the Warsaw area 400 sq. km. Planimetric accuracy of the satellite maps has been checked using 80 well distributed and identified points on the image and topographic maps in scale 1:25,000. The following errors have been achieved:

RMSEx = ± 6 m; RMSEy = ± 5 m, which corresponds to RMSExy < ± 0.3 mm in the map scale.

If better accuracy is required then X, Y coordinates of the points used for rectification should be taken from aerial triangulation or measured directly in the field with GPS techniques.

1. INTRODUCTION

Technical data of the new generation of space high resolution photographs acquired by the Russian Kosmos satellites known as KWR-1000 or KVR-1000 or DD-5 (in digital format) have been published by Marek, 1993 and Sollner, 1993. Recently KWR-1000 and Landsat Thematic Mapper digital data were also used for generation of the digital satellite image map of Dresden by Kaufmann and Buchroithner, 1994. The results of the elaboration digitally of the satellite image map in the scale 1:25,000 using diapositive of KVR-1000 and multispectral bands from SPOT has not yet been published.

Soviet satellite false colour and B/W KFA-1000 photographs with 6 meters resolution have been used in the Institute of Geodesy and Cartography since 1984 for updating topomaps up to the scale of 1:50,000 by anaolgue photogrammetric methods.

The KVR-1000 of Warsaw and SPOT XS data have been available in IGiK in 1993 both taken in summer 1992. Different sophisticated software and hardware were used for digital elaboration of the scanned KVR-1000, digital SPOT XS and scanned topographic maps in the scale 1:50,000 published in 1983.

2. DIGITAL IMAGE PROCESSING OF THE RAW DATA

High spatial resolution KVR-1000 Russian photograph in the scale 1:220,000 of Warsaw area was used as well as spectral digital SPOT XS data acquired in summer 1992. High resolution (2 m) Russian satellite diapositive was scanned on the Photomation P-1700 in OPOLiS IGiK with the aperture size of 25 μm. Some noise implemented by the scanning procedure as well as by the diapositive itself were filtered out in the Fourier domain on the System 600 I²S Model 75 using special advanced filtering software and then smoothed on the Image Station Intergraph using SIGMA filter. This filtered digital image was rectified with accuracy less then 0.5 pixel on ISI-2 Intergraph to the topographic maps in the scale 1:25,000 using more than 180 well identified and distributed points. This task was achieved using a digitizing table and software ISI-2 Intergraph. Bilinear resampling methods were used to generate the new KVR-1000 digital rectified image with pixel size 5.84 m x 5.84 m.

As two bands of multispectral SPOT digital data were correlated (correlation coefficient r = 0.96) XS1 and XS2 bands were added with weighted coefficient and this new "XS12" channel as well as SPOT XS3 data were registered to the rectified image KVR-1000. Bilinear interpolation resampling method was chosen to generate the new data set with pixel size 5.84 m x 5.84 m. During this procedure SPOT XS digital data were enlarged more than 3.5 times. In this case it was not necessary to use RGB to IHS transformation method. Image to image registration has been checked on I²S System 600 using correlation software. The following results were achieved: RMSE < 0.5 pixel; correlation coefficient r = 0.97 which could be interpreted as very good results of merging of different satellite data.

After piecewise contrast enhancement of the merged images, a final false colour composite was prepared as follows: XS3 band was coded with red filter, KVR-1000 with green and XS12 with blue. This file was then transferred to the ERDAS Imagine Map Composer and prepared for printing on an Ink-Jet printer. Raster files of the Red, Green, and Blue colour bands were converted to Cyan, Magenta, Yellow, and Black using colour separation software.

Textual information as well as grid on the image was created also on the ERDAS Imagine. Finally hard copy of the satellite image map of Warsaw in the scale 1:25,000 was printed on the STORK Ink-Jet printer in Germany.

This satellite image map of Warsaw was checked with topographic maps in the scale 1:25,000 using 80 well identified points. Final planimetric RMSE x,y = ± 7.8 m was achieved, which corresponds to ± 0.3 mm in the scale 1:25,000 of the final map. If better accuracy is required then coordinates of the photopoints taken form aerotriangulation or coordinates measured directly in the field using GPS techniques could be used for rectification.

Secondly, a "satellite topoimage map" has been generated also digitally in the scale 1:25,000. The black topographic layer was scanned from military topographic maps in the 1942 cartographic coordinates system in the scale 1:50,000 on the Intergraph large format scanner ANATech 3640 with an aperture of 800 DPI in order to create raster map files. After merging together a few topomaps a new digital map was resampled to 5.84 m by 5.84 m pixel size using nearest neighbour method. Boolean algebra was used for superimposition of the satellite image map and of the digital topomap. As a result a new hardcopy of the satellite image map in the scale 1:25,000 was printed on the BARCO Ink-Jet printer in Belgium. This digital map was used for updating of the old 1983 topographic map. The results were presented at the ISPRS Symposium,Working Group IV/3 held in Athens, Georgia, USA in 1994.

Part of the satellite image map of Warsaw reduced to the scale of 1:50,000 is shown in figure 1. Part of the satellite topoimage map is shown in figure 2.

Figure 1 - Part of the satellite image map of Warsaw area reduced to the scale 1:50,000. Green areas appear red and dense built-up area in blue. Open fields are shown in white and yellow colours.

See plate IV at end of volume

Figure 2 - Part of the satellite topoimage map of Warsaw area reduced to the scale 1:50,000. Topographic features extracted from the topomaps are shown in white.

See plate IV at end of volume

3. CONCLUSIONS

Russian KVR-1000 high resolution space photographs and SPOT XS digital data have been successfully used for generating a satellite image map and a satellite topoimage map in the scale of 1:25,000 with acceptable accuracy.

The following different professional software and hardware were used in this project: System 600 Model 75 of the International Imaging Systems, Image Station Imager ISI-2 of the Intergraph, ERDAS Imagine Map Composer, P-1700 Photomation Optronics film scanner/writer, Intergraph ANATech 3640 large format scanner, STORK and BARCO Ink-Jet printers.

SPOT XS data with pixel size 20 m by 20 m was found good enough for merging with the high spatial resolution KVR-1000 panchromatic photograph. SPOT multispectral data have enhanced false colours of the satellite image maps. High spatial resolution of KVR-1000 and spectral bands of SPOT XS data have been used sucessfully for elaborating two satellite image maps of Warsaw area in the scale 1:25,000.

Once 15 metre or better spatial resolution of multispectral digital data becomes available on the market, we hope, that it would be possible to produce colour satellite image maps up to the scale 1:10,000. So far, only Black and White satellite maps in the scale 1:10,000 could be generated using 2 m resolution KVR-1000 space photographs (see Söllner, 1993 and Kaufmann at. el, 1994).

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