

TOPOGRAPHIC INFORMATION SYSTEM BY SATELLITE AND DIGITAL AIRBORNE IMAGES

Helge Wegmann, Sabine Beutner, Karsten Jacobsen
University of Hannover
Institute for Photogrammetry and Engineering Surveys
Nienburger Str. 1
D-30167 Hannover
Wegmann / Jacobsen@ipi.uni-hannover.de
S.Beutner@gmx.de

KEYWORDS: satellite images, digital airborne images, ATKIS

ABSTRACT

In cooperation with the State Survey of Lower Saxony (“Landesvermessung + Geobasis-information Niedersachsen, LGN”) the suitability of a manual revision of ATKIS with satellite data has been investigated. Two representative test areas, one in a rural area located in the area of Göttingen, 100km south of Hannover and one in the city of Hannover (EXPO), were mapped for this test.

1 INTRODUCTION

The possibilities of updating the Authoritative Topographic-Cartographic Information System (ATKIS) of the survey administration with the Digital Landscape Model corresponding to a map scale 1 : 25000 (DLM 25) by high resolution satellite and also digital airborne images has been investigated. In a test area near Göttingen, 100km south of Hannover, and in the area of the coming world exposition EXPO 2000 in Hannover IRS-1C images and in Göttingen in addition images of the digital airborne camera DPA have been used. Originally MOMS 2P data should be used, but caused by the problems of the MIR-station MOMS-data have not been available in time.

The MOMS-2P-data do have the advantage of a stereoscopic coverage within the orbit, that means the images of a stereo pair are corresponding and do not have the problem of a change of the object within the time frame of imaging. But there has been the problem of the MIR-platform, so MOMS-2P images have not been available in time. In addition the high resolution channel of MOMS with 5.8m pixel size on the ground became out of focus, so now only MOMS-2P-scenes with 16.5m pixel size are available. Because of this, IRS-1C images have been used. In the Hannover area a stereoscopic coverage with optimal height to base relations are available, the 3 images, one with a view direction of 18.7°, a nadir image and one with -20.6° have been taken within 3 days. A

disadvantage of these images is the low sun elevation of only ~13°. In the Göttingen area no stereoscopic coverage is given. A further disadvantage of the IRS-1C-pan-images is the radiometric resolution of only 6bit, corresponding to 64 gray values.

	MOMS-2P	IRS-1C	DPA ms (airborne)	DPA pan (airborne)
f [mm]	220 660	980	40	40
image size	6000 pix	12000 pix	6000 pix	12000 pix
flying height	390 km	817 km	(3.2 km)	(3.2 km)
covered area	100 km 48 km	70 km	4.5 km	4.5 km
pixel size	16.5 m (5.8 m)	5.8 m (23.5 m)	0.8 m	0.4 m
height / base	1.3	up to 1.0	---	1.1

Table 1: technical data of the sensors

The multispectral DPA-images, covering the Göttingen test area only by a nadir view, do have a pixel size of 0.8m which is very close to the announced very high resolution space sensors. These images could not be used because of the failure of Early Bird in 1997, the failure of EROS A in 1998 and the failure of IKONOS 1 in 1999. In addition the Clark system was canceled by the

NASA. But nevertheless for 1999 and the begin of 2000 following launches are announced:

- Quick Bird with 0.82m pixel size in panchromatic, 3.28m in multispektral (ms)
- IKONOS 2 with the same pixel size on the ground
- EROS B1 with 1m pixel in pan, 4m in ms
- OrbView 3a with 1 or 2m pixel in pan, 4m in ms
- IRS-P5 (Cartosat) with 2.5m in pan

With the exception of IRS-P5 all these sensors do have a pointing capability in the orbit direction and across, so a stereoscopic coverage is possible within the orbit.

The development of the space sensors has influenced also the airborne digital imaging. For example with the WAOSS, the HRSC, the DPA and MOMS now digital images can be taken also from the air with a sufficient resolution. This development was only possible with the improvement of the direct acquisition of the image orientation.

The ATKIS has been generated by digitizing existing maps but also by the direct use of photos with a scale 1 : 12 000 corresponding to a pixel size of 15cm. By the rule of thumb for the creation of maps a pixel size of 0.05 up to 0.1mm in the map scale is required, corresponding to a pixel size of 1.25m up to 2.5m in the object space. This is smaller than the pixel size of the IRS-1C pan image but far more large than corresponding the traditionally used photo scale. Only the DPA-image is close to the rule of thumb.

2 TOPOGRAPHIC INFORMATION SYSTEM

2.1 ATKIS

The demand for Geo-Information about topographic features of the landscape has been increasing continuously. Important ranges of application are specious planning of power supply, traffic pilot system, planning of mobile radio and so on. All these applications do require an up to date digital topographic data base. In this context the use of digital satellite and airborne images are considered to be a complementary solution, if it reaches the geometric and thematic resolution required for the Geo-Information System .

The Authoritative Topographic Cartographic Information System ATKIS is a joint development of the Working Committee of the Survey

Administration of the States of the Federal Republic of Germany (ADV). The DLM 25 of ATKIS contains objects and related attributes traditionally represented in a map scale 1:25000, with a positional accuracy of approximately 3m. In ATKIS the surface of the earth is modeled by means of geometric (point, line and area) as well as thematic data, defined in the ATKIS Feature Class Catalogue named ATKIS-OK (“Objektarten Katalog”). This catalogue contains the description of the ATKIS landscape features. The organization of ATKIS will is shown in figure 1.

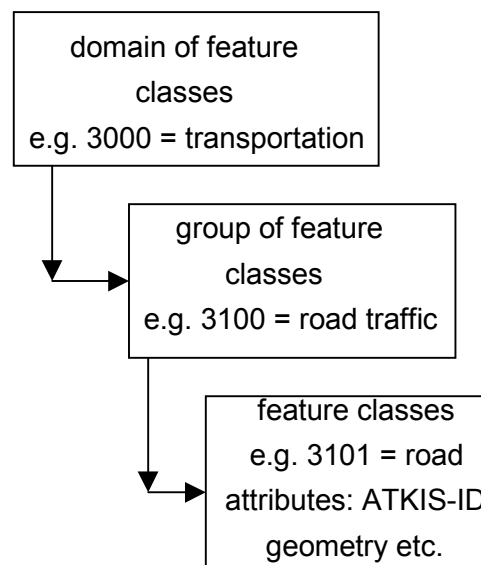


Fig. 1 Organization of ATKIS

In the ATKIS “Domain of Feature Classes” seven classes are defined: Geodetic control points (code 1000), settlement (2000), transportation (3000), vegetation (4000), waters (5000), relief (6000) and administrative areas (7000). Each domain is subdivided into groups of feature classes (for example 3100 = road traffic) and further into single feature classes (3101 = road, 3102 = way, path, etc.). More detailed description of the landscape features are given by attributes (name of road, road conditions and so on).

The creation of ATKIS is extremely time-consuming and so ATKIS is created in several steps. The first phase of the ATKIS DLM25 is entirely available and includes the most important topographic features. This basic data set includes all roads, paths, railways and waterways as line objects and also area objects, they are captured and depicted according to their use. The revising of the first realization stage, date and the creation of new

features and/or attributes are included the next realization stage of the ATKIS DLM25 data.

2.2 Update of ATKIS

Updating a GIS database such as ATKIS can be divided into the tasks of change detection, geometric and semantic description of the changes and their integration into the database. In the project with the State Survey of Lower Saxony (LGN) the suitability of a manual updating of ATKIS line features with digital images Airborne and Satellite data have been evaluated. For more information about automatic update of ATKIS areas feature with digital images see Heipke & Straub 1999.

Of course not all required information for updating ATKIS can be identified in the images. For example the feature classes “administrative areas” like legal border lines and some attributes e.g. “road name” are not visible in aerial or satellite images.

Consequently, the investigation was concentrated to a number of important topographic line objects, and the geometric data acquisition. The determination of feature attributes was part of this project.

3 RESULTS OF MAP UPDATE

3.1 Test areas

The test areas Goettingen and Hannover EXPO are located in the south of Lower Saxony. Both are characterised by rural and urban areas and some forest sectors. The height variation in each area is about 50 meters.

The main region in the project was Goettingen with an extent of 250 km² which covers two sheets of the topographic map 1:25000 (TK25). Hannover EXPO has only a size of 36 km². In this area, the mayor topic was the investigation of the advantage of stereo data acquisition of IRS-1C pan images against the mono method.

3.2 Used images

Originally MOMS-2P images should be used, but due to the known problems of the MIR space station in 1998, no images have been available.

Instead of this, IRS-1C pan images with a similar pixel size have been used. There are differences in the image quality caused by different weather conditions and the time of the year as can be seen in fig. 2 and 3.



Fig. 2 IRS-1C pan ‘Goettingen’, Friedland; 20.09.97

The region of Goettingen was imaged in September, by this reason, the contrast between areas and lines is limited. In comparison, the image of the Hannover area, received in December, seems to show more contrast due to a very thin snow coverage on agricultural areas. The limited contrast is also caused by the radiometric resolution of only 6 bit, corresponding to 64 gray values.



Fig. 3 IRS-1C pan, Hannover EXPO 23.12.96

In both areas aerial photos have been used for comparison. As GIS reference in the Goettingen area the first phase of the ATKIS DLM25 and in Hanover the second phase has been available.



Fig. 4 DPA image of Friedland 11.07.97

A small region around Friedland, which is belonging to the area Goettingen, was covered by a multispectral digital airborne DPA image – see figure 4.

3.3 Data Acquisition

In Goettingen the ATKIS layer ‚lines‘ was overlaid to the digital images during the data acquisition. The operator had to decide, whether the attribute of the feature has changed or the feature itself disappeared. Furthermore he had to grab new objects.

In the Hannover EXPO area, the data acquisition was made without any influence of prior information, that means no overlay was used and no comparison with the existing map has been made in advance.

In both regions, the monoscopic mode (mono-plotting) has been used. As mentioned before, in the Hanover area also the advantage of the stereoscopic examination (stereo-plotting) against the mono-plotting was checked..

3.4 Results

The geometric quality of the images is mainly depending upon the spatial resolution and the quality of the used software for the orthophoto creation.

In the case of the IRS-1C-images the identification of lines is depending upon the context of the surrounding area and the type of linear object itself. Generally the grade of pure *visibility* of lines was mainly influenced by the surrounding feature area (context) and certainly by the sensor’s spatial resolution as is shown in fig.5 and 6.

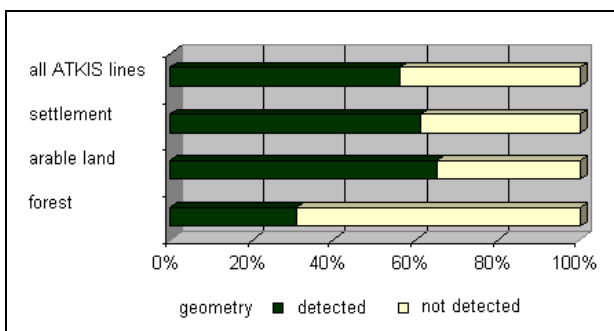


Fig. 5 Visibility in IRS-1C, area Goettingen

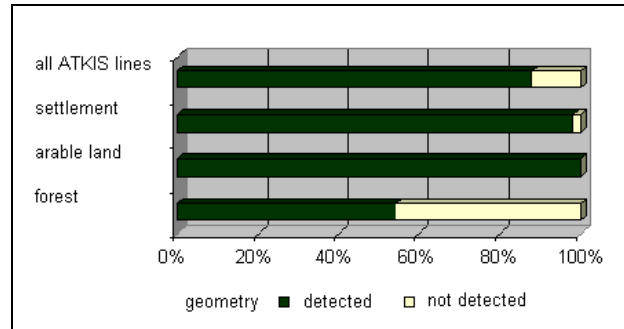
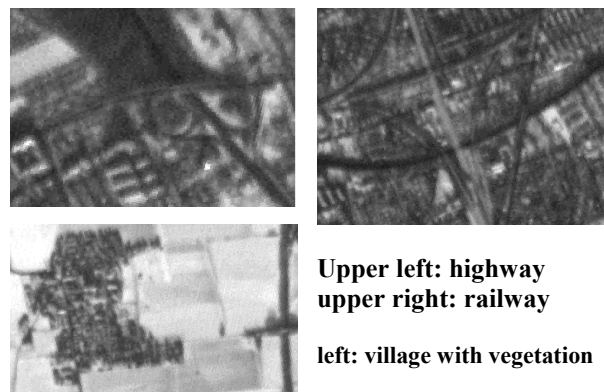


Fig. 6 Visibility in aerial photos, area Goettingen

The charts in fig. 5 do not state how successful the recognition was. Obviously the visibility of linear objects was difficult in forest areas. The percentage of recognition varies between 50% in IRS-1C images to 85% in aerial photos. The result achieved in the Hannover test area was similar. In IRS-1C images, 50% of the linear objects and in the aerial photos nearly 80% have been seen. The small difference in the results for linear objects in aerial photos, between both test areas, may be caused by the not used pre-information (no overlay of ATKIS-data) in the area Hannover.

Another aspect is the *interpretation* of the visible lines. In the IRS-1C-image many lines could only be classified based on the neighborhood information. For example a railway mainly differs from a highway due to different types of the crossing (fig. 7, upper row). In densely settled regions, it could not be identified whether a line is an ATKIS feature or just the space between buildings. Small zones with vegetation, like gardens, sometimes nearly wiped out the structure of lines inside the urban areas (fig. 7, lower left).



Upper left: highway
upper right: railway

left: village with vegetation

Fig. 7 Examples (Hannover EXPO)

The results of two feature classes of the Hannover area are shown more in detail. "Roads" and "lanes" are the most often objects of the line features. A comparison of the results achieved with IRS-1C and aerial photos is shown in fig. 8. In the IRS-1C images 9 to 10% of the ATKIS objects roads and lanes were identified not correctly. 35% of the roads and 60% of the lanes were not visible. In the aerial photo these percentages are much smaller (6 and 26 %). More features could be seen, but only 5 to 6 % have been classified not correct. This result has been obtained without any prior information.

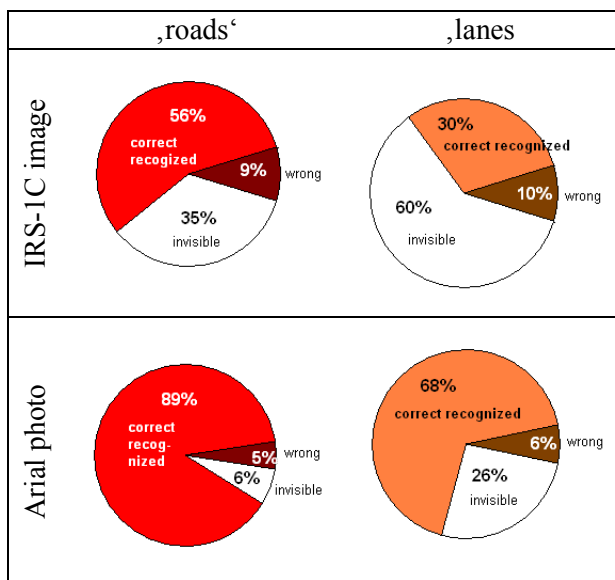


Fig. 8 Percentage of identification;
100% = all ATKIS roads/lanes

The results obtained from the digital airborne images were similar to the results based on aerial photo. The spatial resolution is less by the factor 2 in relation to the used orthophoto, but the recognition was more easy due to the color. The advantage of the stereoscopic data acquisition was limited against the mono-plotting. Only an exploitation could be identified easily by the 3-D-vision.

4 CONCLUSION

Based on IRS-1C-pan-images with a pixel size of 5.8m on the ground, only the major features, included in the ATKIS DLM25, could be identified. This corresponds to the rule of thumb that a pixel size of 1.25m up to 2.5m should be available for the creation of maps with a scale 1 : 25 000. But nevertheless, for an intermediate

update, which is concentrated to the most important features, it may be helpful. In addition in the statistics an important advantage of an update cannot be seen – new objects do have a better contrast caused by the construction than old objects, that means the identification is more easy. A problem still exists with the required accuracy of 3m, because of the limited contrast of most of the features this could not be reached. Only well defined objects can be mapped with an accuracy up to 1/3 of a pixel.

The digital airborne images, taken with the DPA, with a pixel size of 0.8m, are resulting in the same update completeness like the aerial photos with the scale 1 : 12 000. This confirms the rule of thumb and indicates the potential of the announced very high resolution satellite images.

5 REFERENCES

- Jacobsen, K., Konecny, G., Wegmann, H., 1998: High Resolution Sensor Test Comparison with SPOT, KFA1000, KVR1000, IRS-1C and DPA in Lower Saxony, ISPRS Com IV, Stuttgart / Int. Archive for Photogr. and Rem. Sensing 32/4
- Jacobsen, K., 1998: Status and Tendency of Sensors for Mapping, ISPRS I, Bangalore 1998, Int. Archive for Photogr. and Rem. Sensing 32/1
- Müller, Hofmann, Kaltenecker, 1994; Digital Photogrammetric Assembly (DPA), Point Determination Using Airborne Three-Line Camera Imagery – Practical Results IAPRS: ISPRS, Comm.III, Working Group1, Vol. 30, Part 3/2
- Heipke C., Beutner S., Straub B.-M., Wegmann H., Wiedemann C., 1999: Acquisition and updating of ATKIS using satellite remote sensing imagery IGARSS 99; Hamburg
- Heipke C., Straub B.-M.: Toward the automatic GIS update of vegetation areas from satellite imagery using digital landscape model as prior information ISPRS , Munich 99, Int. Archive for Photogr. and Rem. Sensing 32/3-2W5