DIGITAL ORTHOPHOTO IN SLOVENIA

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ABSTRACT:

Slovenia is a small country started its independence in 1991. Up to date information are crucial for good managing of almost all activities concerning our environment. Many countries face problem of updating maps and other spatial information. Digital orthophoto is expanding product that is produced fast and gives objective data. It can be used for very different purposes and users.

We have quite old tradition with photogrammetry in Slovenia started in early fifties. Our own aerial service started in 1970. From 1985 in three years' cycles all country is covered by aerial photography mainly in photo scale 1:17500. This gives us an opportunity to produce digital orthophoto on a regular base. We started with the production in 1994 and needs for such product are growing.

Content of the article is as follows: In the introduction some basic information about maps covering the country and short history about photogrammetry. Then equipment and production line at Geodetic Institute of Slovenia followed by description of some larger projects and why the users are using the products. At the and, some future development of digital orthophoto production is discussed.

KEY WORDS: Photogrammetry, Digital, Orthophoto, Slovenia

ZUSAMMENFASSUNG:

Die Staat Slowenien ist selbstständig ab Jahr 1991. Aktualität der Raumdatem ist sehr wichtig für die Raumverwaltung und auch für alle andere Aktivitäten. In vielen Ländern ist die Aktualisirung der topographischen Karten und Raumdaten eine sehr bedutende Aufgabe. Digital Orthophoto ist ein neues Produkt, der nimmt sehr schnel an Bedeutung und liefert schnell und zuverlässig die Daten.

Die fotogrammetri hat in Slowenien schon eine lange Tradition, erste photogrametrische Projekten haben wir in 50 Jahren durchgefuhrt. Ab 1985 machen wir die photogrametrisce Befliegung der gesamten Staat in 3 Jahre Zyklus im Maßstab 1:17.400. So erzeugten Aeroaufnahmen sind die Grundlage für eine umfassende Orthophoto Production, die startete im 1994.

Inhalt des Beitrags umfast: In der Einleitung sind wichtige Informationen über Kartenwerke und Photogrametrie in Slowenien vogestelt. Weiter stehen die Beschreibungen der Produktionslinie bei Geodetschem Institut der Slowenien mit der Daten über grössere Projekten und dessen Endverbrauchers. Am Ende haben wir unsere Projektion der Entwicklung der Orthophotoproduktion vorgestelt.

1. INTRODUCTION

1.1 Maps and plans

Slovenia covers the area of 20256 square kilometres. Our base maps are in scale of 1: 5000 (2530) and 1:10000 (258 sheets) which covers mainly mountainous regions. They were produced from 1963 to end of seventies. More than half of all sheets have never been updated, which now is causing a serious problem of their use. In spite of that all sheets have been scanned on different layers, like situation, hydrology, relief contours and their combinations.

Then we have topographic maps 1:25 000. There are 201 sheets and for which now updated series are being produced. For that series scans have been produced also. Atlas of Slovenia contains 218 sheets of topographic maps in scale 1:50000 and 44 town planes in scale 1:12500 except for Ljubljana that is in scale 1:20000. Recently third edition has been published; all together 135000 units. Basic topographic maps 1: 5000 and 1:10000 were mostly used for producing the atlas. Scans have been produced also for those maps.
Overview maps are in scale 1: 250 000 and 1: 750 000.

1.2 Short history of photogrammetry in Slovenia

The first known aerial photos of Ljubljana were made by a photographer from a balloon. Those photos were used to produce photo mosaic. This happened in 1933.

Exist some aerial photos from Second World War made by the RAF. VGI (Military Geographic Institute) from Belgrade has given us service among 1953 and 1970 when Slovenian own aerial photography service started. First photographs have been made on glass plates.

The first analogue photogrammetric instrument in Ljubljana was bought in 1954. This instrument was Wild A8. Two of its younger ancestor are still in use.

The first orthophoto was made whit Zeiss - Topocart Orthophot in 1972. Production of such orthophotos has never been very large.

The first prototype system for producing digital orthophoto was made in late eighties. A PC was used as developing platform. The greatest problem at that time was haw to produce quality large format hardcopy that only counted at that time because

hardly any user exists who could use digital images as a background. Unfortunately this self development stopped at stage of the prototype.

In 1991 the first analogue instrument was upgraded to a semi-analytical photogrammetric instrument by using KORK digital mapping system.

The first large project of digital orthophoto was done in 1992-93. Some few tenth sheets in scale 1:5000 were produced for near coast region by a private company.

End of 1993 first high end digital photogrammetric workstation was bought. After hard work and step from analogue to digital system, production line of digital orthophotos has started.

Surprisingly first analytical instrument was bought in 1995 when digital photogrammetric production line was well established already. Two of them are now working in the whole country.

1.3 Aerial photography

As we have heard before, our own aerial photography service started 1970. The first equipment for aerial photography was aeroplane Morava and aerial camera Wild RC-8. Interest for aerial photos grew fast end the first camera follows second which was Opton RMK both with 150 mm focus.

CAS stands for cyclical aerial photography that has purpose to cover the whole country in three year cycle. The aerial photography that is not CAS called PAS what stands for special project aerial photography. For both, CAS and PAS a database where 16 different facts, like photo scale, date, strip number, film number, ... for each strip are stored.

In 1975, for the first time, almost all county was photographed in scale 1: 17 500 in E-W direction. The second full covered CAS followed in 1980 where 1: 30 000 scale photos were produced in N-S direction. From 1985 till now four complete three years' cycles (CAS) were made mostly in scale 1: 17 500. Some strips, usually urban areas, were produced in scale 1:10 000. Almost 2600 strips were made. One of three years' cycle has more than 5000 photos if photo scale 1:17500 is performed.

Since 1980 almost 2000 strips were photographed for very different purposes (PAS) at almost 500 different locations. Scales differ from 1:500 to 1:47 000. More than ten different films and filter types were used.

1.3.1 Equipment

At present our company owns two aeroplanes (Paiper and Cessna) with three cameras and four lenses (RC8 23/15, RMK 23/15 and LMK 23/21 and 30 cm) are used equipment. We can also use four Hasselblad cameras with four different lenses. At our company complete fotolaboratory for developing aerial films, contact copies and enlargements is also available.

2. DIGITAL ORTHOPHOTO

In Slovenia are very few companies that produce digital orhtophotos either from aerial or satellite images. Here is mentioned only Geodetic institute of Slovenia because the authors are working there.

2.1 Equipment

At the Geodetic Institute of Slovenia we have the following equipment:

Digital Scanning Workstation DSW100, which is mainly used for a semi automatic digital data acquisition of aerial triangulation, adjustment up to 4000 units (photos or models) and for high precision scanning of aerial films.

Digital Photogrammetric Workstation (DPW770). This is high end digital workstation where steroviewing, DTM generation, DTM editing, orthophoto computation, mosaicing and 3D digitising are performed.

As additional we have SG for quality check of digital data, few PC-s for preparing additional information or plot files, raster plotter for low cost hardcopy output, CD-ROM writer for archiving and delivering the data. All computers are connected to the local computer network.

Beside digital orthophoto equipment we have 4 semi-analytic photogrammetric instruments WILD 2 x A8, A7 and A10 and the analytical instrument Leica - SD2000. All are equipped with digital mapping system VI - KDMS. These instruments are used for collecting vector data as addition information onto digital orthophoto products.

2.2 Digital orthophoto production line

The used method of measurement of control points largely depends on wish of the user. When we produce digital Orthophotos in scale 1:5000 from CAS control points from topographic maps are usually used. Only when we cannot find good identical detail on a photograph and a map, we perform field measurements with GPS. If special aerial photography (PAS) is planned, then points on the field are marked and measured by the GPS.

The aerial triangulation is performed on DSW100 using DCCS. Resolution of 2000 DPI is used for that purpose. Usually nine points per photo are measured. Each point, when digitised first, is saved on a hard disk as an image and as a photo co-ordinate. When the same point is searched on next photo, this saved image is served as a reference. DCCS helps to find approximate position on the next photo. If a correlation is on, it also finds the exact position of the point, if compared images are similar enough. The saved images of tie-points are later extracted to the TIFF format and printed with a point name and cross in the middle (see Figure 1). This sketch is served as control point for orientation on semi-analytical instruments.

Scanning is usually performed by second resolution that is 1250 DPI. B/W scanning for full frame takes about 35 minutes and for colour for 1.5 hour. Fortunately, not the full frames need to be scanned but only a part that is useful for the project. This saves a hard disk space and does not need high performance computers as automatic digital aerial triangulation procedure.

After aerial triangulation and scanning are done, orientation parameters and images are imported to DPW. Immediately one can start stereoviewing of a model through passive polarisation system. Automated DTM extraction is the next step. Editing tools are used to check and correct automatic produced DTM. Mostly point to point editing tool is used.
After DTM is produced orthophoto generation is the next step.

To get a nice mosaic geometric and radiometric adjustment is needed, which can be done on B/W and colour images. Sheets or square images are cut from the mosaic where softcopy and hardcopy output are produced.

For hardcopy output we have two different production lines, one using Arc/INFO Workstation and the other FreeHand. Here additional features like contours, annotation and other vector features are added.

Archiving is important for later retrieving or updating a data. So produce a copy of final result on a CD-ROM, one for the user and another for archiving. Intermediate results are stored on tapes.

2.3 Digital orthophoto projects

Here are mentioned only three larger projects. The first project was done at the beginning of the use of new equipment. Later fewer problems occurred and the production now runs smoothly.

The first project started in 1994 and covered the city of Ljubljana and it's surrounding. Two different GSDs (0.5m and 2m) have been produced from same aerial photography that were in scale 1:25000. In GSD of 0.5m 34 sheets were produced and with GSD of 2m 16 sheets.

Second project runs on a continuos base and contains many smaller projects. Those projects have from 1 to 40 sheets in scale 1:5000 at different location in the country. Each of those projects is ordered by the government, local authority and sometimes third user. All have the same input that is aerial photos in scale 1:17500 from CAS. Different methods for measuring of control points are used, mainly depends on the project location. Procedure for producing digital orthophoto and DTM is the same for all smaller projects. This project has been running for two years and some additional information as geographic names are added to the product. Beside digital data a low cost hardcopy output is produced for each sheet.

Third project mentioned here is mapping of Slovenian coast in scale 1:1000 and with GSD 0.2m. Colour aerial photos were taken in scale 1:8600. Eighty GPS points were measured on the field to serve as control points for the aerial triangulation process. The diapositives of aerial photos were put in the DSW100 three times, first for the purpose of aerial triangulation, second for B/W scanning and third for colour scanning. B/W scanning was used for DTM generation and colour for digital orthophoto production. The 10m DTM regular grid was produced and the project area was divided into almost 400 squares 250m x 250m. After the DTM was generated and edited the coast line was digitised in the stereo mode. Each square contains 4.7 MB of digital data. Beside the digital data 114 hardcopy sheets were produced in colour on the low cost 360 DPI ink jet raster plotter. The results were satisfied and hardcopy serves as good working material.

2.4 Use of digital orthophotos

Digital orthophotos are used for very different purposes. Here are mentioned only those our customers have been using:
- map updating for basic topographic maps
- urban and rural planing
- regulation of owner rights in near coastal areas
- support to agency for agriculture development in private sector
- support to renovation of cadastre
- planning and regulations of near spring areas
- geological researches

3. FURTHER DEVELOPMENT

Further developments are close related with aerial photography development and increasing resolution of satellite data. Concerning aerial photography we are going to preserve 3 years cycle aerialphotography and try introduce to 3 to 5 years cycle orthophoto coverage of the country. To achieve that goal GPS has to be introduced in aerialphotography and automation of aerial triangulation that is already available on the market and proven as so. Automation in scanning is needed for faster automated aerial triangulation.

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