

ISPRS - WG VI/3:
"International Cooperation and Technology Transfer",
ISPRS – WG IV/3:
"Temporal Aspects and Topographic Database Maintenance"
and
Slovenian Section of Photogrammetry and Remote Sensing

Meeting "Bridging the Gap"
Ljubljana (Slovenia) - February 2-5, 2000

USE OF SATELLITE IMAGES FOR CREATION OF DIGITAL MODELS

(by Plamen Maldjanski)

SUMMARY

Possibility of using satellite images for creating digital models are discussed. Most popular photogrammetrical technology for create digital models by satellite images are showed. Most important examples of digital elevation models (DTM) and digital models of monument of culture and architecture in Bulgaria are described.

Classification of Satellite Images

Satellite images are appropriate to cover large territories of land cover. The development of modern communication networks helps implantation of new, mostly photogrammetry data for the creation of Digital Models. The most commonly used images are:

- Frame (these are images, taken with fixed focus distance and the carrier) the film is brought back to Earth)). The images are Central Perspective;
- Electronic; images where content is transferred via television way (via electromagnetic radiation). The development of the image (flash) is determining. A solar ray, moving in certain principle over a special screen of the receiver creates that;
- Scanner; images are taken on a special mirror, which moves in certain principle and reflects different part of the land cover. The principle of the movement of the scanner mirror can be determined in advance;

Satellite images, regarding the diapason where the photographing is done, are:

- Within the visible spectrum (they are used rarely, because of the insufficient cognition of the integral of atmospheric refraction distributing);
- Polyzonal; images that are taken simultaneously in different diapasons of one and the same area of the investigated territory with different length of waves (i.e. in different diapasons). Actually these are informational independent channels (everyone in different diapason), out of their mixing is possible to be produced different informational-saturated images, which generalize the qualities of every single channel. Polyzonal spectrum projectors and synthesizers are used for the development

of those images. The field of exploration is decoding of images in regional studies, discovering of mineral resources, etc.

Data Requirements for the Development of Digital Models

Raster and vector data are usually used. Contemporary methods of photogrammetry digital technologies consist in the following:

Area images, taken from a satellite /with an analogue or digital camera / are preliminary subjected to correlation processing in order to improve qualitative and quantitative characteristics /contrast, brightness, etc./. Special program systems are usually used like CorelDraw, PhotoShop, Imagin and others, that enable the application of appropriate digital filters and the desired correlation function. In many of these systems the paths of processing are standardized /appropriate plug-ins /digital filters/ are developed/. If the taking of the picture is done with a digital camera, the raster images appear to be input data of the areas in appropriate graphic format /*.tif, *.gif, *.pcx and others/. The camera resolution should be minimum 1200dpi, which corresponds to 5-7 microns size of pixel from the raster network.

When frame pictures /analogue cameras/ are taken scanners with high resolution are used for the digitalization. Corrections are necessary to be done over the satellite images, because of the roundness of the Earth, distortion of the lens and the atmospheric refraction. Usually, in case of frame space pictures technology corrections are done at the stage of preliminary processing, by means of so called image calibration. Calibration is the precise specification of coordinates of some definite points of the square network frame, taken during the photographing, through comparing with beforehand known points. Different methods and models can be used for the purpose. Most often corrections are in the form of polynomials and are plotted as unknown elements of the space images orientation. The creation of analytic model, reflecting the connection between image and space point coordinates, as a function of the orientation elements is a basic method in working out data from satellite images. Important stages appear to be the so-called transformations between defined coordinate systems. A preliminary processing of the input data is also necessary. Some of the possible technologic schemes are:

- Using photogrammetry working stations; The are combination between precise analytic photogrammetry appliances, high efficient hardware and appropriate software /CAD with GIS systems/. RD2000 and others are of that type.
- DVP /Digital Video Ploter/. This technology supposes the usage of scanned images for the development of stereoscopic model and vectorization of the data based on the observation of this model. Systems exist which provide stereoscopic observation by means of stereoscopes or polarizing glasses. These are DVP Leica, MPG Integraf and others.

The high efficiency and preciseness of these systems are determined by both the short technological cycle and the analytic way of orientation of the initial image and their further stereoscopic observation and measurement. CAD systems, where digital model is developed, are usually used as input for correction and processing of DVP-systems.

Methods for the Creation of Digital Models

Many methods for the creation of Digital Models exist. Most widespread are:

- Regular method; It consists of covering the region with data /most often discrete points and lines, taken from characteristic places / with a regular, usually quadratic net. The density of the discretely represented elements from the surface is usually defined as a function of geomorphometric parameters of the region /for topographic surfaces/ or by the character and the purposes of the task. It is necessary in any case to pass through preliminary study of the object. Next stage is the expression of the coordinates of the discrete net climaxes as a function of the coordinates of object's discrete elements. That is fulfilled by of appropriate prognoses /predicative functions/. They are used both in interpolation operation and in extrapolation of data. Polynomials, linear and spline functions are most often applied. A key stage is the acceptance of predicative function and the density of the regular net. They are also called indirect, because the direct results of the measurements do not participate in the presenting of the regular net. These methods give good results in regular distribution of data;
- Irregular; Data from the direct measurements / mostly point/ are used, as they are connected with uncovered triangles /facets/. And that is the surface is formed.

Graphic systems exist, that allow the creation of Terrain Digital Model by the above-mentioned methods. Such are: Inroads /works as an upgrade for Microstation/, Civil Engineering /as an upgrade for AutoCAD MAP, SCOP, List CAD/ and others. The common thing in these systems is the fact that the model exists only in the relevant system. Exchange of data with other systems is only possible in using standard import-export formats.

The contemporary tendency is in the using of models created in a way they could be used out of the graphic systems where they were developed. /For example their viewing to be done by browsers and their usage to be offered in Internet. Such models are written in format VRML. Special photogrammetry systems are used in their development /Photomodeler/.

Types of Digital Models and the used program languages.

Digital models are raster, vector and combined, while the technical means they are created are universal and specialized. Contemporary achievements of the multimedia production and the high-speed exchange And transfer of data are very important for the nowadays development of Digital Models. Specialized languages are used for the creation of relevant software /Java, Java Script, Visual C++, Delphi and others/

Technologies and experience in creation of Digital Models in Bulgaria

Terrain Digital Models and Digital Models of the monuments of culture are mostly developed in Bulgaria.

Cad systems are used – AutoCAD, 3D Max, Gif-animation, Microstation and others.

There is no normative basis for the creation and usage of Digital Models. The energies are directed towards creation of Territorial Digital Model of the whole country.

Images /mainly air/ are used in the Cartography Institute in Troyan for reabmolization of topographic maps of 1:25000 scale and larger scales. There is a Territorial Digital Model created for Bulgaria over 5 000 map, but it does not cover the whole country.

Territorial Digital Model of the Danube delta is currently developing. The project is international and the SCOP system is used.

The Technical University in Sofia creates Territorial Digital Model of Iskar Dam Lake with AKSTAR M system.

Digital Models of the monuments of culture are developing by scientific teams of the Institute for Preservation of the Monuments of Culture /Digital Model of the Boyana Church, the Bulgarian National Bank and others/.

Satellite images are used for the creation of a digital map of Sofia, for some subject atlases and informational systems being developed by the Photography and Cartography Department at the University of Architecture, Construction and Geodesy in Sofia and the Institute of Cartography.

The University of Architecture, Construction and Geodesy in Sofia is a party in co-work and scientific exchange between specialists and technological projects with the Technical University in Wien, the Institute of Geodesy in Ljubljana and others.

Bibliography

[1] Inroads, User guide,1990

[2] AutoDesk Civil Engineering ,User guide,1997

[3] Kalay, Y.,E., Modeling solids bounded and Annex to the parametric surfaces ,CAD 15,No3, 1983

[4] Diplomas work and projects of students in UASG, department of Photogrammetry and Cartography, Sofia