

ZEISS DIGITAL MAPPING

A new hardware and software system concept from
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Mapping and map production as the main tasks of geodesy/photogrammetry as well as of remote sensing are characterized by rapid advances, which are essentially aimed at the generation of digital maps. These advances have been made possible, on the one hand, by the development of computer hardware including most sophisticated firmware and the resulting possibilities of efficient software solutions, but on the other hand also by revolutionary solutions in the equipment systems. ZEISS JENA has made its contribution to this trend with the LMK aerial camera, the first commercially available camera with forward motion compensation (1982) as well as with the efficient plotting machines STEREOMETROGRAPH, TOPOCART and STEREOPILOT, of which the two last-mentioned systems will also in the era of analytical plotters have a strong foothold for a long period in the field of stereoplotting because of their favourable price/performance ratio.

In the following a system is presented which is characterized by its capability of being connected with equipment existing at the user and by its high utility value in all its parts and which radically changes the traditional process of map production and map use. The block diagram shows the structure of ZEISS DIGITAL MAPPING in a generalized form.

Modern digital mapping systems are distinguished by homogeneity relative to the accuracy of data acquisition and data processing. Moreover, the user expects complete solutions which are immediately applicable after a short period of familiarization and with the experience of the existing personnel. In other words, the user expects a solution dedicated to his needs, that is based on the practice to which he is accustomed.

User-friendliness is guaranteed by the experience of ZEISS JENA regarding the development of photogrammetric camera and restitution systems and the long experience of the software developer, Messrs. Walter Bonne DIGITAL MAPPING SYSTEMS gained over decades in the field of applied photogrammetry for the production of maps of all kinds, including digital maps. The incorporated instruments of such companies as HEWLETT PACKARD, INFOTEK, CALCOMP and others are a solid basis of the performance in every partial solution of the system.

ZEISS DIGITAL MAPPING shall be demonstrated in the following by the example of map production from aerial photographs. A few remarks on the use of digital maps will round off this article.

1. Map production from aerial photographs

1.1. Aerial photography in the ZEISS DIGITAL MAPPING system

No evidence need be given of the fact that the accuracy of the map is decisively influenced by the photographic process. The ZEISS JENA LMK 1000 in their design variants with 90, 150, 210 and 300 mm focal length has in the past 5 years proved to be an ideal camera system. Unlike traditional cameras, which utilize the efficiencies of high-performance lenses only under favourable conditions, the LMK 1000 boasts of considerably improved features. For example, the forward motion compensation allows:

- photography from a relatively low height, i.e. with the largest possible image scale and hence increased restitution accuracy;
- photography under light conditions of an overcast sky, where conventional cameras fail to produce useful pictures or where highly sensitive emulsions become necessary which entails a reduced resolving power;
- photographs with high-resolution, relatively insensitive emulsions under normal light conditions and hence better detail recognizability and higher restitution accuracy as compared with conventional photographs;

- unusually high image sharpness at increased flying height and hence smaller image scales. Compared with conventional camera systems this leads to larger model areas and hence increased ground coverage without loss of information, resulting in increased photoflight economy.

These benefits are completed by the computerized exposure control. It ensures

- optimum matching of film parameters and flight parameters,
- optimum exposure of dark image regions, and
- largest possible relief of the photoflight operator and optimum control of the photoflight parameters.

A valuable supplement to this equipment configuration is the NCU 2000 Navigation Control Unit which is functionally a combination of the AEROSKOP navigation telescope and the control unit of the LMK.

Attendant consequences are:

- The photograph can be flown with a two-man crew, i.e. with pilot and camera operator.
- The number of holes in the aircraft's fuselage is reduced from hitherto three to two.
- The reduced load and the saving in space permits better working conditions for the crew, increases the useful load and also allows the use of smaller aircraft.
- The optimized auxiliary images with perspectively running travelling marks along the flight line create the best prerequisites for the visual navigation in forward and backward view.
- All camera controls are clearly arranged for convenient manipulation.

The 4- and 6-channel Multispectral Reseau Cameras (MSK 4/MKF 6) of ZEISS JENA featuring also forward motion compensation are increasingly of interest for the purposes of mapping from photographs taken from high-flying aircraft or from satellites. Of decisive importance is the high resolution in the spectral ranges and the geometric accuracy of the individual pictures as well as their combinations from selected channels.

1.2. Airphoto restitution in the ZEISS DIGITAL MAPPING system

The restitution of aerial photographs is that part in map preparation which requires a maximum of equipment and is at the same time the bottleneck in the map production process. The analytical plotters offered so far were not capable of leading to a significant reduction of the process times, but first of all involved an increase in price of the final product. Also image correlators could so far not bring about a radical solution, especially when the restitution at large scales was concerned. At the moment a preliminary solution can only be found technologically. This means that the plotting machine issues all data immediately into the data bank and that these data can then be used in the production process for different map types. The acquisition of the data must be possible in a straightforward way partially with equipment existing at the user.

The ZEISS JENA TOPOCART D equipment which is distinguished by universality and precision as well as its comfortable observation system, has become a standard machine. We merely refer to the following conspicuous parameters:

$c_k = 45 \dots 310 \text{ mm}$, large z range, $m_{xy} < 10 \mu\text{m}$, maximum oberservation magnification 12 times. For users working with focal lengths of 90, 150 and 210 mm it is recommendable to employ the ZEISS JENA STEREOPLOT, an equipment for stereomapping with optimum price/performance ratio. This is a machine of streamlined design doing away with all superfluous mimickry, but a high value was set on convenient manipulation and sufficient accuracy in stereomapping.

Any other plotting machine, whose model coordinates are fitted with TTL-compatible digital encoders, can without any problem be used for data acquisition.

Importance should be attached to the homogeneity of the measurement relative to its accuracy, since differences in the acquisition or recording jeopardize the value of the data bank being created.

1.3. The data bank in the ZEISS DIGITAL MAPPING system

The hardware of the data bank comprises the HP 9000/Series 300 computer optionally with 16 or 32-bit processor with 5 Mbyte RAM and a Winchester drive of minimally 20 Mbyte as well as a colour monitor (12, 16 or 19 inches).

The MERCATOR D.M.S. software of Messrs. Walter Bonne organizes the data acquisition process (CAPTOR), data management including interactive work (ACTOR) and the graphic data output (PLOTTER).

Data acquisition is performed with CAPTOR via photogrammetric plotting machines, via digitizing tables (e.g. of Messrs. CALCOMP), via ZEISS JENA electrooptic tacheometers RECOTA, RETA and others as well as scanners (see schematic).

Data acquisition can be ON-line or OFF-line. In the first case, data is stored in the previously selected coordinate system, e.g. ground coordinates. In OFF-line, however, data is temporarily stored in a machine coordinate system, with the position of the control points being taken into consideration. If the control point coordinates are measured at a later date, the temporarily stored modules are transformed into the particular system. Also the fitting of the models into the data bank system, for example a geographic information system (GIS), is made automatically. This kind of parallel stereoscopic restitution and geodetic supplementary measurement leads to a considerable saving in time for many projects. Especially when delays in geodetic point determination occur caused by climatic or seasonal reasons, the restitution process will not be delayed by this.

The capturing of the restituted objects in different colours on the monitor ensures a complete checking of the state of

restitution. Thus, CAPTOR immediately accelerates the process of restitution. Erroneously recorded data is simply deleted in the data bank. Drawing tables are no longer needed for checking.

ACTOR automatically checks the data bank completely and in all its important parts. In this program section the digital map is completed, corrected and finished. More than 170 interactive functions which are called up from a graphics console ensure a fast and comfortable processing of the map in all its details. Text, symbols, line types, hatchings, fillings, line forms etc. are easily producible by users and can then at any time be used according to standard. In the software part FRAMER as a constituent of ACTOR all kinds of map frames and legends are prepared and applied according to the map type.

If the final product is required to be a digital map, an appropriate extraction is stored on diskette, with data quantities of several Mbyte on tape cassette. A graphic printout on a DIN A3 printer (e.g. Thinkjet) completes the result.

For many purposes the drawn map is preferred to the digital map or a combination of both is desired. With the PLOTTER program every extraction from the data bank can be produced "as printed" or as an original for print.

Maps in low quantities are directly issued or duplicated in monochrome or multicolour. The Hewlett Packard plotter equipment with 8 drawing tools and in formats of up to DIN A0 enables the PLOTTER-optimized output with a maximum drawing speed of up to 600 mm/s with sufficient accuracy. For map sheets in appropriate quantities the originals are output on dimensionally stable film. Laser printers can be used for the most exacting demands. Combined outputs of text and graphics e.g. for cadastral extractions are likewise possible.

The high quality of the graphical output by PLOTTER renders the engraving technique practically superfluous.

Each graphical final product is called up directly from the data bank. Such work as compositions, tracing on overlay sheets, pasting of single or area-covering symbols and text as well as other work to be done by cartographic tracers become superfluous or are prepared under the control of ACTOR and any tracing operations are performed by the plotter. The times saved in the map preparation and production process are of considerable orders of magnitude. The technical personnel saved in this section may be used for the interactive work with ACTOR and can accelerate the total process with incomparably higher effectivity.

2. Map utilization with ZEISS DIGITAL MAPPING

It must be considered as a great advantage that the utilization of the digital map in the form of the data bank established in coded planes is enabled on the basis of the same hardware and software. The size, performance and the required investment for a system range within an order of magnitude, which enables wide utilization.

The logical, staggered data bank structure allows the user to work in that plane, which is necessary for the solution of his task. Hence, it is for example possible to handle separately the inland waterways system, the road network, residential and industrial premises, cabling systems and pipe lines, different vegetation etc. The data bank structure proves to be particularly favourable for land register (cadastre), whether centralized or decentralized. The combination of topographic and administrative data renders ZEISS DIGITAL MAPPING into an ideal working tool for planners of cities and highways, for project engineers concerned with water, energy and communication routes (telephone, TV cable systems), for agriculture and forestry and for municipal and regional cadastres,

to mention only a few of the major applications. The application spectrum includes road accident surveys, environmental protection as well as the wide field of thematic map production.

The output of accurate data ensures the quick graphic availability of the required documentation.

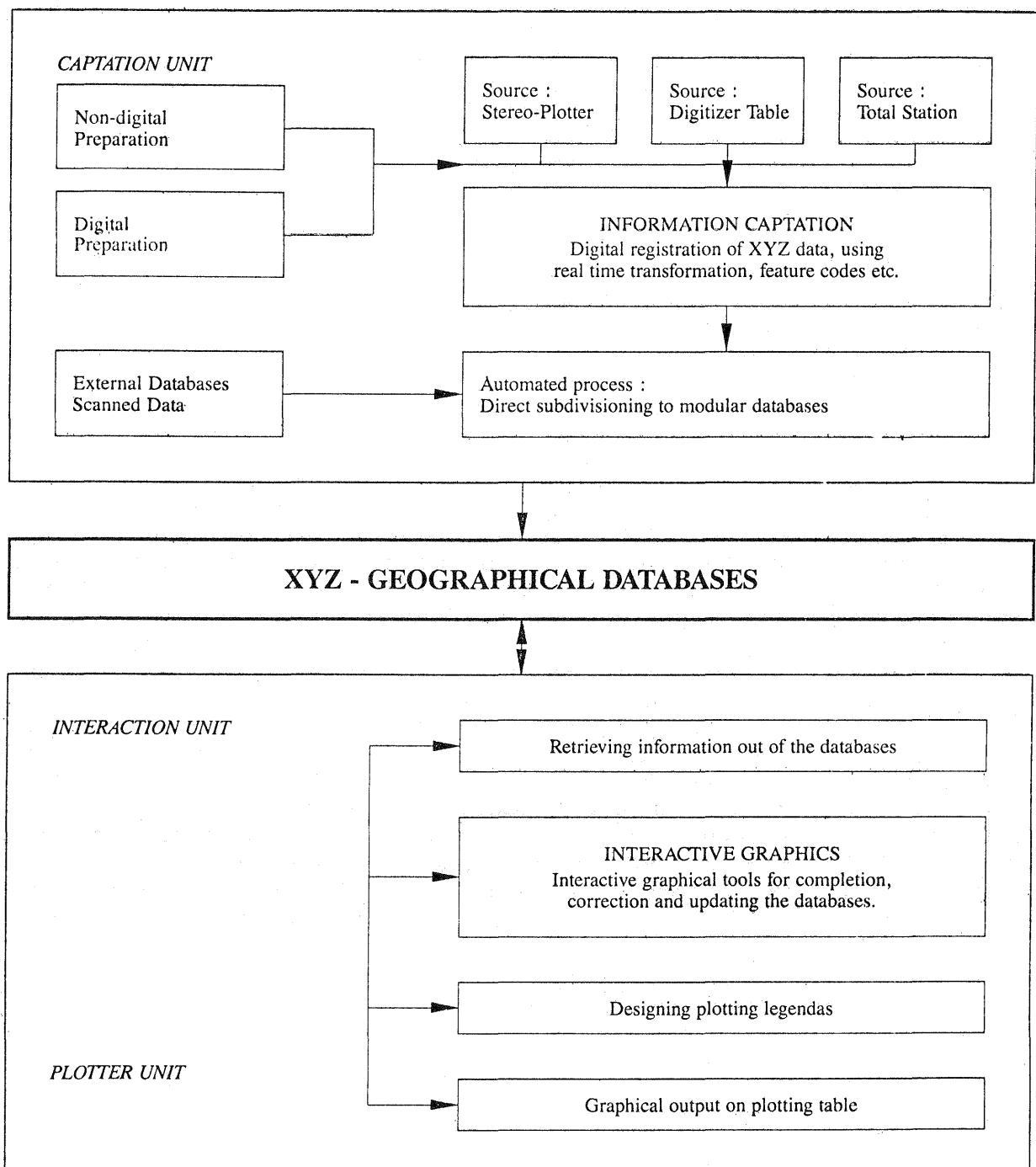
Map revision can be implemented by central institutions and by the user himself, with the procedure doing away with any tracing work and ensuring a high degree of up-to-dateness.

If ZEISS DIGITAL MAPPING works as a geographic or land information system (GIS or LIS), the SHARED RESOURCE MANAGEMENT of HEWLETT PACKARD offers the prerequisites for an optimum hardware/software configuration as well as an efficient periphery.

The ZEISS DIGITAL MAPPING system offers users of ZEISS JENA remote sensing equipment or of ZEISS JENA MSK 4/MKF 6 4- and 6-channel Multispectral Reseau Cameras the most favourable prerequisites for the processing of data gained from photographs taken from high-flying aircraft or satellites. The geometric accuracy of the interpretation results ensures a reasonable transfer of the results into the data bank for creating the digital map.

3. Summary

The article presents the concept of the ZEISS DIGITAL MAPPING system, which consists of aerial photography and restitution equipment and the hardware and software of a data bank. All parts of this modular system are efficient and user-friendly. The MERCATOR D.M.S. software rationalizes the map compilation and utilization process by eliminating several process steps cutting the remaining processing times and improving the accuracy and usefulness of the final product, whether this is a data bank extraction on a data carrier, a plotted map, or an original for monochrome or colour printing. All processes of compiling and utilizing digital maps are fully supported by software and hardware.



Zeiss Digital Mapping