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DATABANK- AND INFORMATION SYSTEMS FOR DIGITAL TOPOGRAPHIC PHOTOGRAMMETRY

Abstract

A rigorous automation of photogrammetric procedures for topographic mapping causes new requirements to facilitate automated data processing and plotting These requirements originate from more complex structures of points, lines, symbols, additional information, and the necessary lettering as compared to the pure single point measurement of aerotriangulation. The application of databank- and information systems for topographic photogrammetry is of vital importance for the effectiveness of any further automation.

The paper discusses in detail the desirable and necessary functions of databank- and information systems. Data collection, data manipulation for editing, data processing for various plotting purposes, but also for further multiple use of the primary digital data require different such functions. They are collected for the main work-phases of photogrammetry and for related desirable additional economic and universal utilisation of the digital topographic data.

It is not intended to define and classify databank- and information systems, e.g. according to inherent system-functions, but to help a potential user specifying his own requirements.

Introduction

Recent developments in computer technology and increasing applications of electronic data processing to automated plotting have a growing impact on topographic photogrammetry. (/9/,/14/,/15/). Especially for topographic applications any intended automation requires a change from traditional analog to a higher degree of digital procedures. The rapid spread and acceptance of analytical stereo restitution instruments of many different manufacturing companies in Europe and North America clearly demonstrates this tendency.

Analog stereo restitution is a powerful and highly sophisticated method to achieve geometric as well as semantic information with great precision from stereo photography without the need of elaborated continuous calculations. The reason for this is, basically, that all analog stereo restitution instruments are analog computers, that resolve continuously the coplanarity equations of stereo photogrammetry. Up to about 1960 the importance of topographic photogrammetry for the collection of environmental information originated from this principle.

For every multiple use, the map manuscript as a main and frequent result of analog photogrammetry has the disadvantage to contain all the collected information in only one distinct and specific scale. This makes it very clumsy and expensive to reuse the collected information of environment for other purposes than the originally intended ones. This holds for selections of specific classes of information as well as for a multiple use of the

general information for the development of map series in varying scales.

Automation and digital photogrammetric methods promise condiderable advantages especially for reusing the information that has once been recorded (/9/,/15/). But there are also caused new requirements by the complex structures of points, lines, areas, symbols, and the necessary lettering in topographic photogrammetry as compared to single point measurements of the traditional digital procedures of aerotriangulation. This automation of topographic photogrammetry basically requires the application of databank- and information systems.

These databank- and information systems are of special and vital importance for a further automation in photogrammtry.

Therefore, geodesists and photogrammetrists are discussing about "land data systems", land information systems","Grundstücksdatenbanken", "resource information systems", "land registration and information systems", "geographic information retrieval and analysis systems", "land information management" (/25/).

For automation in cartography this subject also plays an important role. This is demonstrated by "the Canada geographic information system", "spanish cadastre and its incorporation in a data bank", and "...mapping from a large scale data base" (/24/). Other contributions in /24/ did not mention terms related to databank- and information systems in their titles, but nevertheless are based on the application of these systems. The two symposia referred to are only a small random sample of a world wide vivid interest and research in this topic (/26/).

Unfortunately, up to now the use of the terms databank- and information system is not yet standardized. In contrary, there are many program systems available and in practical use for very different applications. Furtheron, several modified software packages are in practical use for quite different applications than originally intended. Marketing strategies have made it necessary to distinguish each system from the competing others by impressive names. These names are mostly combinations of some of the principal terms: base, data, information, management, system, etc.

It is obviously not easy and often not possible for the potential user of any such system to recognize the available system functions from its name. It is even much more difficult to study the feasibility, applicability or economy of different software-systems or to compare them with each other, relying only on the information contained in system manuals. Limitations of available and accessible hardware-configurations and of realistic sample sizes of test data, to be prepared for various system formats, frequently make a direct comparison of practical results impossible.

In order to assist a potential user to recognize and specify his intrinsic demands principal features as well as necessary and desirable functions of databank- and information systems are collected in this paper. Naturally, special emphasis is given to the specific application in topographic photogrammetry.

Data base

For the applicability of digital procedures, one must generate precisely defined formats and structures of the data concerned. During the data collection phase the desired environmental information is recorded and stored in digital form. Preferably this encoding contains a unique code for the semantic information of each detail plus coordinates for the geometric information, defined by its mutual position. (/9/).

Only this principle to record an object code for the semantic information as well as the geometric coordinate information will permit an unrestricted

use of the recorded data for multiple use and users. If the coding of the information of environment is done dependent on a specific legend used for plotting, the data base produced can only be utilized for that unique plotting. Even a selection of specific information from the data base can then not be achieved, because the original semantic information is lost by such a graphical encoding. In the contrary, from a set of unique object codes, it is always possible to derive the plotter commands for drawing the semantic information accordingly to any defined legend (/15/).

The resulting structure of the data collection phase is certainly that of a digital map. Not all experts will agree to call the data base already a digital map. This is because a map is not only a pure collection of information of environment. Its presentation basically and essentially depends on various, elaborate processing. Of course, most of the processing will leave the data structures unchanged. Therefore mostly the pure data alone will give no advice wether any processing has already occured or not. Such an advice should be contained in the general or specific header information of logic units of the data base. Therefore it is important to specify the formats and structures of the environmental information completely independent of any of its further use or users.

Databank- and Information Systems

In order to be able to access and retrieve information collected in a data base it is mandatory to have certain hardware and software components that form a databank- or information system. These system components must facilitate a communication between the user and the system.

Economic aspects of the communication process require an interactive dialog, especially for specific non standardized questions, for data manipulation and for editing. Other problems also exist and must be solved where the access to the data base is not as time dependent as in editing. (/13/). This holds especially for the selection of classes of information for the generation of standardized special maps.

The following general requirements can be defined:

-- unlimited access to the information at any time (this can only be realized within certain restrictions. Because of practical reasons the direct access-storage will always be of limited capacity. Therefore especially for topographic photogrammetry, parts of the data base must be copied from tapes to direct access storage media like disks before any manipulation could be started.),
-- optional access depending on various criteria, that are defined later on,
-- minimized response-times (Even for huge data bases the user should not be blocked, waiting for the response on his query),
-- rapid changes of extensive data,
-- standardized dialogue to enter search- and access- criteria and for the output of adequate information by the system as well as for the interactive dialogue,
-- universal access to all elements of the stored information,
-- comprehensive updating facilities,
-- modular program structure with predefined input and output facilities for extending user defined programs.

Depending on limited capacity and speed of electronic computers, the realization of a databank or information system and its universal economical application are creating the following general requirements in order to facilitate an easy and confident manipulation:

-- all data must only be stored once in the data base,

-- logic relations of specific data must be stored within specific relation-tables and not by multiple storage of the data itself,
-- variable length of records to optimize storage requirements,
-- data compression to eliminate empty space within the records,
-- optimized organization of storage locations,
-- organizational aids to facilitate a fast access to the data,
-- system protection in case of a current break down and for a desired re-start,
-- data protection against loss or damage of information due to errors inherent in the system or its use, despite the fact, that each facility to manipulate the data must contain the possibility to destroy it,
-- data protection against unpermitted access,
-- facilities to define logical relations and structures during the creation of a databank or information system,
-- facilities to adapt existing structures according to changing requirements,
-- prespecified multiple time sharing access,
-- and in some cases teleprocessing facilities.

From the user's point of view one can distinguish two levels of search criteria, which are required to access the stored information. These two levels of search criteria presuppose also two different types of processing to be applicable

The first and lower level of access criteria ensures the possibility to search, retrieve and change each element of the stored information, e.g.the object code as well as the coordinates or, additionally, the various classes and subclasses of names (/14/).

The second level of access criteria gives extended additional facilities to select required information depending on logical relations. These logical relations enable the deduction of complex structures and connections of secondary information from the directly stored primary information by means of a simple standardized request dialog. (/8/).

It is of utmost importance to achieve very fast access facilities even with very large data bases. A satisfactory application of databank- and information systems for topographic photogrammetry should require only the absolutely necessary minimun of time to respond. This holds, despite the fact that most reactions of the operator of a system are very slow, even when compared with non-optimized systems. Practice shows that the operator will be dissatisfied if he or she has to wait more than half a minute to one minute. In fact each waiting period slows down the progress of work. Interactive editing of a topographic data base is composed of numerous identification (=search) procedures and subsequent changes of the information.

Mainly two possibilities exist to speed up the whole procedure. First of all it is necessary to optimize the search procedures, and secondly one should try to reduce the necessary number of human decisions and also the time they require. The latter lead to the implementation of automatic editing procedures whenever possible, e.g. for automatic fitting of lines crossing different digitized sections. These facilities will not be treated furtheron, because they are not specific features of databank- and information systems. The use of twin-display-systems also originates in efforts to accelerate the progress of work (/8/,/15/).

Organizational aids to accelerate the search procedures

For exacting databank- and information systems the 4 known types of index-lists must be realized, preferably in combination (as demonstrated by the

samples of the bibliography):
-- reference addresses: for the realization of arbitrarily complex tree- and network structures of the information. Each record contains then one part for the actual data as well as one part to define the structures. The databank processor distinguishes where to store each element of the information and also inserts the actual search address into the table of reference addresses,
-- chaining addresses: within hierarchical structures principal master records are distinguished from dependent secondary slave records. The rapid access is then realized directly only to the master records via index-lists, and only afterwards to the dependent slave-records. Chaining addresses define mostly ascending as well as descending structures. Very complex structures can be defined if each record can be slave of many masters as well as master of many slaves,
-- inverted files: adequate to the index of a book, where book and index have different hierarchical structures, but each index references each part of the book where it occures. Relating to the numerous words of a book only specific ones are indexed; others must either be searched for sequentially or systematically in logic relation to the indexed words,
-- logical relationship: adequate to the footnote-technique of a book to reference from one part of the data to one or more relating parts.

The main possible facilities to access the stored information are:
-- sequential access: adequate to the reading of a magnatic tape
-- index sequential access: via index-tables, the area of the storage-medium is found, where the information is being stored,
-- associative access: via chaining addresses the relevant information is being found,
-- direct access: for known storage addresses in case this can physically be realized,
-- random access: where the system processor calculates the valid address via a specific keyword of the data record.

The index-lists as well as the access facilities mentioned above are the main tools to obtain a fast response for the general access criteria. The reader should realize that the index-lists enlarge the required storage capacity. It is not necessary to store both, lists and data, permanently if the index-lists are to be setup during the copying-procedure of the relevant data from a permanent storage medium to a direct access disc. Anyhow, this is possible for the topographic information, which should be organized in relation to gridded sections.

Furtheron the additional second level of access criteria requires program modules to select information also depending on the following functions:
-- a and b,
-- a or b,
-- not a,
-- a less b,
-- a equal b,
-- a greater b, and
-- from a to b.

These logic functions belong to Boolean algebra. By a combination of these logic functions all desired logic relations can be constructed. The practical application of these access facilities has to be facilitated by a formalized dialogue language and must be realizable by appropriate program modules.

The user can only access the data but not the index tables. Changes of the data will change the tables, but the inverse function does not exist.

Databank- and information systems can act passively or actively. With passive systems the user must activate the search procedure himself, whereas with active systems appropriate messages are initiated by the data itself if programmed time - or event - dependent constellations occur. It is obvious that for photogrammetric topography highly sophisticated and optimized passive systems will suffice.

Conclusions

Practice proves that one can achieve a considerable high flexibility and comfortable usage with databank- and information systems by exploiting the now available technology. This only holds if the field of application is thoroughly specified and carefully limited. A complete general universality concerning contents and structure of the data base, multipurpose applications and optimized economy is far beyoned any realization or practical feasibility. Even though it is important to continue and intensify the dialogue between all parties interested in those systems. Thereby one must specify realistic demands and operational concepts for an optimized exchange and utilization of the environmental information.

For mapping purposes topographic photogrammtry has a long and important tradition in collecting environmental information. For this, a change from analog to digital procedures offers more flexibility and new possibilities to compensate for an increase in demands to manipulate the collected information. These demands comprehend the derivation of a variety of thematic information and its appropriate presentation.

The features of databank- and information systems are an indispensable basis for digital topographic photogrammetry. The above specified first level of access criteria is a necessary tool to provide economic editing facilities in order to correct the data base for any further automated processing and presentation. Additionally, it contains already the desired flexibility for a fast and computer aided selection of optional items and also of classes of the stored information for arbitrary further utilizations

Mostly, derivation and processing of thematic information from the data base however will only be feasible on the basis of the specified second level of access criteria. It is obvious that any automated topographic photogrammetry presupposes also additional sophisticated and complex program routines for the processing and a flexible plotting depending on various changing requirements.

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