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An Integrated system for acquisition, processing and displaying cartographic information

A b s t r a c t. In this report, the perspectives of development in automatization of cartographic processes are shown at the stage of data acquisition, their processing and presentation. Digital and analog methods of data processing were discussed, especially images, concluding with the possibility of constructing an integrated system for the acquisition, processing and display of cartographic information.

1. Introduction

The current technology of map compilation and up-dating is at present, stated by analog and digital methods of acquisition, processing and rendering of image information.

From the point of view of technological execution — maps are realized about 90% of the time by photogrammetric methods, utilizing a number of highly automated devices.

Interactive computer systems, needed as data processors in the process of map generation, are frequently used.

The basic technological problems which at present arise, especially thematical maps compilation, result from the necessity of converting analog information (imagery) processing into digital form and vice versa. These unite with information preprocessing, coding, pattern recognition and obviously with capacity and computer access. In the author's opinion at present, and still more in the future, an imagery is becoming the main problem on which the attainment of maps is conditioned. For several years now, at the Institute of Geodesy and Cartography in Warsaw, studies and experiments have been conducted on automatic map production systems most useful in Polish conditions. Some of this work has been presented at the seminar in Nairobi in 1978 and at the 4th International Auto-Carto Seminar in Reston — USA in 1979 [1, 2]. The outlook on integration of the mapping process with the use of automatic registration techniques, read-out and selection of information was discussed in the author's paper at the 10th International Cartographic Conference ICA in Tokyo in 1980 [3].

In this report I want to present the actual perspectives of automati-

zation in cartography taking into consideration its complexity at the stage of acquisition, processing and presentation.

2. Data acquisition

2.1. Short Term Requirements

As it is known, the applied technology is the function of the most profitable technical map parameters, as well as of the best conditions of economic outlay.

We must take into consideration the form of information which we want to introduce into the system's input according to the source of their acquisition. Most frequently they appear in the form of alphanumeric, photogrammetrical (tonal) and linear maps.

Pieces of information understood in this way may be registered in a digital or an analog form. In the data registration process it is important, especially for photogrammetric sources and the linear map, the occurance of colour areas, so in effect, from the point of view of data registration, we can consider information in different parts of the spectrum. In view of such a philosophy, for photogrammetric methods, as well as for earlier linear maps, still more sophisticated scanners are indispensable. In their structure it is becoming customary to search for such scanning techniques which would protect the use an image correlation technique with the possibility of converting it into an electrical signal suitable for entry into a cartographical data bank memory.

An essential problem for images acquired from air and space-borne platforms is their orientation assurance especially for scanning methods. Scanner orientation considerably conditions the quality of images in geometric meaning and has a decisive influence on resolution. Progress may follow after the construction of a new generation of scanners, allowing for application of inertial technologies and interference measurements. The consequence of such a procedure will be the possibility of assuring full orientation for each of the lines of a scanner image, even for a single „pixel". It will make it possible to look in a new manner on quality information obtained in individual parts of the spectrum, and in consequence it will widen and specify thematic information presented on a map. Successes obtained in inertial package by Ferranby land surveyor and other firms in the US and Canada make such expectations realistic for the coming years.

2.2. Long-Term Requirements

From the point of view of the quality and velocity (volume) of image processing, that will be discussed later on, and digital processing incon-

venience, which I mentioned in the introduction, there occurs a need for image operations (addition, substraction, etc.). Attractiveness of such an approach is obvious due to the map editing process, not to mention the advantages resulting from the considerable speed of such systems (information access) in relation to classical techniques. In light of such needs, the vision of practical technologies using the attainment of interference images by means of holographic mehods and more successful experiments utilizing diffraction phenomena, especially optical filtration, allow the expectation of scanners with Fourier spectrum recording and practical systems of thematic information extraction in the process of its filtration [7].

3. Methods and techniques for processing airborne and spaceborne imagery

3.1. Digital systems of image processing

Acknowledging surfacial density as the most important parameter of the composition of map content, which in the quantitative meaning corresponds with the density of graphic signs, we can alter the image of a map to a matrix form, in which each of the elements will be assigned to a natural phenomenon, anthropogenetic phenomenon and some individual features. During the map creation process these visual phenomena may take the form of thematic overlays.

In the gometric interpretation, units of such a matrix of a map picture may be assigned an appropriate ordering feature, cartographic grid is particularly suitable for the purpose.

If we mark by a_{ij} an element of a matrix which corresponds to the grid system coordinates (i, j), where $i \leqslant N_1$ and $j \leqslant N_2$ then a_{ji} matrix unit is defined by the following expression:

$$a_{ij} = (a_{ij}^k)$$

where examples of a_{ij}^k may be:

a_{ij}^1 — natural phenomena,
a_{ij}^2 — anthropogenetic phenomena,
a_{ij}^3 — individual features,
a_{ij}^4 — user's priorities,
N_1, N_2 — belong to the set of natural numbers.

This kind of spatial record in the form of marked fields for individual geographical grid meshes allows the recording of any kind of information.

Essential, at the moment, limitations which appear in the digital image processing systems are connected with the storage capacity, data transmission and their storage [4]. In the author's opinion, in order to

find solution, laser systems for images recorded on optical disc will have a more universal application. Systems elaborated by Philips, Thomson, Drexter allowing for accumulation or registration of many thousands of colour images on a metalized carrier by means of a suitable focused laser beam are especially most promising.

Accessibility of one image among thousands of others in the form of a monitor display takes a few seconds. The essential activity of such systems needs the output of image operations to be gathered on a video--disc, from where, with the help of a read-out laser, they can be displayed on the monitor. The configuration of such a system is presented in Fig. 1.

DIGITAL SYSTEM CONFIGURATION OF OPERATION ON IMAGES

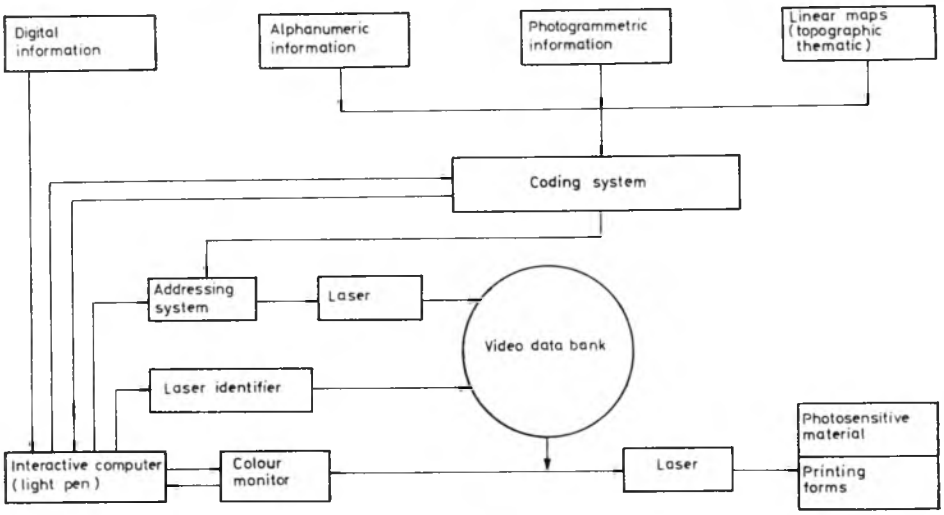

Fig. 1

The method of coding cartographic information becomes essential due to the automatization process of its acquisition, processing and displaying. Three possibilities can be distinguished:

1) computer rastering [6],

2) optical rastering for tonal information,

3) optical filtering and then rastering (for conventional linear maps).

The coded information concerning particular images is recorded in the video data bank through the addressing system and laser.

The process of map editing is based on recalling the information recorded in image sequences from the data bank with the use of an interactive computer.

Overlaping of the information from different sources can be new information concerning a particular topic and it must be recorded as a new image in the data bank. There is also a possibility, with the help of the laser system, of displaying information on light-sensitive material or preparing a ready-made printing form.

The attractiveness of this system is based on the possibility of its implementation in the entire process of acquisition, processing, editing and displaying of cartographic information or its implementation only in individual stages.

3.2. Analog methods of image processing

The convenience of systems that convert images to analog form conditions the tests of optical image processing [5].

To elaborate, optical processors making operations out of automatic processing their link with the computer is necessary for assuring required circulation and reciprocal „complement" information. Coupling memory with an optical processor should take place with the help of an hierarchic organized memory. This role may be played in the future by the holographic memory.

Holographic memory linked with an optical processor should take place via dynamic holograms playing the role of a scratchpad store. It can be expected that the practical use of holographic memory in optical processors will assure a growth rate of processing systems by a few orders of magnitude compared to current methods. This optimistic view is based on the progress in material technologies, especially that of thermoplastic, photoplastic thin metal membrans, electro-optical crystals etc.

4. Conclusion

On the basis of the performed analysis of the development trends in the automatization of cartographic processes a complex approach to acquisition, processing and presentation of cartographic information is observed.

It must be expected that in the techniques of data acquisition there will be an increasing withdrawal from traditional photographic materials in favour of scanner recording with simultaneous display of digital information in a form suitable for recording in video systems.

We expect a general use of primary colours and raster as identification systems and information coding and the use of coherent light in the process of realization of cartographic data banks, as well as illustration of results of output information.

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SYSTÈME INTÉGRÉ D'ACQUISITION, DE TRAITEMENT ET DE VISUALISATION DES INFORMATIONS CARTOGRAPHIQUES

Résumé

Depuis plus de 20 ans l'on perfectionne d'une façon permanente les systèmes automatiques d'acquisition, de traitement et de visualisation des résultats dans différents organismes cartographiques. Dans l'Institut de Géodésie et de Cartographie à Varsovie, depuis quelques années sont poursuivies des études et des essais sur les systèmes d'élaboration automatique de cartes les plus utiles dans les conditions polonaises. Quelques-uns de ces travaux ont été présentés auparavant dans les éditions mantionnées à la fin de l'article.

Ici l'auteur présente les résultats récents de ses recherches et études et montre les perspectives de la réalisation d'un système intégré qui, d'une façon complexe, permettrait l'établissement automatique d'une carte à la base de différentes formes d'acquisition d'informations de source.

Dans le procédé photogrammétrique d'acquisition de données, l'auteur suggère la nécessité de la mise au point d'un scanner inerte, qui permettrait de déterminer l'orientation des lignes respectives de l'image et c'est là qu'il voit la possibilité d'une amélioration du pouvoir de résolution des scanners. Dans le procédé du traitement des images l'auteur développe son idée du système vidéo-cartographique

adapté aux différentes sources d'acquisition d'informations publiée en 1979 à Reston (E.U.). Par contre l'auteur voit dans des délais plus éloiqués le developpement de ces systèmes dans les methodes optiques du traitement de l'image.
Traduit par: M. Bohdan Jakubowski

ХЕНРЫК ЗЕНОН КОВАЛЬСКИ

ИНТЕГРИРОВАННАЯ СИСТЕМА ПОЛУЧЕНИЯ, ОБРАБОТКИ И ОТОБРАЖЕНИЯ КАРТОГРАФИЧЕСКИХ ИНФОРМАЦИЙ

Резюме

Свыше 20 лет ведется постоянное совершенствование автоматических систем получения, обработки и отображения результатов в различных картографических организациях. Несколько лет в Институте геодезии и картографии в Варшаве ведутся исследования и эксперименты по системам для автоматического производства карт, которые были бы наиболее пригодны в польских условиях. Некоторые из этих работ были представлены раньше в публикациях, указанных в конце работы.

В данной публикации автор излагает последние результаты своих исследований и представляет перспективы реализации системы, которая комплексным способом давала бы возможность создания карты автоматическим путем на основе разных форм получаемой исходной информации.

В процессе фотограмметрического получения данных автор внушает потребность создания инерциального сканера, который имел бы возможность определения ориентации отдельных линий изображения, и этим путем видит возможность повышения разрешительной способности сканеров. В процессе обработки изображений автор развивает свою идею видио-картографической системы, опубликованную в Reston (США), применительно к разным источникам получения информации.

Зато в оптических методах обработки изображений автор видит развитие этих систем в дальнейшем будущем.
Перевод: Róża Tołstikowa

HENRYK ZENON KOWALSKI

ZINTEGROWANY SYSTEM POZYSKIWANIA, PRZETWARZANIA I ZOBRAZOWANIA INFORMACJI KARTOGRAFICZNYCH

Streszczenie

Od ponad 20 lat dokonywane jest ciągłe doskonalenie systemów automatycznych pozyskiwania, przetwarzania i zobrazowania wyników w różnych organizacjach kartograficznych. Od kilku lat w Instytucie Geodezji i Kartografii trwają studia i eksperymenty nad systemami do automatycznej produkcji map, które byłyby najbardziej użyteczne w polskich warunkach. Niektóre z tych prac prezentowano wcześniej w publikacjach podanych na końcu artykułu.

W tej publikacji autor przedstawia ostatnie wyniki swoich badań i studiów i prezentuje perspektywy realizacji zintegrowanego systemu, który w sposób kompleksowy dawałby możliwość tworzenia mapy w sposób automatyczny w oparciu o różne formy pozyskiwanych informacji źródłowych.

W procesie fotogrametrycznego pozyskiwania danych autor sugeruje potrzebę budowy skanera inercjalnego, który miałby możliwość określenia orientacji dla poszczególnych linii obrazu i na tej drodze upatruje możliwości podniesienia rozdzielczości skanerów. W procesie przetwarzania obrazów autor rozwija swoją ideę video-kartograficznego systemu opublikowaną w Reston (USA) w 1979 r. w dostosowaniu do różnych źródeł pozyskania informacji. Natomiast w optycznych metodach przetwarzania obrazu autor widzi rozwój tych systemów w dalszej przyszłości.