THE ELECTRONIC MAPS SYSTEM : SCIENTIFIC BASIS, METHODS AND TECHNOLOGY

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Abstract

This article highlights methodologic and technological issues of electronic map development and utilization.

Electronic map (EM) is a new powerfull means to increase efficiency of utilization of automated control systems in industry,agriculture, transport, ecology, meteorology, defense and other fields, to solve many problems on the basis of GIS.

Today in Russia the concept of electronic maps system development has been implemented and technical means, methods and technologies of electronic maps automated development and utilization have been worked out.

The electronic maps system is a totality of electronic maps, which are amalgamated by common idea and have regulated and coordinated scales, coordinates system and symbols. These maps are stored on optical disks in accordance with user requirements.

EM is a digital map, visualized with the help of special technical and software systems in adopted symbols. EM is used to demonstrate the terrain analysis along with special information on displays and to perform informational and computation tasks.

EM has substantional advantages in comparison with paper maps .

EM provides possibility to display any part of terrain in real time with required extent of detalisation in order to:

- obtain access to terrain data.
- display and correct special information.
- perform numerous informational and computation tasks and display the results on EM.

Methods and technologies provide development of following kinds of EMs: electronic city plans, electronic topographic maps, electronic general geographic maps, electronic aeronautical charts. EMs are represented in raster and vector forms.

The process of EM development can be devided into following stages:

1 Automated transformation of original cartographic information into digital form

2 Symbolization of digital information and automated compilation of EM

3 Development of user data bases management system (DBMS) for map utilization

The first stage includes obtaining of vector data structure model on the basis of existing original cartographic materials (aerospace images, diapositives and maps colour production prints).

This probem can be solved using following basic methods:

- digitizing of original materials using digitizer by tracing of features contours, preparation and plotting of semantics and structurization of digital information.

- scanning and further automated or interactive vectorization of original cartographic materials, recognition of raster image on the display, input of required semantics and structurization of digital information.

Cartographic expert system is used for automatization of recognition and vectorization of raster image.

Modern scanner techologies of automated vector digital information production with the help of cartographic expert system using map diapositives provide automated pattern recognition with efficiency of about 90 % of relief information, 50-60 % of hydrography and vegetation information. Estimated time, required to produce one map sheet is 70-90 hours.

The second stage includes following tasks:

- symbolization of vector model.

- EM compilation regarding details extent.

- control and editing of symbolized Ems.

- obtaining of symbolized paper copy of EM.

Symbolization is a process, when a respective symbol from symbols library according to its classification code, feature charachteristic and meanings is assigned to each feature.

This process is carried out automatically, depending on the scale and EM kind. It provide a compilation of a unified libraries of symbols and fonts.

Extent of details is one of substantial charachteristics of EM. It means, that original image, for example, is considered to be basic for 1:50 000 map. Further each feature, depending on its significance, is given a separate details extent index. This approach provides readability of cartographic image on the display practically regardless of area coverage (window) in the map sheet limits.

Compilation of EM regarding details extent indexes is carried out on the display screen in interactive mode from window to window, beginning with the smallest, in the limits of

which all features are readable, with further increase of windows dimensions according to the quadrant tree method.

Special attention is paid to details extent co-ordination and matching of features between windows both in the limits of a separate map sheet and between adjoining map sheets for each details extent index.

This problem is solved with the help of expert systems , which optimizes the process of features selection regarding details extent index, taking into consideration various factors and establishes spatial-logical relations among features.

EM compilation is performed in universal data structure, which provides possibility of vector information recording both in consecutive and chain-nodes representation and also in raster form.

The technology is implemented by a complex of automated work stations, integrated into a local computation net.
Informational support of the EM system development technology includes:

- system of classification and encoding of cartographic information.
- rules of digital description of cartograpgic information.
- system (library) of EM symbols.
- EM data format.

The main methods of EM design are as follows:

- methods of automatic feature (raster images obtained by scanning) recognition.
- methods of cartographic generalization, using theory of graphs and logical - procedure approach.
- methods of multimedia software.
- methods of expert systems.
- methods of spatial - logical relations establishment.

The EM production technology and user visualization software are based on standard computing facilities configuration on the basis of personal computers and can also be adapted to other computing facilities.

At present EMs are being used in raster and vector forms.

The main EM main advantages become apparent in the process of utilization. That is why apart from EM itself the EM data base managment system can be distributed to the user. DBMS performs following tasks:

1 EM data base design and management

2 Cartographic image processing:

- cartographic image display, scaling and transfering in arbitrary direction.
- dynamic window and visualized image details extent management.
- receipt of terrain features reference data.
- image edition.
- classificator and symbols library management.
- development, storage, editing and plotting of user layers on EM.
- user classificator and symbols library (e.g. tactical symbols library) management.
- cartographic image and special information output to plotter or other facilities.

3 Connection with standard data bases

4 User interface for the purpose of applied informational and computation problems sulution (relief elevation matrix design, construction of terrain profiles of visibilityzones, spot coordinates and elevation determination, distances and azymuths definition etc.)

Combined utilization of abovesaid technology and DBMS made it possible to develop a flexible GIS.