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THE SYSTEM OF DIGITAL IMAGE PROCESSING: A TOOL FOR INTEGRATED AUTOMATION OF MAP PRODUCTION

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ABSTRACT: Digital processing system for images obtained from any kind of survey consists of two input and one output inits that provide image scanning and converting by means of servodrives. An image is used as an element of the memory unit being addressed to any point of the image. Software allows geometrical transformation and generation of line and halftone images based on digital models, thus solving the problems of automatizing the processes of largescale plans and photomaps production.

Conventional processing of remote sensing data on the Earth and planets, as well as that of hydrographic, Side-looking Radar Systems (SLAR), and in some cases, airsurvey data becomes either irrational or impossible, and it calls for computerised technique with digital image processing (1).

New technical means made in USSR, which are standart input and output devices interconnected with computer and aimed at image topographic data processing, can be used for autmation of processes of image transformation, as well as to file in additional graphical data. Special software and a number of hardware parameters are aimed at mapping (2), (3). The system censists of three practically the same devices. Two of them are designed for synchronous image input into a computer, while the third one is applied for output of the transformed image into photomaterial.

Fast Cathode Ray Tube (CRT) scaning and relatively slow scaning by mechanical shift of the image are base if each device. Combination of electronic scaning inside CRT working field limits and mechanical scaning inside image frame provides high resolving power and geometrical accuracy of the transformed image as well.

Monitoring of scaning parameters is programmed from the computer interconnected with image input-output device. Quick adress to any point of CRT scaning field allows to use directly the initial image as an operative file, not overloading this data into computer's files. The following parameters are controlled by programs: size, pace, brightness, spot diameter of grid, position of co-ordinate origin and shape of scaning grid in image co-ordinate system.

To make easier image input-output control, a special software was elaborated. It provides programming of all the tasks in Assembler language. Block-scheme of one of the devices is shown in Fig.1.

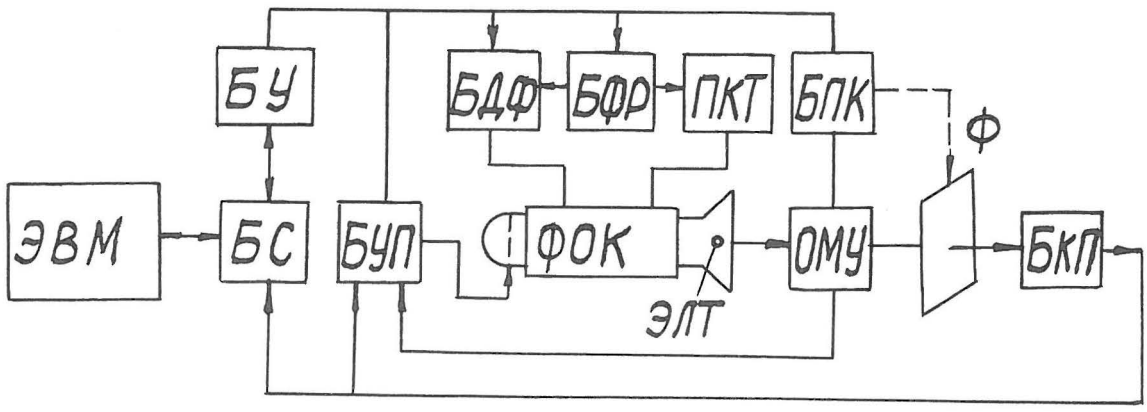

Fig.1

ОМУ - optical mechanical device;
БПК - carriage translation assembly ;
БДФ - dynamic focusing assembly ;
БФР - grid formation assembly;
ПКТ - code-current transformer;
ФОК - focusing and declining assembly of the CRT;
БУП - ray lighting control assembly;
БКП - shade coding assembly;
ЭВМ - computer;
БС - interconnection with computer;
БУ - monitoring assembly;
Ф - negative photo image.

Wide dynamic range of shade transfer, as well as stability of characteristics due to deep response signal through photoelectric channel are peculiarities of the electronic scheme.

The main technical features of the system are as follows:
- image size is up to 30 x 30 cm;
- maximum CRT grid working size is 32 x 32 mm;
- maximum number of grid elements is 4096 x 4096 ;
- resolving power is from 32 to 4 1/mm;
- number of CRT brightness gradations is 128;
- maximum speed of image mechanical movement is up to 20 mm/sec;
- geometrical accuracy of:
  a) electronic grid - ± 10 μkm;
  b) mechanical movement - ± 4 μkm;

The inherent main technical parameters of the system define its utilization as means of comlex automation of mapping. It allows:
- to make orthophotomosaics out of hydrolocational sonar images of sea and ocean shelf floor;
- to compile orthophotomaps out of space images;
- to use it as a high speed coordinatograph.

The first stage of software (МО) of the system consists of systematic and applied software and it is aimed at efficient utilization by the user of the software and hardware of the system, as well as orthophoto rectification of the images and plotting additional graphical features.

The systematic software is based upon disk operational system of DOS, ES, which had been modified in part of monitoring program; also some access means had been provided. A new supervising device was generated. It is based on modified macrodeterminators. New transit phases of dealing with image input-output device (УВВИ) blunders were elaborated and included into the system, as well as macroterms of language for their control.

The applied software is a packet of applied programs. It is organized on block-library principle, and it is stored in library on magnetic disk. Four main program modules (ПМ1-ПМ4) can be distinguished in the packet.

The ПМ1 module is aimed at determination of linear equation factors which describe relations between image coordinates and УВВИ. The initial data for the module are precise co-ordinate values of several co-ordinate crosses in the image

co-ordinate system and approximate (within 1-2 mm accuracy) co-ordinate values of the same points in УВВИ co-ordinate system. The latter are rendered more precise by input of spots

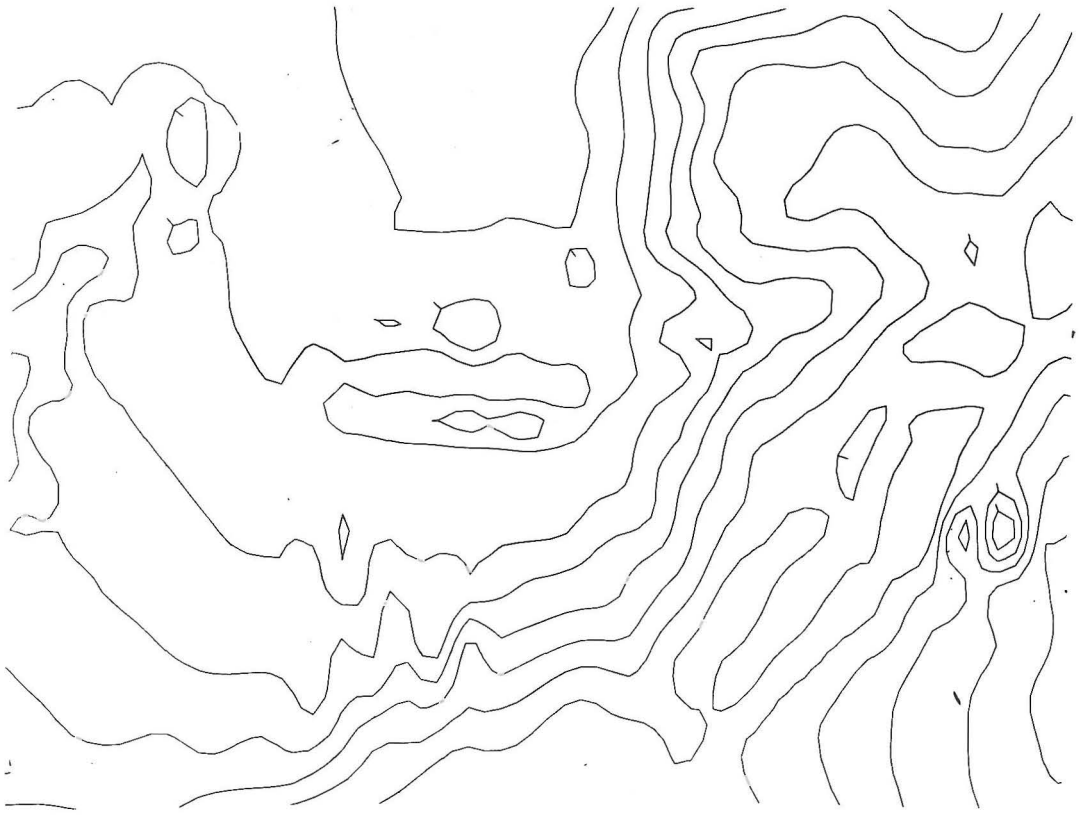

Fig.2
A fragment of topography representation by the system of digital image processing

of co-ordinate crosses from УВВИ into digital print, as well as by correction of crosses positions by an operator and introduction of these into the program. Image orientation parameters on УВВИ are determined by least square method.

The ПМ2 module is aimed at automatic co-ordinate description of modified interferentional lines of hydrolocational sonar images (ГЛС). After lines have been stored in computer files, they are preliminary processed (filtered, smoothed, line elements are discerned). Further on, for a given CRT "window", a task of unification of separate sceletal elements into track of certain lines is solved. There after lines are compiled from tracks of separate "windows". In the last stage of module the list with numbers of interferential lines and co-ordinates of their points is formed. These data are used further for digital terrain model of the sea floor formation, as well as for tables of corrections for topography while sonar image rectification.

The ПМ3 module is for image rectification according to a given law. The latter can be given eitner in analytical form, or as a table of co-ordinate values of elements, arbitrarily positioned in initial and rectified images.

A concluding table is formed at the first stage of module operation. There are co-ordinates of points of the rectified image for regular cross net, as well as co-ordinates of corresponding points of the initial image, there. It is implicated that orientation parameters of image in УВВИ, as well as relief correction, rectification law into the given projection, etc. are considered while compilation of the conclusive table.

At the second stage input of parts of the image into computer is performed, as well as its quick processing in accordance with algorithm, described in (4), and resulting output of image on photofilm.

The ПМ4 module is aimed to plot semantic features (such as contour-lines, km grid etc). The initial data for the module are given as a massive of indeces I (while I = 0,1 - 1 are indeces of the begining, continuation and the end of graphic file) and point co-ordinates; the latter are positioned on the registered line. Each three adjacent points, positioned on a line, are used for smoothing with third degree polynom, while initial data, if necessary, are redetermined by the necessary number of points, which provides the given accuracy.

Processing of in redetermined initial data and graphic data output is also performed by "windows" with size, determined by working space of CRT. There are description programs in the module for preparation of the initial data (size, scale, thickness, brightness, of lines, etc), as well as service programes, aimed at data transformation and preparation in from of their output to УВВИ.

Fests, performed with the system, proved its efficiency and wide functional potentialities inherent therein. A fragment of topographic map with contour-lines is shown in Fig.2. The use system for line representation renders additional potentialities for programed control of width of lines and their type (continuons line, dotted line, stroke-dotted line etc.), for plotting letteral-digital information and symbols. The size and shape of symbols practically do not effect on time of plotting. The tests also clarified the ways for system impovement, both hardware and software for their inculcation into general production.

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