ERRORS AND TOLERANCES IN THE MAPPING, PHOTOGRAMMETRY, RS AND GIS INTEGRATION

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Abstract

The computational cartography or the automated mapping involves digital map achievement. The features of digital map can be captured using vectorial or raster photogrammetric or cartographic digitizing, remote sensing (only with the raster data). So, the actual technologies are integrated in a single process flow. A great importance in the mapping, photogrammetry, RS and GIS integration have the study of errors and tolerances of heterogenous data, first of all of locational data.

1. ACHIEVEMENTS AND DEVELOPEMENT TRENDS

The mapping, photogrammetry, RS and GIS were developed much independently, that much in increased correlation in the last years. Suddenly with the concept of geoinformation appeared the concept of GIS, system composed by hardware, software, technologies, locational and thematical data (spatial data), designed to give to the users the necessary information for GIS represented space management.

The system is horizontally and vertically extended, with vectorial data or with raster data, or, in actual time with both types of data. For these data there are specific algorithms [4,5].

The first layers or coverages in GIS data base there are the digital cartographic data, which defines the location of all thematical data. All the classes of GIS inputs and outputs are geoimages, the object of geoiconics [5]. The capture and processing of digital cartographic data are made with the complex systems and heterogenous methods [6].

By integration are created geoiconics supersystems (GIS, expert systems, cybernetics, geodesy, cartography, RS etc. integration). The first role of the computational (digital) cartography is given by: (1) the basic sources of the spatial and temporal organized geoinformation are the maps and the charts; (2) the geodetic and topographic coordinates system there are the base for the geoinformation location; (3) the analogical published and displayed maps and the digital maps are the principal mean for the geographical interpretation and for data organization on the thematical layers (coverages); (4) the cartographical analysis is and will be afterwords the most efficient method for geographical and topographical similarity determination and for knowledge base interdependency; (5) the mathematical-cartographical modelling is the principal method for the geoinformation transformation (conversion).

2. THE INTEGRATED PROCESS FLOW PROCEDURES

The integrated process contains, as a rule, the following procedures: data acquisition (capture), data processing, analysis and conversion, error analysis and data validity and final products (outputs) presentation [4,6].

Data acquisition is made in the field with topographical methods, in the labs with photogrammetrical and RS methods (using data from the sensors mounted on the moving platforms) or from direct digitizing (scanning) of maps, charts, photogrammes or of other kinds of geoimages.

The data processing is performing with complex algorithms for geometric and radiometric rectification, for geodetic and geographic location. The data analysis involves the exploration of relationships between the variables amd comprises the quantitative analysis, data classification and generalization.

Data conversion is performing all the time depending on the processing and presentation demands and may be raster-to-raster (in the case of geoimage resampling), raster-to-vector or vector-to-raster.

The data error estimation accompanies all the stages of integrated process flow, or is apriori or finally made, regarding to the final product presentation. The error estimation is made for location or thematical data.

3. THE INITIAL, INTERMEDIATE AND FINAL DATA ERRORS

The complexity of integrated process flow and the initial data heterogenity leads directly to he heterogenity of the intermediate and final data estimation. The errors of captured data have differant sources and a sistematic or accidental characteristic. E.g., the topographical, photogrammetrical or RS measurements must be corrected for the atmosferic refraction and Earth curvature influence, but not completely [7].

The total spatial error is given by the succesion of conversions and transformations for the data contiguity assurance into the coordinate system accepted for spatial (cartographic) data base. More simple are the transformations in the case of cartographic vectorial data digitizing and more and more complex in the other data capture procedures, but all the transformations may be regarded as generalized polynomial transformations [5].

The stochastic model of transformation is always redundantand for the spatial data they use accuracy indicators like RMSE, the errors of converted data etc.

Among the errors of initial data there are: the calibration error, the errors due to unstable moving of bearer vectors (platforms), the errors due to the atmosferic refraction and Earth curvature, the ground control errors, the data processing errors using multiple spatial correction, data conversion errors (lower in the case of vector-to-raster or raster-to-vector conversion and bigger in the case of raster-to-raster conversion).

4. LOCATIONAL TOLERANCES OF DATA

On the base of RMSE and cofactor matrix of redundant conversion (transformation) there are established tolerances on the basis of statistical tests. The tolerances have a measuring unit of locational data (in the case of raster data, the measuring unit is the pixel edge equal with 1).

The tolerance of map resolution may be used for vectorial data at the definition of topological arcs (e. g. the definition of minimum length of the arc, when the arcs with the length lower than the tolerance are eliminated). The dangle length tolerance has the same value as the map resolution tolerance and defines the fact that all the arcs with the distance between their ends lower than this value are considered incident in the same node.

The converted coordinate tolerance is estimated differently regarding to the processing type, using the RMSE multiplication with the Student distribution factors, regarding to the confidence level.

For altitudinal tolerance is estimated a value, different to the transformation model and to the adopted function for the terrain approximation, which, from the theory and practice [3], is

$$v(d) = k\, d^{R}$$

where d is the distance between points with altitude, R is the rugosity of the terrain, experimentaly determined for the different terrain forms; the variance v is equal with k when d = 1.

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The final locational accuracy in the integrated supersystem data base or in the digital map given by a lot of indicators, but the most important is the RMSE of the generalized transformation. The locational errors and tolerances may be defined in the 2D or 3D space, like the locational data, the passing from one space to another may be rigourously controlled.

The later on studies must refer to thematic error estimation or the classification error, generally, in the spaces upper than the 3D space. Is also necessary the standardization of all types of errors, accuracy indicators and tolerances and their introduction in the normatives, so that the GIS calitative factor underlining becoming prevalent.

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