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 cartographic or photogrammetric digitizing, remote sensing (only with raster data). So, the actual technologies of the process are integrated in a single process flow. A great importance in the mapping, photogrammetry, RS and GIS integration have the errors and tolerances of heterogenous data study, in the first place of the locational data.

1 ACHIEVEMENTS AND DEVELOPMENT TRENDS

The mapping, photogrammetry, remote sensing (RS) and a geographic information system (GIS) were developed independently, that much in increased correlation in the last years. Suddenly, with the concept of geoinformation appeared the concept of GIS, 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, in the space too, with vectorial data, with raster data , or, in actual time with both types of data; for these data there are specific algorithms, separate or common algorithms.[4, 5].

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

By integration are created geoiconics supersystems or systems with many subsystems (GIS, expert systems, cybernetics, geodesy, cartography, RS etc. integration). A firs role of the computational (digital) cartography is given by: (1) the basic sources of the spatial and temporal organized information (geoinformation) are the maps and charts; (2) the geodetic and topographic coordinate 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; (4) the cartographical analysis is and will be afterwords the most efficient method for geographical and topographical similarity determination and for knowledge base independence; (5) the mathematical-cartographical modelling is the principal method for the geoinformation conversion (transformation).

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 (validation), 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 or charts (or even aerial photos) or of other kinds of geoimages.

The data processing is performing with complex algorithm for geometric and radiometric rectification, for geo detic and geographic location. The data analysis involves the exploration of relationships between the variables and comprises the quantitativeanalysis, data classification and generalization.

Data conversion is performingall 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 (output) presentation.The error estimation is made for locational or for thematic data.

3 THE INITIAL, INTERMEDIATE AND FINAL DATA ERRORS

The complexity of integrated process flow and the initial data heterogenity leads directly to the heterogenity of the intermediate and final data estimation of accuracy . 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 foe 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 digitization and more and more complex in the other data acquisition procedures, but all the transformations may be regardedaes generalized polynomial transformations .

The stochastic model of transformation is always redundant and 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 for 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 correlation, data conversion errors (lower in the case of vector-to-raster and raster-to-vector conversion and begger in the case of raster-to-raster conversion).

4 LOCATIONAL TOLERANCES OF DATA

On the base of RMSE (root mean square error) and cofactor matrix of redundant conversion (transformation) there are established tolerances on the basis of statistical tests. The tolerances have a measuring unit, the same as locational data (in the case of raster data, the measuring unit is the edge of a pixel, eqal 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), and for raster data in the case of the transformatin in the other coordinate system. The dangle length tolerance has the same value as the map resolution tolerance and defines the fact that all the topological arcs with the distance between their ends lower than this value are considered incident in the same node (for the topological vectorial data).

The tolerance of converted coordinates 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 regarding to the transformation model and to the adopted function for the terrain form approximation which, from the theory and practice [3], is $v(d) = k.d^{r}$, where d is the distance between points with known altitude, r is the rugosity of the terrain surface, experimentally determined for the differant terrain forms. The variance v is equal with k when d = 1.

5 AKNOWLEDGEMENTS

The final locational accuracy in the integrated supersystem data base or in the digital map is 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 3D or 2D space, like the locational data, the passing from one space to another may be rigourously controlled.

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

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