

The Development of Research on Automated Geographical Informational Generalization in China

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Abstract: On the basis of reviewing background of map generalization, analyzing user's needs and recent research results from abroad and at home, commenting on development tendency in this field, this paper presents the design idea and technical program of synergic automatic map generalization. Man, computer, generalization algorithm and control tactics respectively have different advantages during processing automated generalization. However their abilities of solving the problem are limited, and using them respectively don't make satisfied results. But combining them rationally and giving full play to each advantage, can increase the ability of solving problem in the information system according to this idea.

1. Introduction

It is very important to the research on geographical informational automated generalization based on the two factors hereinafter: the first, the need of automated composite drawing of small-scale maps based on geographical spatial database; the other, the need of multi-scale display of spatial data in GIS.

Why the research on map automated generalization don't get qualitative flight, the main reason is that this question depends on cerebral judgment very much. That is to say, because in the process of map generalization, we need to recognize the structure, which are the spatial distributing pattern and spatio-temporal multiplex characters etc, of external object, do judgment on the process of the measures of generalization in point, make tool-choices on the operational model and scientific principal which is need to use, make synthetic estimate of the output of generation considering the aspects that are the adjustability of map, the coordination between elements, the oneness between the degree of expressional clarity and the degree of content integrity etc. In traditional cartography, the all depend on the cerebral judgment, but in the environment of computer-assisted map production or GIS, the only way must use artificial intelligence. People still can't expatiate and summarize the human's fuzzy generalization judgment in the process of map generalization clearly at present. These knowledge and principles still can't be summarized to the formal depiction which computer can use. So, to solve automated generation is difficult very much. Well then, to solve automated generalization under current conditions, we must find new break-point.

2. The new methods of automated geographical informational generalization

(1) The application of the method of mathematical morphology in automated generalization

The major research focuses on the confirmation of structuring elements, merging faced element by closing and facing lifting the graph which has been merged by thickening.

(2) The application of the method of neural networks in automated generalization

The generalization of water depth in maritime charts is taken for example. The major research focuses on the secondary network configuration made of two double functional layers forward networks, transmission function, network input parameter, network study model, factual output and the control

method of iterative process of the imminent degree of expect output.

(3) The application of fractal method in automated generalization

The major research focuses on the fractal dimension estimation of linear element and faced element, further, the fractal dimension estimation of river net and the fractal dimension estimation of terrain surface are expanded. According to this, the automated generalization of relief form and river network are done.

(4) The application of wavelet analysis in automated generalization

First, wavelet transform is implemented to original spatial data; next, after the prosecution of multi-resolution are decomposed, low frequency configuration information and high frequency configuration information can be got, and generalized display is processed; last, wavelet contrary transform is done, and the generalized results are achieved.

(5) The application of Delaunay Triangular Network in automated generalization

Delaunay Triangular Network can be used to describe the spatial proximal relationships and some processes of automated generalization dynamically partly. The key to this method is Delaunay triangle-interpolating of convex hull and inner interpolation of discrete points. The method can be used in the automated generalized such as conversion of graphical degree, graph merging, graph enlarging, graph simplifying, graphical position changing and so on.

(6) The other operators of automated generalization

Many questions in the process of automated generalization can't use mathematical model to describe, under these conditions, using some kind of operator to describe will get distinct effect, so the operators of generalization are the footstone of automated generalization. All vector-mode operators which are developed at the present time emphasized the generalization of line greatly. These operators of generalization mainly include :① the simplified operator of line feature; ② the operator of displacement; ③ the operator of contour generalization; ④ the operator of network feature generalization; ⑤ the operator of configurable choice of linear and faced element. and so on.

3. The synergic method to resolve automated generalization

Because automated generalization have barged up against the strict of computer technology, it is impossible to carry automated map generalization out fully in this phase; on the other hand, the flying development of GIS technology is on edge to this, then, the way can but be considered from another point of view.

The human-computer synergic system of digital map cartographical generalization is the only way that can be selected now. So-called human-computer synergic system is that all numeric computing about abstract thought and logistic ratiocinative question must be done by compute., all mature disposal technologies of generalization which have achieved so far are computerized, but visualized thinking in the process of generalization ,for instance which object need generalized ,the setting of spatial parameters and so on, will be decided or finished by people, accomplish the whole map generalization by the method of intercommunion between human and computer. In this kind of system, computer will fulfill the work do its best. but people control the whole work at pivotal point, so that this work can be sure to be accomplished at high efficiency.

There are three synergic models of automated generalization: default model, consultative model (Fig.1) and alternating model (Fig.2). When the system is running, consultative model can be adopted for pre-generalization and analyzing the output of generalization firstly, then be changed to alternating

model according to the conditions of generalization. Of course, default model or alternating model can be adopted directly.

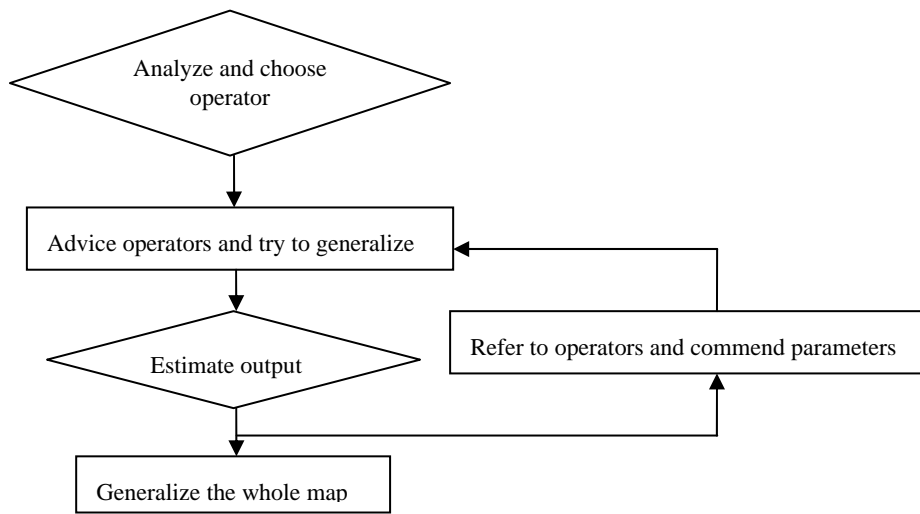


Fig.1: consultative model

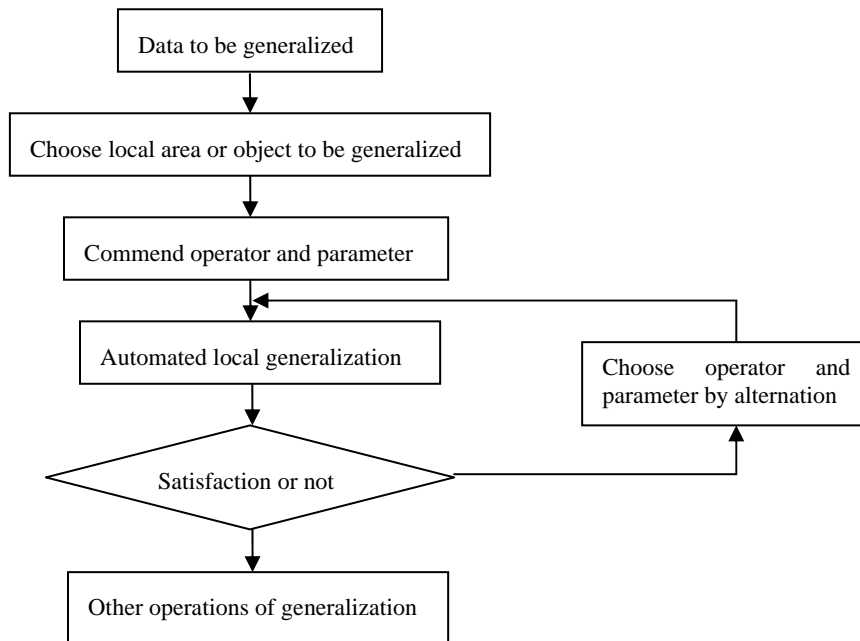


Fig. 2: alternating model

4. The establishment of synergic automated generalization system

Based on the methods listed above, we establish two types of automated generalization systems as follows.

System 1

Based on the theory of software engineering, according to the “synergic map generalization” model which is brought forward in this article, we developed corresponding experimental system by the use of *Microsoft Visual C++6.0* which is a kind of visual languages for program, the system was developed by the way of OOP in window98 platform, the system had been used for experiments of generalization of several scales. We can see the functional structure of the system in Fig. 3, Fig. 4 is the

interface of the system.

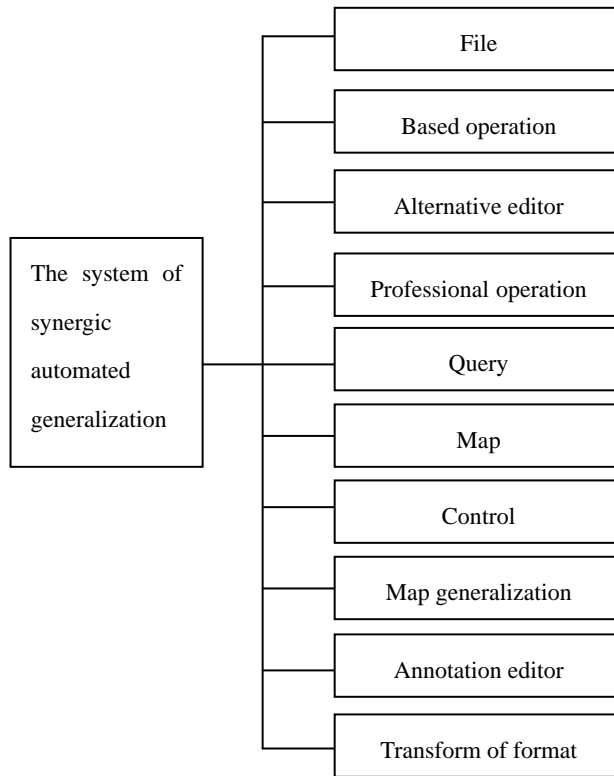


Fig.3: The functional structure of the system

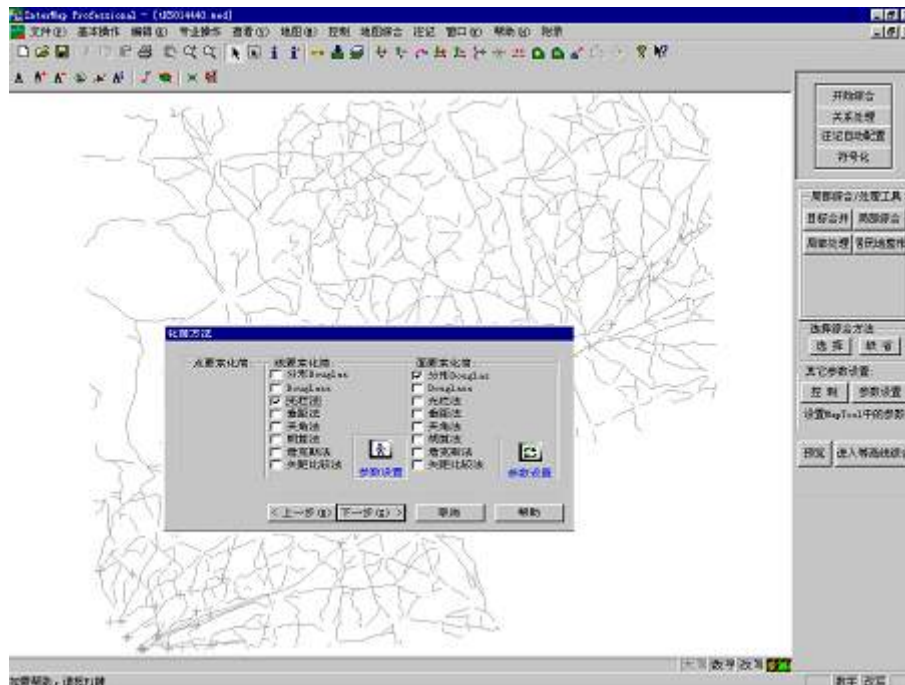


Fig.4: The interface of the system

System 2

This system is the software that is developed for the generalization of large scale based on Microstation.

On the platform of Microstation, We developed the system of generalization which is used to produce practically by the use of MDL which is a kind of second language provided by Microstation. The system adopted the “synergic map generalization” model which is brought forward in this article too. We can see the functional structure of the system in Fig.5, the interface of the system is as the same as the interface of Microstation, Fig.6 is the interface of the system.

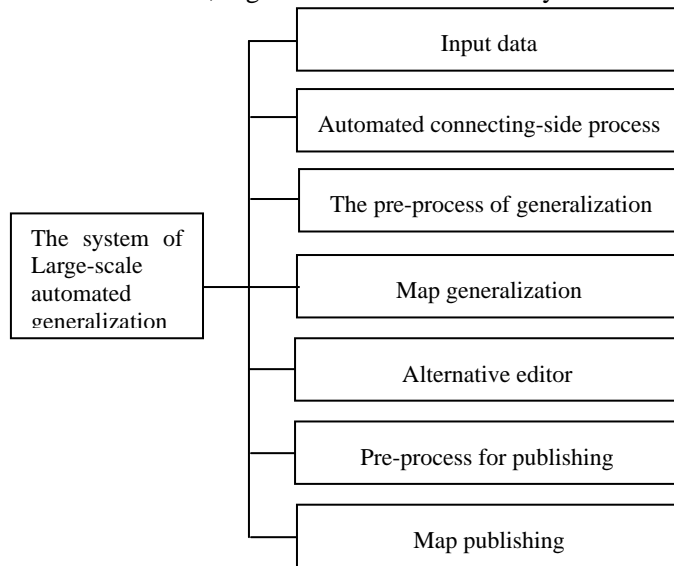


Fig.5: The functional structure of the system

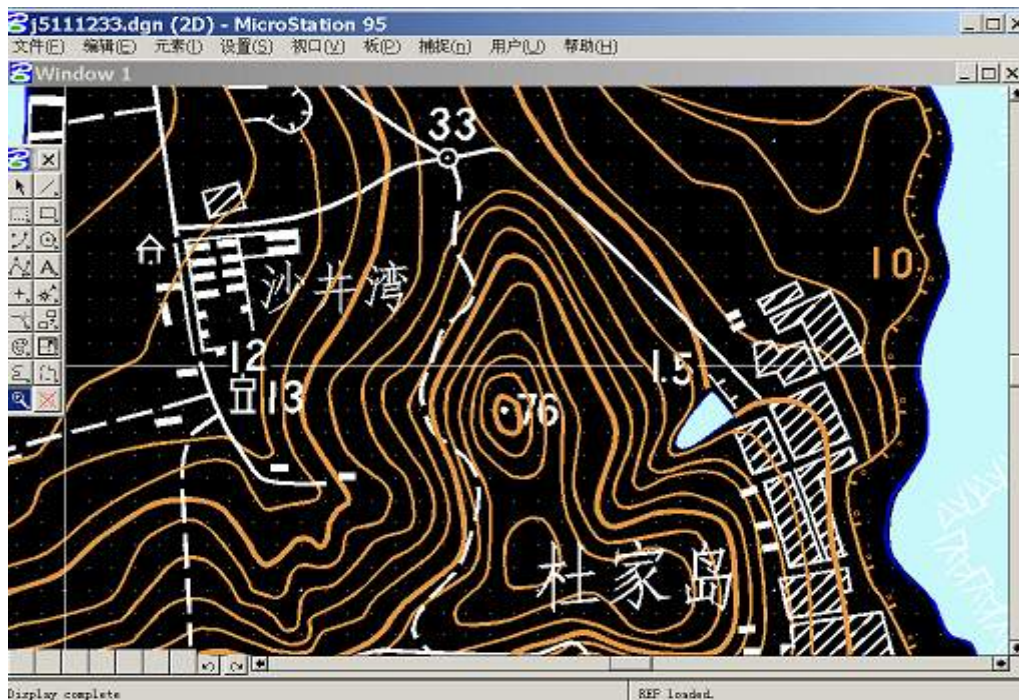


Fig. 6: The interface of the system

5. Conclusions

(1) The key of the mathematical morphology method applied in automated generalization is designing and selecting appropriate structuring elements. It is mainly used for merging faced object(such as blocks).Because it need to change vector data which need to merge to grid data firstly, to merge graph by closing to face lifting the faced graph which had been merged by done at the present, so the

application is confined to a certain extent.

(2) The method of neural networks applied in automated generalization, it processes the function of intellectualized illation, can get process round knowledge, can not be disturbed by the yawp which is produced when information inputs, adapts to some generalized processes which refer to semantic information and need to do fuzzy illation. Its defect is that the disposal process is pressed for transparency, so the disposal can not be explained.

(3) The fractal method applied in automated generalization, its theoretic base is that the part of object self-resemble the whole at some aspects in "region without measurement units", further fractal dimension is quantitatively complicated degree of cartographical object. Accordingly, this method had wider applied foreground in automated generalization, for example selection of point, faced element, simplification of linear、faced element and so on. But to the generalization of terrain contours, this method is still difficult to achieve good effect.

(4)Wavelet analysis processes "micro-scopical function" and "zoom-focus function", can adjust the density of sampling automatically, can observe all random detail of image and do further analysis, especially the decomposition of multi-orthogonal wavelet can keep the configuration feature of original image, which more adapt to the graphical simplification of grid data. But it need to do the process that is "vector-to-grid" and "grid-to-vector", the application is confined in certain extent.

(5) Because Delaunay triangular configuration can work out the proximal relationships among spatial objects expediently, furthermore which is built dynamically, partly, it can be use in many aspects of cartographical object, which are selecting, simplifying ,conversing graphical degree, merging, enlarging, changing position and so on . It has wider applied foreground in automated generalization.

(6)Because any one single method can not resolve all problems in automated generalization. It is reasonable to adopt the coordinated automated generalized system. The key is to design reasonable generalized hierarchy、scientific synergic model and the flow of synergic automated generalization according to fact.

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