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QUANTITY CONTROL OF DIGITAL MAP

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ABSTRACT:

The quality is the life of surveying and mapping. Before printing or going to database, digital maps must to be checked completely. In the past we can check it only by means of manual ways, but this makes the cost higher, the period longer and the work harder. Quantity control of digital map is more complex than paper map. It includes studying characteristics of space data errors and errors analytic model, the topologic relation between the space elements, the system of space data's quality evaluating and checking, etc. The vector terrain data checking is a most important content in digital map quality control. The main method this paper presented includes form checking, attribute checking, ground feature's position checking, topologic relation checking, relation checking between attribute data and coordinate data, contour checking, etc.

1. THE MEANING OF QUALITY CONTROL

The quantity is considered the life of Surveying and Mapping' products. When aerial photogrammetry product still was analog map, people already have summarized many theories and technique, which guarantee the quality of map. With the survey and mapping technique developing, the quantity of digital map is more and more and the application is wider and wider, so the quality control is even required. Traditionary methods of quantity control already can't be satisfied with modern production, furthermore new better technique has not founded yet. Then studying the new quantity control technique to digital map is becoming our current work now. Although in the last few years people had already payed attention to the quantity problem of the digital map and many people or organizations for surveying and mapping had done much fruitful research, current research is very not enough in regard to need. This condition makes the cost higher, the mapping period longer and the labor strength bigger. It has limited the technical development of the Surveying and Mapping，and may even take serious problem into the application realm. If inferior digital maps are to be used, it would bring serious result. For example, in the public realm, it would cause law dispute, decision error, and suffer great loss from economic development. In the military realm, it would cause the invalid stroke or mistake to harm oneself, make military activity not attaining the anticipant result even failure, influence directly the result of war, even endanger the national security. It is too terrible to dare to think.

2. RESEARCH CONTENTS

The quality control problem of digital map is more complicated and more diverse than that of paper map It includes studying characteristics of space data errors and errors analytic model, the topologic relation between the space elements, the system of space data's quality evaluating and checking, etc.

2.1 Characteristics of Spatial Data Error and Models of Error Analysis

Obtaining spatial data is very complicated, from the angle of the digital photogrammetry. It generally pass by photograph scan, control point bridging and plotting and editing, but each process would influence the last accuracy. Such as:

While image scanning, geometrical shutter of the digital image may be formed which may influence the measurement accuracy. While control point bridging, calculation error and measurement error will result in the control point error, which will influence the orientation accuracy. The measurement error of plotting and error of calculation and the occasional false operation would influence the accuracy of spatial data, Etc.

Therefore, in the proceeding of quantity control, should analyze the error source and characteristics of spatial data, study how to predict, how to verify, how to control and how to analyze the spatial data error, should research the error's law about propagation and how to decrease the error propagation。In the proceeding of analysis and research the tradition probability and statistics theory is still the theory base of establishing the error analyzing system. But, must expand the classic theory according to spatial data characteristics about producing.

2.2 The Topologic Relationship between the Space Elements

In order to make GIS suit to be analyzed and be used, vector graph need use vector data structure with topologic relationship that also be called topologic data structure. If the vector map topologic relation is false，the error will bring bane to the data's usage. In the proceeding of topologic analysis, should judge whether the topologic relation is false or not with topologic semantic. Such as Telegraph pole can't be inside the independent building; settlement place must have road to reach; The contour line can't cross; Two buildings can be close together but can't lap over, etc.

So this would need deeply analyze and research the topologic semantic characteristic between point and point, between line and line, between plane and plane etc, in order to confirm the right topologic relationship. The mathematics morphology and the graph theory is the main tools that study the topologic relationship about vector data.

2.3 The System of Spatial Data Quantity Evaluating and Checking

If we want to establish the system, first the quantity model of the spatial data must be established. Which can qualitative analysis and quantitative analysis the spatial data' quantity. Second, further design the system of spatial data' quantity evaluating and checking before acceptance and give integrate quality checkup project about spatial data, which is the essential assurance that tell us how to realizes the quantity control of spatial data in a specific way. The quantity model of the space data is the foundation. It must can objectively describe the spatial data's accuracy, logic consistency and integrity. The spatial data' quality measuring model is the key of establishing the system. It must be scientific and have maneuverability.

About the system and project that we have designed not only consider whether it is scientific and advanced or not, but also make sure of the production system and the technical level and the technical equipment suiting the fact.

3. THE METHOD OF QUALITY CHECKING

The quantity check of the digital map is a key, and it can prevent the false digital map to be used. The quantity check can divide into process check and final product check. The process check is in the operation process, which depends on the workers and its managers. Its check method has relation to each process's characteristic, generally, the technology's inventer should give the corresponding check method.

The final product check is in the last product process, which is finished by each unit's special functionary with special technical equipment and method. The intendance and the check should be finished by the corresponding product custodian.

The vector map is the digital map that it's application of quantity checking is most, and it is the most complicated. its main method have:

3.1 Checking Data Form

The data form check about the vector graph can be divided into four parts: whether the data file's name is coincide with the provision or not; Whether data file is all ready or not; whether data contents is coincide with it's file name or not. Whether the data format is coincide with it's provision; whether the ground coordinate of the landform and the ground feature is coincide with map sheet.

The form check need to give method of files' automatism searches and form checking with standard data format. For searching all the existent updated data file will use too much time, so in order to manage all data and realize file searches, we can specify regular catalog and regular file name.

3.2 Checking Attribute

In digital map, the attribute data's errors is most possible, the combined attribute is so flexible and the input of the attribute's value is so complicated that the worker mistake more possibly.

The attribute check is the most hard work in the quality check of spatial data, for the true value the of attribute (or called reference data) is hard to get, and the combination model of attribute is so complexity. Then the check of attribute data becomes a hard work. In order to solve it, this paper brings up the method that auto check the Attribute's accuracy of ground feature data with templates matching, which greatly increase the work's automation degree, and make the result more dependable. The templates matching method is based on attribute template file. After the standard about digital map has made, we may build the attribute template file of each feature coverage. When checking, after the file data of attribute was read into the memory chain, we can get the corresponding template file according to the checking attribute file extension, then put the data into the corresponding data structure. After that ,we can compare attribute data with template data. If in attribute data each data combination can't be found in the template, we would consider the data false and automatic write down the errors.

Using this method, the found error must be false, but some errors can't be found yet. So man-machine interaction check is a necessary method to further check.

3.3 Checking Ground Feature's Position

The main check whether the ground feature's space position is exact or not. Now adopted primarily method is that the result and image will be superimposed, then be showed to check.

In other words, the newest image is set background, and the ground feature's data that it's coordinate has been transformed superimpose upon the image to show. Then according to the image check the accuracy of ground feature's position.(such as formula (1). The coordinate transformation include the changing from ground coordinate to photo coordinate and from photo coordinate to screen coordinate. After interior orientation and space resection finished, we can according to the formula (1) inverse calculate the corresponding photo coordinates of ground feature, then according to the formula (2) calculate the corresponding screen coordinates.

$$x = -f \frac{a_1(X-Xs)+b_1(Y-Ys)+c_1(Z-Zs)}{a_3(X-Xs)+b_3(Y-Ys)+c_3(Z-Zs)}$$
$$y = -f \frac{a_2(X-Xs)+b_2(Y-Ys)+c_2(Z-Zs)}{a_3(X-Xs)+b_3(Y-Ys)+c_3(Z-Zs)} \quad (1)$$

$$I = \frac{b_2(x-a_0)+a_2(y-b_0)}{a_1b_2-a_2b_1}$$
$$J = \frac{b_1(x-a_0)+a_1(y-b_0)}{a_1b_2-a_2b_1} \quad (2)$$

If the accuracy of orientation pass muster, but ground feature data and image have clear departure, it is said that the ground feature data has errors, we can make marker of error with the

man-machine interaction method and write in the error statistics. Which also find the pretermission of ground feature etc.

3.4 Checking Topologic Relationship

The main check whether the topologic relations can be rightly established or not, whether the existing topologic relations is right or not. between the elements.

The method has two modes of automatic mode and man-machine interaction mode. The automatic mode is based on the topologic semantic characteristic. When the automatic mode is disabled, man-machine one will be used.
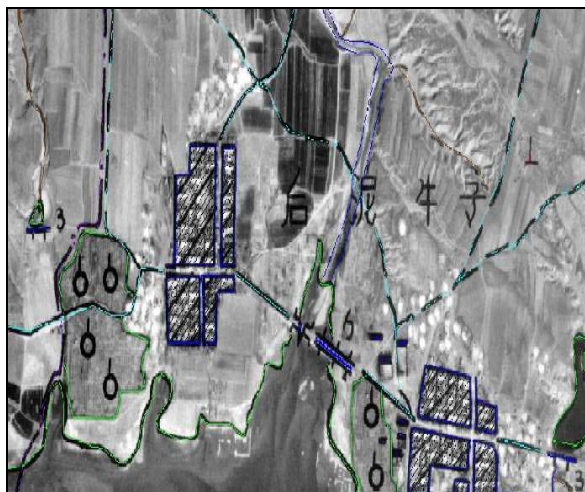

Figure 1.   The sketch map of ground feature and image
                 superimposing

3.5 Checking Relationship between Attribute Data and Coordinate Data

Primarily checking whether the corresponding relation of attribute data and coordinate is right or not.

If there is a feature that it has attribute data except coordinates or has coordinate except attribute data, then we consider the corresponding relation of attribute data and coordinate is false.

3.6 Checking Contours

Checking contour vector data is an important part of map vector checking. At present, contour data can be obtained by stereo-mapping system, or collected from old relief map, still it can produced by DEM automatically. Whichever method is used, it can't avoid appearing some mistakes and errors. If these mistakes and errors can't be found and rectified promptly, they can bring serious or even fatal affect to all the apply of contour. The existing check method of contour vector data include displaying them on screen in different colors according to different elevation, graphically outputting, etc. It can also check the plan metric position and omission by means of overlaying contour image and figure. These methods need large quantity of labor and time, and it can't guarantee to check comprehensively and accurately because of so much artificial factor. In fact, it's unreal to assume checking all the problem existing in contour vector data thoroughly by a perfect method. Now the paper presents an integrative method of checking contour vector data. Firstly, it can scan contours data automaticly from two direction, horizontal and vertical, to find abnormal contour elevation.

Secondly, because contours data is three-dimensional, it uses OpenGL to display contours on DEM to find out abnormal conditions. Lastly, it overlays identified photographs with contours data on the computer screen to check reciprocal relation between contours and ground features. It has been proved the integrative method can comprehensively and accurately discover and find the problem existing in contours vector data.

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