3D Visualization Method of Large-Scale Vector Data for Operation

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Abstract. In order to make fast 3D visualization and operation to be feasible for large-scale global vector data, in this paper, one method based on real-time simplification to vector data is presented. This method use a list of expression error limitation to simplify line objects in the iterative process, and the result is recorded by coding. In order to realize effective data organization, line objects are divided into different priority types according to its attributes and indexed with quadtree. In addition, proper original data with certain scales are suggested to select. At last, one demonstration is given, and the result shows that the method is efficient.

Keywords: cooperative visualization, geo-information, large-scale vector data.

1 Introduction

Sharing and cooperation to large-scale spatial information over internet becomes very important in geographic information system (GIS) field, one typical case is that many users try to access, browse and operate their interested data in different places on the globe, similar to utilities of query and browse function provided by Google Earth, Virtual Earth and so on systems. However, these systems do not provide operate function to vector data, which is very important in GIS field. So the main aim of our work is to resolve large-scale vector data visualization for operation, as visualization is the basis of sharing and cooperation to geo-information.

In order to realize fast 3D visualization of vector data, we use simplification method to vector data, it's similar to data generalization in cartography field. Many research works have been done in data generalization, e.g. Li-Openshaw algorithm and Daglaus-Peauker algorithm, while many improved works have been done for these algorithms. But the main aim of these algorithms is to resolve problems in cartography field, they are not suitable for fast visualization. In addition, data generalization methods orient to internet environment are also presented, as works state in literature [1][2], but they are also can't satisfy requirement to fast 3D visualization.

2 Real Time Simplification for Vector Data

In order to realize real time simplification to vector data, firstly we simplify the vector data, then record the result with coding. In the rendering time, different levels of detail

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is extracted and rendered with given expression errors. In order to simplify the problem, here we only discuss line objects.

Line simplification can be considered as a process of point elimination: e.g. assume $\{a\ b\ c\}$ is a set of neighbor points on line l, if distances of ab and bc are less than one given error, then b is a point can be eliminated, otherwise calculate distance from point b to line ac, if this distance less than one given error, then b is a point can be eliminated. For a list of given expression error, eliminate points in such a way by an iterative process, and record the result by coding. For real time elimination, we developed a very fast algorithm, which could extract salient point in real time. The specific code method is (fig. 1): assume line l is composed of m points, and n times simplification are required, then one number with n bits length can be used to record each point state. If one point is eliminated in ith iterative process, then mark ith bit in the number to 1 otherwise to 0, when $n < 4$, then number 1 2 4 8 can be selected to record point state, and the whole line simplification result can be record with a code of length m.

The simplify process is controlled with a list of given expression errors, which can be determined by visualization process. Vector line expression error should be coincident with image resolution, so its value should take resolution of pyramid levels of the image, e.g. {0.5, 1.0, 2.0, 4.0, 8.0, …}, assume image is divided into block with size of 512×512, then error list $\{L_i\}$ can be calculated with formula:

$L_n = 2\pi R_E/(2^n \times 512 \times 10)$where R_E is radius of earth, if $n = 14$, $L_n = 0.477$m, i.e. the resolution is about 0.5 meter, and keep coincident with vector map scale 1: 5000. Considering specific hardware and software environment, the value of $\{L_i\}$ can be relaxed to 2 or 3 times of ideal value.

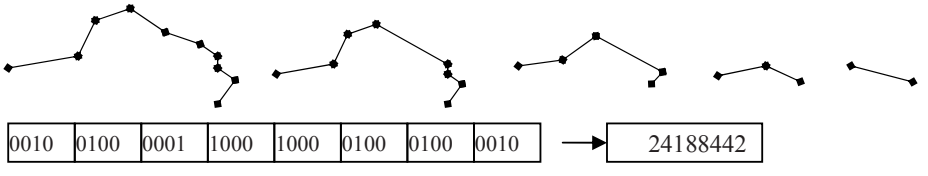

Fig. 1. Coding to data simplification result

3 Data Organize Strategy

Original vector data generally has certain scales, so select proper data is very important to real time data simplification and data organization. From many sides consideration, a scale series that could be selected is: 1:10,000, 1:100,000, 1:1,000,000, 1:10,000,000, and a series: 1;5000, 1:50,000, 1:250,000, 1:1,000,000, 1:10,000,000 can also be selected in practice if necessary.

In order to promote data operation efficiency, for each scale of original data, all line objects are divided into different types with its attributes, and assign different priorities, quadtree index is established to line objects with priorities. When data amount is too huge to realize real time visualization, only render visible objects with higher priorities.