Research on the method of selecting Point elements of electronic map based on Voronoi diagram

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Abstract: In this paper, a method of selecting point elements in electronic map based on Voronoi diagram is proposed. The retained point elements can better reflect the weight of their spatial distribution. The POI is gridded in advance, the grid index is established, and the speed of Voronoi graph is improved. The distance limit between adjacent POI is added to ensure that the adjacent POI does not conflict with each other when displaying name notes, thus improving the display performance of terminal map.

Key words: Voronoi diagram; Electronic map; Point elements; Grid index

Introduction

Electronic maps display different POI sparsity under different scales, so there is a screening process for the massive POI data sources provided by map manufacturers before display. At present, the screening of POI is mostly based on the use of the map, according to the type of POI classification, and then according to the level of screening, does not take into account the spatial distribution characteristics of POI, adjacent POI may exist in the display of annotation conflict problems.

1. Existing problems of prior art

The original POI data source can be screened by using Voronoi graph, which has good spatial equalization characteristics and can express the spatial occupancy of point-like elements and the role of points on the spatial distribution of the whole point set. Obviously, POI points with large space occupancy that can maintain the spatial distribution pattern of the whole point set should be preferentially retained.

At present, a problem in electronic map point element screening is that the POI data sources provided by map manufacturers generally reach tens of millions of this order of magnitude, and the time to establish Voronoi diagram will be very long, and it is even impossible to achieve in the case of a sharp increase in the amount of POI data.

2. Electronic map point element screening technology improvement

In this paper, a method of selecting point elements of electronic map based on Voronoi diagram is proposed. The retained point elements can better reflect the weight of their spatial distribution. The POI is gridded in advance, and the grid index is established to improve the speed of obtaining Voronoi diagram. The distance limit between adjacent POI is added to ensure that the adjacent POI does not conflict with each other when displaying name notes, and the display performance of terminal map is improved. The method is divided into four steps as follows.

2.1 Grid division of POI point sets

The purpose of this step is to speed up the calculation of Voronoi graphs and solve the problem that it takes a long time to calculate massive POI point data Voronoi.

The specific method is to divide the national map data along the longitude and latitude directions according to a certain distance, and regard the nationwide map data as consisting of a series of square grids. The grid numbers are stored in order from small to large, and the grid numbers start from 1. The numbering rules are shown in Figure 1:

5	10			
4	9			
3	8			
2	7	...		
1	6	...		

Figure 1 Grid numbering rules

The specific example of division is shown in Figure 2 (the number in the example is the grid number) :

2.2 Voronoi diagram of each point is obtained

By obtaining the Delaunay triangulation net, the Voronoi diagram of each point in the POI point set contained in each grid is obtained indirectly. After completing the grid division of POI data under each Billy scale, the following is to calculate the Voronoi diagram of each point in the POI point set contained in each grid by grid unit. Here, the point-by-point insertion method is used to calculate the Delaunay triangulation network first, and then the Voronoi diagram of each point is calculated indirectly according to the duality of the Delaunay triangulation network and the Voronoi diagram.

Because the POI points are meshing in step (1), the number of POI points in the Voronoi diagram is much less than that of all the POI points in the Voronoi diagram calculated at one time, which greatly reduces the time of calculating the Voronoi diagram.

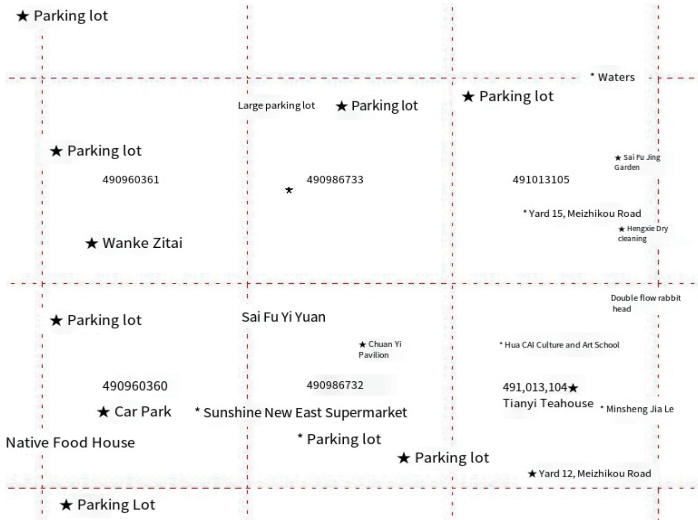

Figure 2 Grid instance

FIG. 3 shows the example of Voronoi diagram generated after a single grid calculation:

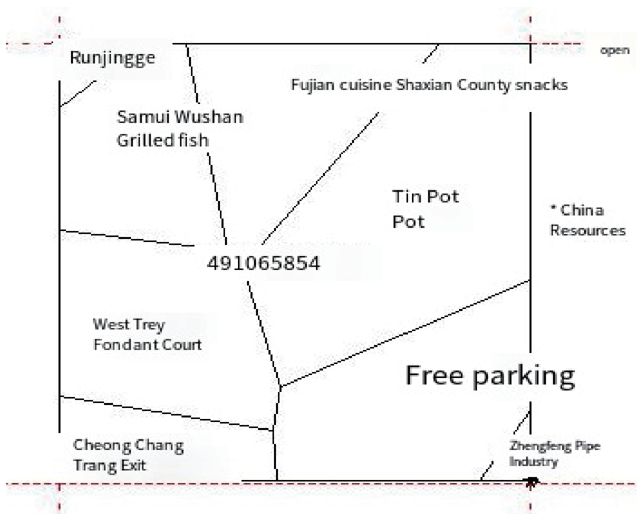

FIG. 3 Calculation results of Voronoi diagram for a single grid

2.3 Determine the final display rating for each POI point

Include 3 sub-steps:

① According to the specific application requirements of the map, by the type number of POI, divide the first level of display level of each POI.

② Calculate the Voronoi polygon area corresponding to each POI point.

The special treatment to be done here is that the Voronoi polygon of some points intersects with the grid boundary line, at this time, the grid boundary line should be taken as part of the Voronoi polygon of the point, thus forming a closed convex polygon, the area of which is calculated using the following formula:

$$S=\sum_{i=0}^{n}\frac{1}{2}(x_{i+1}+x_i)\times(y_{i+1}-y_i)$$

Where is the x and y coordinates of adjacent points on the Voronoi polygon. x_i, x_i+1, y_i, y_i+1

③ The area of Voronoi polygon corresponding to POI points with the same level of 1st display is sorted from small to large, so as to determine the final display level of each POI point in each grid.

If there are n POI points in a grid with the same level of level 1 display, set the Voronoi polygon area corresponding to the i point, indicating the final display level corresponding to the i point, then, there are. S_i L_i $S_i>S_j>...S_n$ $L_i>L_j>...L_n$

2.4 Determine the POI points retained by each grid

Include 2 sub-steps:

① The POI point in the grid with the largest display level (that is, the largest Voronoi polygon area) is used as the pre-reserved point.

(2) Determine whether the distance between the point and the pre-reserved point of the surrounding grid meets the distance restriction requirements: if it meets the requirements, the point is the reserved point determined by the grid; If it does not meet the requirements, select the point with the second final display level as the pre-reserved point, and re-determine the limiting distance until the reservation point that

meets the requirements of the distance limit is found.

As shown in Figure 4:

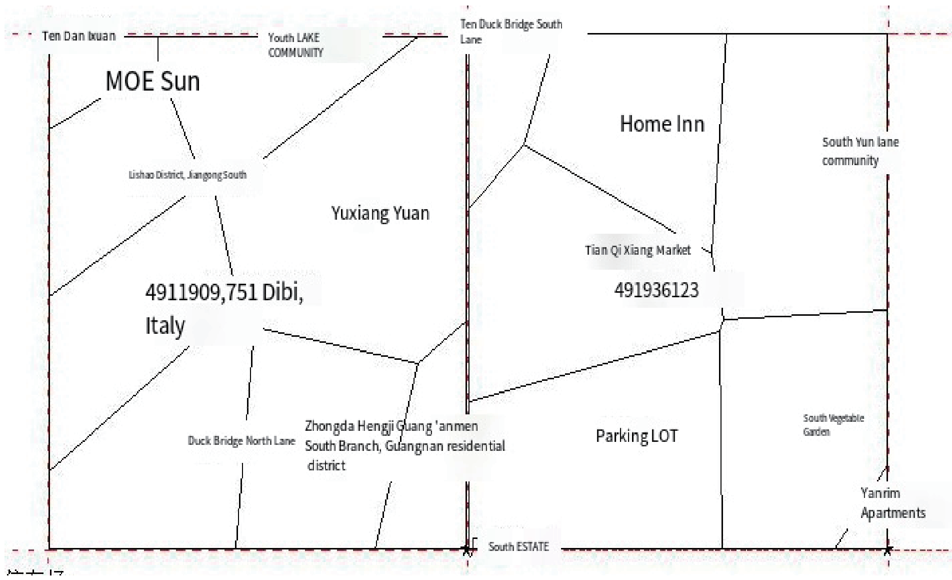

Figure 4 Grid filtering POI instances

For the two adjacent grids numbered 491,909,751 and 491,936,123, the Voronoi polygon area corresponding to each point can be determined according to steps 2.2 and 2.3. “Yuxiangyuan” and “Tianqixiang Market” are the points with the highest display level in the two grids respectively, and the distance between the two points is calculated. If the distance restriction conditions are met, the two points are taken as the final reservation points of the two grids. If these two points do not meet the distance restriction conditions, then select the “parking lot” in the grid 491,936,123 with the second final display level as the pre-reservation point, judge whether “Yuxiang Yuan” and “parking lot” meet the distance restriction conditions, if yes, the “parking lot” as the final reservation point of the grid number 491,936,123.

3 Epilogue

The characteristics and advantages of the point element screening method proposed in this paper are as follows:

(1) The grid division of POI data is pre-processed, and the Voronoi diagram of each point is calculated by grid, which greatly reduces the time of calculating Voronoi diagram and improves the compilation efficiency of map data.

(2) Using Voronoi diagram as the method of screening POI, it fully reflects the characteristics of the spatial occupancy of point elements and the role of points on the spatial distribution of the whole point set. The retained POI points can better reflect the geographical information characteristics of the region.

This method uses the combination of POI type number and Voronoi diagram to determine the final display level of POI, which is a way to screen by integrating multiple feature quantities. This method can better reflect the geographical information characteristics of the grid area than the commonly used method which only divides the display level according to the POI type number, especially it can effectively solve the problem of screening POI points with the same type number in the same grid.

(3) In the screening of POI, the distance restriction condition is added to avoid conflicts between adjacent POI name annotations. In the compiling stage of map data, this restriction condition is added to screen POI. In the display of navigation terminal, there is no need to use complex collision avoidance algorithm to solve the problem of POI name annotation conflicts, and the POI can be displayed directly. Greatly improve the performance of navigation terminal map display.

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