A Displacement Method Based on Field Analysis

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Extended Abstract

In map generalization, the displacement of geographic objects has to take into account the propagation influence in the context. One object receives the driven force moving itself and also pushes the force to its neighbors with magnitude reduction. This process is similar to the phenomena of magnetic or electronic field in physics subject. Based on this idea, this study presents one displacement method using field analysis in the context of building cluster. Through the vector operation applying the grads and other field concepts, we offer the computation of displacement direction and offset distance of each building. This method maintains the relative spatial relationship after the displacement of building cluster.

Each building in the field context has a certain influence region surrounding to which this object is closer than any other objects. Assuming that the space is isotropic, we can use the Voronoi diagram partitioning of the area to act as the spatial entity influence region. The boundary of VD cell polygon equally partitions space between two neighbor left/right entities. The VD partitioning can be thought of as the result of each entity equally competing outward for growth range. If two VD cells share a common boundary, we can say that the two entities belonging to the cell polygons are adjacent, even if their metric distance is far. Based on this idea, we can use the topological relationship between VD cells to represent the distance relationship between spatial entities. In our method, we use Delaunay triangulation of outside buildings to extract the skeleton and then through topological organization get a special geometric construction similar to VD. (When extracting skeleton, we just consider the triangles link two or three buildings, removing those in the concave area of one building). Making use of the adjacency transmitting property, we define a variable *adjacency degree* to describe distance relationship and use the next algorithm to obtain the *adjacency degree* value of all objects with respect to the street boundary, say *b*. The immediate related buildings of boundary *b* belong to set *A*.

1> Let building in set *A adjacency degree* 0, and initiate other objects adjacency degree -1;
2> Initiate *A* belonging to active object set, Initiate variable *degree_count* 0;
3> Repeat next steps until active object set NULL;
  3.1> Find all adjacent objects of active object set based on VD cell extending search;
  3.2> Ignore those adjacent objects with *adjacency degree* greater than -1;
  3.3> *degree_count* adds 1 and assign the value into each valid adjacent object;
  3.4> Empty active object set and let valid adjacent objects belong to active object set;

Next we remove the VD cell arcs which face the two side buildings having the same *adjacency degree,* represented as yellow line in the third picture of figure 1. Then the connection of the rest VD cell arcs form the contour line which separates objects with *adjacency degree n* from those with *adjacency degree n+1*. The objects within the loop between two neighbor contour lines have the same *adjacent degree* with respect to boundary *b*. So we call this kind of contour line the iso-distance-relationship contour, just like the altitude contour of terrain representation. Obviously this contour is different from the iso-distance contour which is represented as progressive circle buffers with the same center and increasing radius. The iso-distance-relationship model considers the context environment and spatial distribution. An object far away in metric distance, possibly have very low *adjacency degree* and close distance relationship with the reference boundary *b*. We suppose the boundary is the force source to drive the displacement, the force propagation will pass across the contour and this kind of contour could be thought of as the displacement field representation, just like magnetogram in magnetic field.

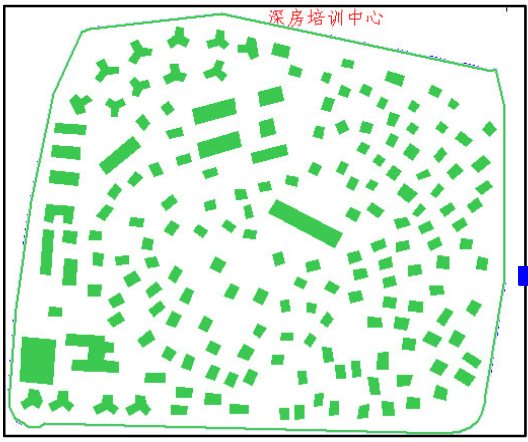
After finishing the displacement field construction, we present the movement computation including direction and offset of each building. Each building object faces some VD cell arcs with adjacency degree n and adjacency degree n+1. Through vector add operation, we can compute the movement direction of each building pushed by propagation force from objects with low adjacency degree. For offset distance, we can define a decayed function of the adjacency degree, say f(x)=kx-c. The objects within the same contour loop will have the same grads and move the same offset. The core objects which are far away from the boundary could be controlled to keep original position.

One question is that too densely distributed buildings may overlap after displacement. The improvement is to consider the local force produced from the close objects to each other. It means the displacement driven is not only from the boundary compress but also the close objects. When too close, the objects generate the local push force and the new vector is added to the vector operation. But when objects distribute very densely, the final combined vector of some objects approximates to zero, and the overlap does not yet avoid. In this case, the only displacement generalization could not resolve the question, the aggregation, deletion is required.

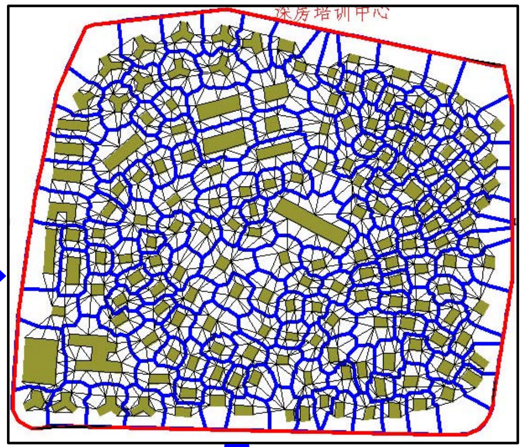
We realized this method in our interactive generalization system. If accepted, we will present the live demo in the workshop. Some hardcopies running the system is illustrated here.

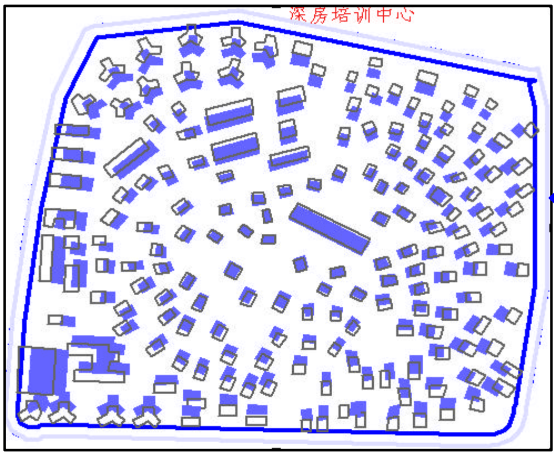
Keywords building generalization, displacement, field analysis, Delaunay triangulation

Original building cluster and street boundary

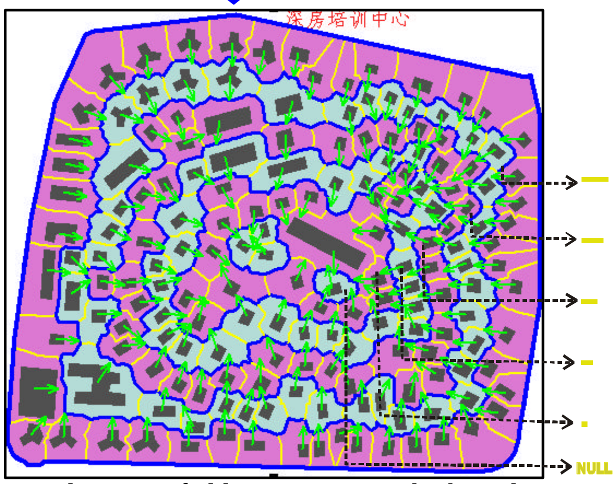


Based on Delaunay triangulation and conditional skeletons, construct the partitioning model similar to Voronoi diagram.

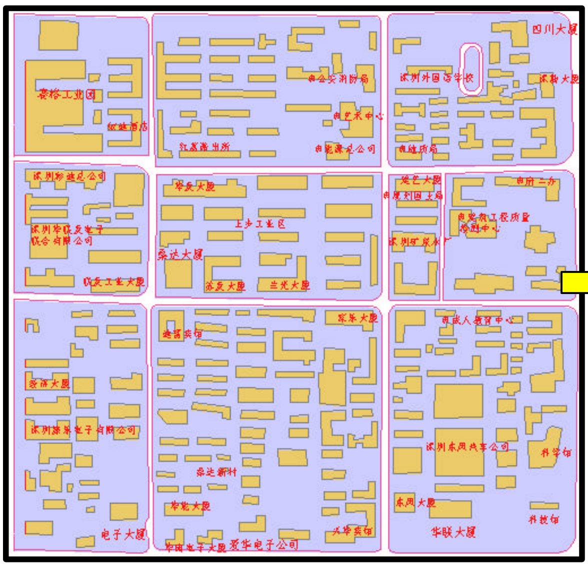


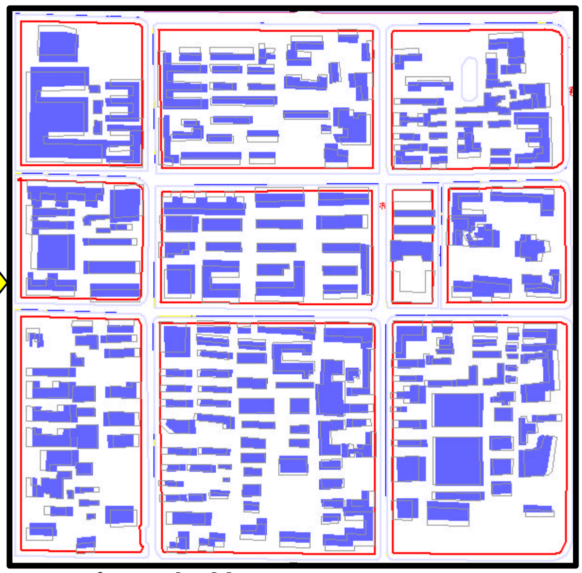


The displacement result driven by boundary compress. The nearer to the boundary, the longer offset the building has moved. The core buildings have no movement.



Displacement field construction. The boundary acts as the force source. The force propagation direction and magnitude is computed based on the field analysis in physics subject.





Real application in the displacement of street buildings.