CARTOGRAPHIC GENERALIZATION (SELECTION) FOR 2D MAP OF URBAN AREA

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ABSTRACT

In cartographic generalization process essential characteristics and behaviour of objects are to be preserved. When a map is represented graphically, if the represented scale is reduced, then some area features will become too insignificant to be represented, i.e. they will be too small to be viewed and cluttering the whole map making it illegible to view even according to the map's theme. These unimportant small area spatial objects are to be eliminated. This elimination procedure is part of generalization process called Selection. This paper presents a new approach to selection process of cartographic generalization. This technique includes three steps. These involve a process to calculate area of the spatial object i.e. polygon, drawing a virtual square, elimination of the spatial object after processing. Generally selection process doesn't consider the spatial density and eliminates all areas less than the threshold value. In virtual square method according to spatial density objects are eliminated. A virtual square is drawn around a spatial object and total number of spatial objects inside it is counted. If the count is greater than threshold then it is eliminated. This technique described in the paper has been tested using many examples and deployed in an application which is developed using Microsoft Visual C++, a robust platform for application development.

KEYWORDS

*Cartography, Elimination, Generalization, Map object, Selection process, Virtual Squar*e

1. INTRODUCTION

Generalization is the process of deriving from a detailed source spatial database a map or database the contents and complexity of which are reduced, while retaining the major semantic and structural characteristics of the source data appropriate to a required purpose. It represents a process of informed extraction and emphasis of the essential while suppressing the unimportant, maintaining logical and unambiguous relations between map objects, maintaining legibility of the map image, and preserving accuracy as far as possible [1]. Digital map generalization has been considered by many researchers as a fundamental function in spatial data handling. Many research projects on this topic have been carried out world-wide and number of generalization operations have been identified [2]. Most of the generalization process remains at the conceptual level and it has to be developed or improved for the various generalization operations. This paper describes an improved method for one of these operations, viz the selection operator (area elimination). Elimination of small and unimportant feature becomes necessary when the physical map space available for detail is reduced as the scale of the spatial data is reduced. Those area features which are too small to be represented need to be eliminated. The normal practice for eliminating area feature is:

- To compute the size of all area features, and
- To delete all the area features smaller than a given criterion.

The figure 1 show input map and output after the process of selection (eliminating the object) to make map objects more visible and understandable to user.
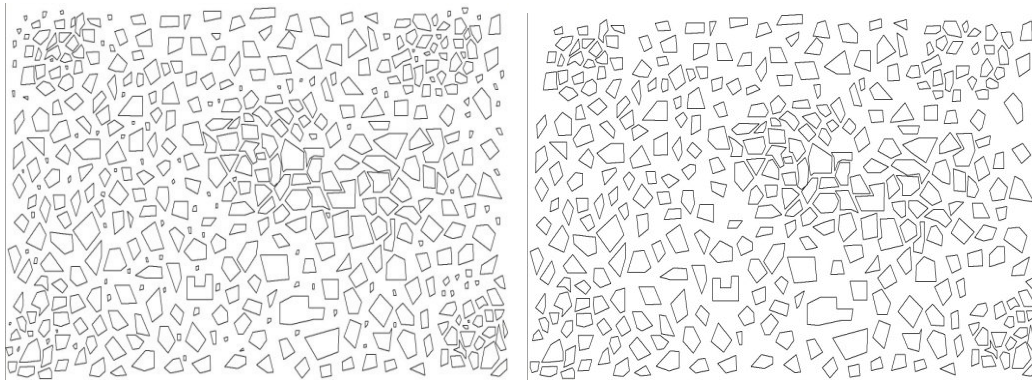

Figure 1: (Left) Input Map and (Right) Output Map after applying the Selection Process

Although area elimination seems to be simple this is not a case in practice and not much research on this topic has been done. In the following section the algorithm is discussed.

2. ALGORITHM

The basic idea of the selection process is to eliminate the smaller objects which are not required i.e. some object which are very smaller and which makes map more congested and difficult to understand.

  Step [1]: Open GML file.
  Step [2]: Input minimum area and virtual square size (m).
  Step [3]: Select a new spatial object.
  Step [4]: Calculate the area.
  Step [5]: If the area is less than the minimum area then
        5.1 Calculate the top left (xt, yt) and bottom right (xb, yb) co-ordinates of the enveloped rectangle.
        5.2 Create virtual square of dimension (xt+m, yt-m) and (xb+m, yb-m).
        5.3 Count total number of spatial object inside virtual square box.
        5.4 If the count is greater than threshold value then eliminate the spatial object.
  Step [6]: Repeat the step 3 to 5 until all objects are processed.
  Step [7]: Exit.

3. DETAILED EXPLANATION

In general selection process area of all the objects are calculated and smaller area will be eliminated from the map without any criteria. In our method first minimum area should be mentioned. Each object in the map is taken and its area is calculated. If the calculated area is less than the minimum area required, a virtual square of specified dimension is drawn which can be equal to the size of the display area in case of small display devices. Number of objects inside this virtual square is counted. If the count reaches a threshold value then the object under consideration is eliminated and the process continues to the next object. This way all objects inside the display area will be processed and eliminated which will make the map to be viewable [3].

            Data input is given either by drawing a map or opened from a file (GML). All the spatial objects are stored using linked list which points to an array of co-

ordinate points of the spatial object. The process starts by taking the first object from the linked list and progress through rest of the elements stored in the list till it reaches the end of the list [4, 5].

3.1. Area Calculation of Spatial Object

Area of the object under consideration is calculated using triangulation method. A polygon of n vertices gives n-2 triangle with one common vertex. Area of each triangle is calculated using co-ordinate geometry method and summed up at the end to give area of the polygon [6].

Figure 2: Triangulation

Area of the triangle $(\Delta 1)$ = 0.5 * [(x0 (y1-y2) - x1 (y0-y2) + x2 (y0-y1)]

Likewise area of other triangles is calculated.

Area of the polygon = $\sum_{0}^{(n-2)} (Area\ of\ triangle\ \Delta n)$

3.2. Drawing the Dynamic Virtual Square

This step is carried out only if the area of the spatial object under consideration is less than the minimum area. The spatial object is enveloped by its maximum rectangle. From the top left and bottom right corner of the rectangle a bigger rectangle is drawn according to the specified size. If the map is viewed in a small screen displays then the display size can be considered as the virtual square.
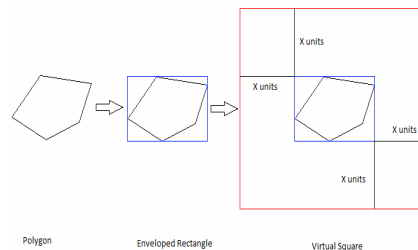

Figure 3: Virtual Square formation

3.3. Why Virtual Square

Virtual Square is used to maintain the integrity of the map. In a map if there are spatial objects of smaller area (area less than minimum area which are to be eliminated) in a group. By general method the whole group will be eliminated and map's view will be totally changed. By using virtual square before eliminating a spatial object, density of the spatial object's surrounding is taken into account. So that the whole group is not eliminated making a void space in the map. The figure 4 shows the difference in selection process using general method and virtual square method.
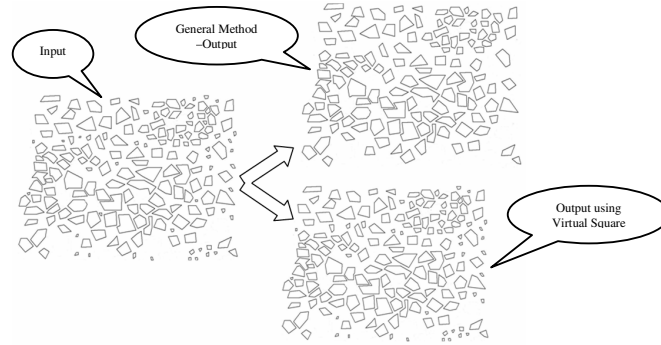
Figure 4: Object elimination with Virtual Square and without Virtual Square.

The main objective to draw the virtual square is to check whether smaller area spatial object is in congested area or not and to remove it accordingly. If there are very less number of spatial object in some part of map then there is no need to remove the spatial objects.

3.4. Area Elimination

After forming virtual square around the selected spatial object total number of spatial object inside the virtual square is calculated. If the count is more than the threshold then the spatial object under consideration is eliminated.
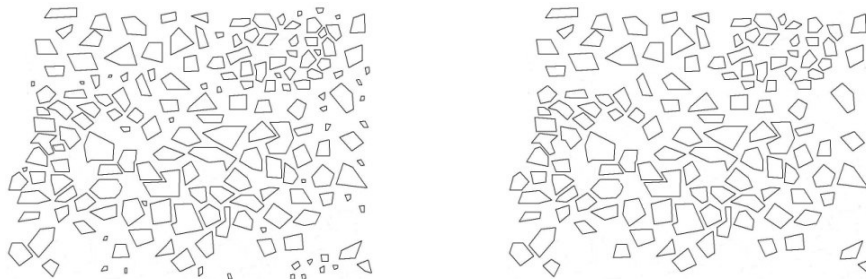

Figure 5: (Left) Input Map and (Right) Output Map after Area Elimination Process

The figure 5 (Left) shows the input map for the area elimination process and (Right) shows the output image in which small objects has been removed. This process repeats for other spatial objects in the display area.
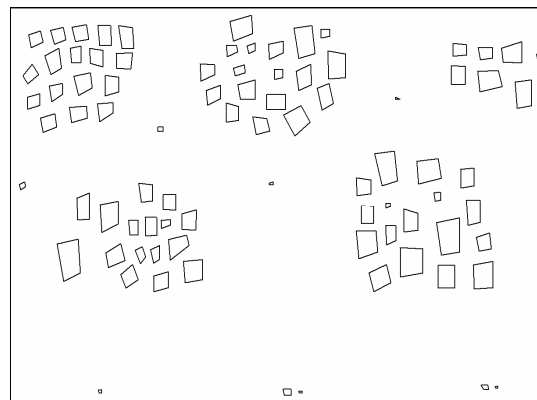
3.5. Example

Figure 6: Input Map

Initial input data is loaded from a file or drawn. All these objects are stored as a linked list array which stores vertex co-ordinates of the entire polygon.
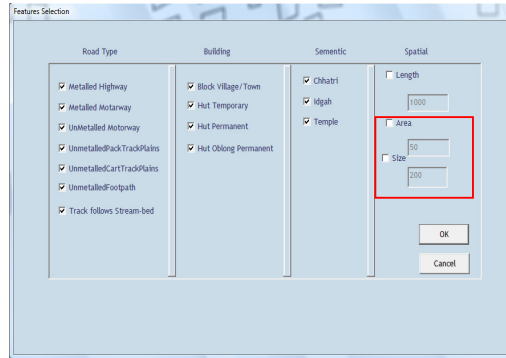

Figure 7: Minimum Area Value (50) and size of Virtual Square (200)

To eliminate small and insignificant area from the map's view a minimum area value less than which should be eliminated is entered in the Area box. Then the length of the virtual box from the edges of the enveloped polygon is entered in Size box. The other selections in the Feature Selection are to specify the level of consideration of Road types, Buildings.

Figure 8: Virtual Square of size 200 enclosing 15 objects. Threshold Value = 13.

The algorithm checks for objects less than size 50 and creates a virtual square around it and counts for total number of objects that the virtual square encloses. This is done by comparing the top left and bottom right co ordinates of the other objects with virtual squares. In our example there are 15 objects inside the virtual square including the ones that are intersecting which is greater than 13 our threshold value.
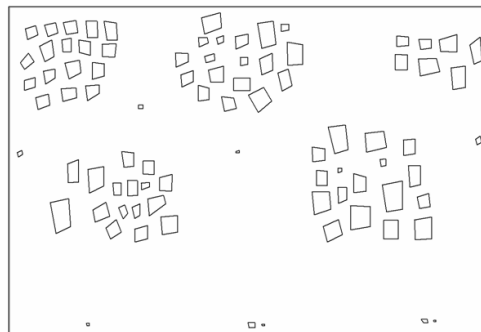

Figure 9: Area eliminated since number of objects inside Virtual Square is greater than Threshold Value

The object is eliminated. Few objects at the bottom of the map are not eliminated even though their area is less than 50. This is because the virtual square of size 200 did not enclose 13 objects.
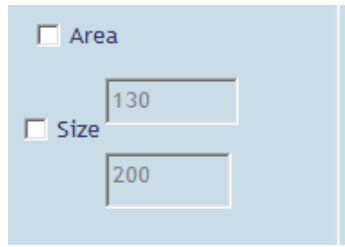

Figure 10: Now Area = 130 and Virtual square size remains the same.

In order to prove that the algorithm works properly the virtual square size remains same and area is increased to 130.
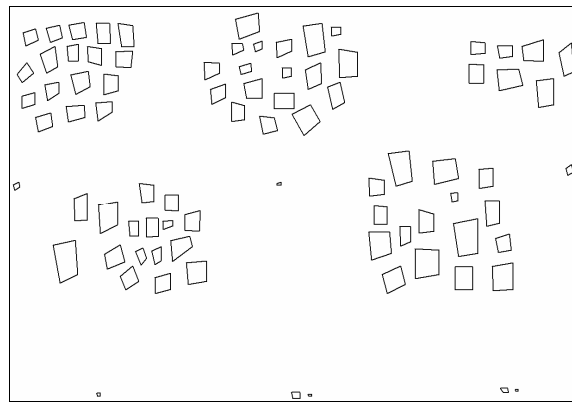

Figure 11: Area eliminated. But smaller areas at the bottom didn't get eliminated even though their area is less than 130 because virtual square did not enclose 13 objects.
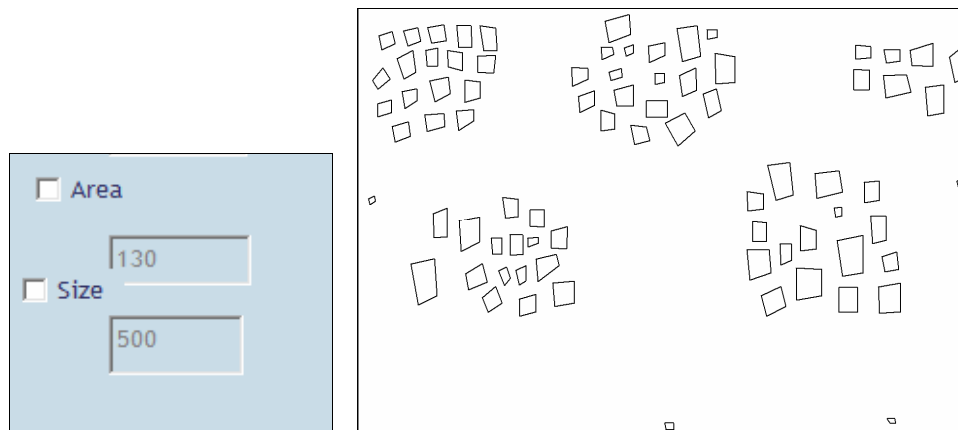
Two objects of area less than 130 got eliminated.

Figure 12: (Left) Area remains same and Size = 500 and (Right) objects at the bottom of size less than 130 got eliminated since the virtual square size is 500.

Now area remains the same and virtual square size is increased to 500. Size 500 covers more than half of the screen.

4. CONCLUSION AND FUTURE WORK

The proposed solution has been tested and gives good result. The basic object elimination technique which removes the map objects simply based upon their sizes affects the map's legibility. The proposed technique modifies the existing technique which checks that the area surrounding the given object to be deleted is highly dense or not. Future work includes adding of additional features like if the spatial object is of historical importance or important landmark like hospital, police station etc., and those entities should be retained regardless of the size.

ACKNOWLEDGEMENTS

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