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Rule Based Selection of 2D Urban Area Map Objects

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Abstract
The purpose of cartographic generalization is to represent a particular situation adapted to the needs of its users, with adequate legibility of the representation and perceptional congruity with the real situation. In this paper, a simple approach is presented for the selection process of building ground plans that are represented as 2D line, square and polygon segments. It is based on simple selection process from the field of computer graphics. It is important to preserve the overall characteristics of the buildings; the lines are simplified with regard to geometric relations. These characteristics allow for an easy recognition of buildings even on small displays of mobile devices. Such equipment has become a tool for our everyday life in the form of mobile phones, personal digital assistants and GPS assisted navigation systems. Although the computing performance and network bandwidth will increase further, such devices will always be limited by the rather small display area available for communicating the spatial information. This means that an appropriate transformation and visualization of building data as presented in this paper is essential.
Keywords: *Cartographic Generalization, GIS, Map, Object, Selection.*

1. Introduction

In natural environment human senses perceive globally, without details. Only when one has a particular interest he observes details, and this is a normal process, otherwise abundance of details would lead to confusion. For similar reasons, in the process of cartographic generalization many details are omitted. Generalization is a natural process present everywhere, as well as in cartography. Generalization in the compilation of the chart content is called cartographic generalization and it is one of the most important determining occurrences in the modern cartography, included in cartographic representations. The quantitative and qualitative basis of cartographic generalization is determined by the purpose of the chart and scale, symbols, features of the represented objects, and other factors. Besides in mathematical cartography, the main chart characteristic is based on the reduction of objects and representing them in a generalized form at low resolution devices like mobile and GPS system.

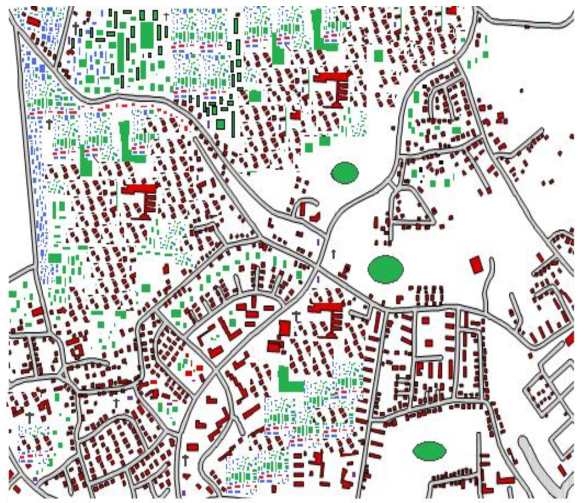

Figure 1: City Map

Figure 1 shown above illustrates the congestion found in a typical map. If it is represented on a small display then it would not be easy to understand. It is a fact that modern determinants of map representation and cartographic generalization are highly interrelated. This paper aims to explain the process of generalization and selection using basic computer graphics operations. The objective of this paper is to define the selection based on certain rules derived from the map to maintain the holistic relations between map objects and their consistency without leading to confusion for the user. Rules are defined in this paper for aggregation based on the type, structure of the objects.

2. Related Works

Cartography is a very old scientific discipline, and generalization dates back to the times of the first map representations. The paper focuses on the automation of the generation of scale dependent representations. There are a lot of research proposal in this domain. Many different techniques have been proposed: pragmatic bottom-up approaches use specific algorithms for different generalization tasks. Then there are more holistic ideas, using top-down strategies, to strive at an integrated solution of this complex task. Thus research issues have to deal with the integration of different methods for the solution of a compound task. Selection aims at a reduction in the number of points the object is composed of, with the constraint that the characteristic shape of the object is preserved. For arbitrary shapes, algorithms respecting the curvature of the object are typically used. The most efficient algorithm is developed taking the maximal distance of points from a hypothetical generalized line into account. This algorithm, however, cannot be used simply for special shapes like rectangular structures like buildings etc. Staufenbiel derived a set of rules for dealing with building facades that are too small to be represented and came up with a detailed processing scheme that was later implemented in the CHANGE software. Similar concepts are currently being implemented in many GIS products. The algorithm developed as part of the AGENT project aims at a concurrent solution of several competing issues: squaring, rectification, and enlargement of minimal narrow objects inside the building. The approach presented there is similar to a method that has been used for the reconstruction of parametric buildings in aerial images. There is a long history of automatic methods for displacement: Nickerson developed an approach for linear objects, which are displaced according to the degree of overlap of their corresponding signatures. The use of so-called displacement mountains is proposed by J¨ ager 1990. The importance of an object is coded in a raster image, with important objects producing high mountains. This mountain allows for the extraction of the degree of displacement and the direction. Mackaness proposes a radial displacement of objects around a given point. His approach allows for the degradation of the degree of displacement depending on the distance from the given point. Another approach given by Ruas aiming at an incremental dis-placement. Objects producing the greatest conflicts are treated first. As with all local operators, secondary conflicts can be induced by solving one conflict, thus there is a need for iterative operations and a control strategy to decide when to stop. Only recently, an emergence of using ’force models’ to solve displacement can be observed. These approaches aim at a global reduction of all spatial conflicts.

3. Rule Based Selection

When a map is represented graphically and 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 will cause cluttering of the whole map as can be seen in figure 2. Such insignificant objects are to be eliminated. However, indiscreet removal may lead to inconsistency and confusion. Selection provides the appropriate rules for removal. The results of application of the procedure may be seen in figure 3.

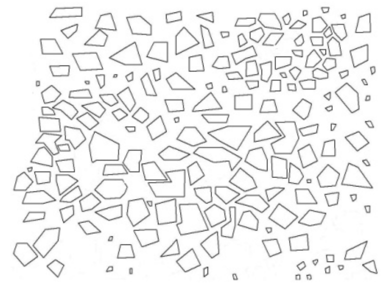

Figure 2: Input Map Image

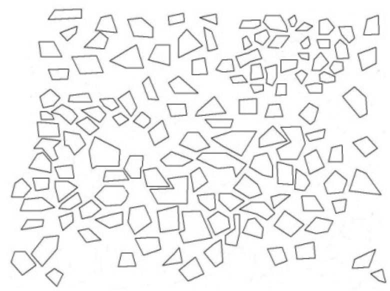

Figure 3: Output Map Selection Process

This idea was presented by Raheja, Umesh, KCS [2010] but it concluded in maps marked by inconsistency (elimination of important objects). To counteract this problem we describe some Rules of Ignorance in this paper, which result in more holistic maps from which more accurate information may be obtained.

Object Size with Congested Environment: This rule addresses the problem of providing Geo-Information about congested areas. This is accomplished by dropping unimportant features like small sized buildings from the map to make it more readable. For example a user searching for the route from location A to location B doesn’t have much importance for detailed representation of buildings, gardens, parking etc., all of which may be removed for enhanced clarity. The operation involves making simple measurements of sizes of buildings, and then a weeding out process of all features smaller than a threshold.

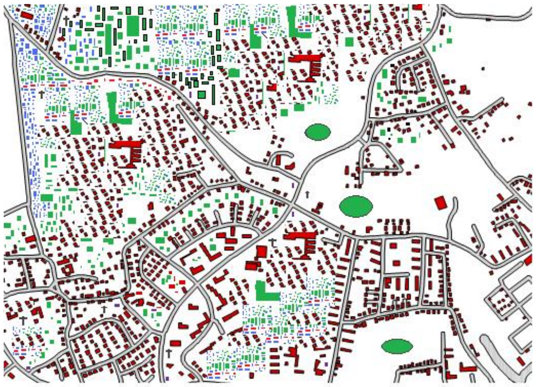

Figure 4: Congested Map

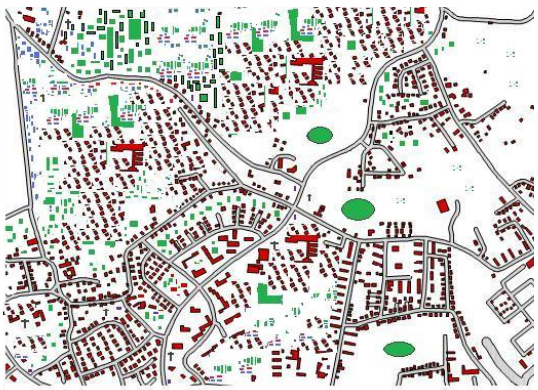

Figure 5: Map with Size Ignorance with congestion Rule

As the reader may gather, figure 5 above is less distracting than figure 4 where one can note the presence of many unnecessary minute features. The patches of green have been pruned to give a sparse representation. A salient point about the rule is the consideration of the location of an object before making a judgment on its removal. Smaller features in less feature dense regions are retained whereas similarly small sized objects in areas of congestion may be removed.

Historical Building: The previous rule makes its decisions on the basis of the sizes of buildings measured as 2D objects. But the importance of features may also arise from their status as landmarks, regardless of their size. For example a temple in a congested area is subject to removal as per the previous rule, but its utility is indispensible with regards to finding one's way with a city. This is illustrated in figure 6.

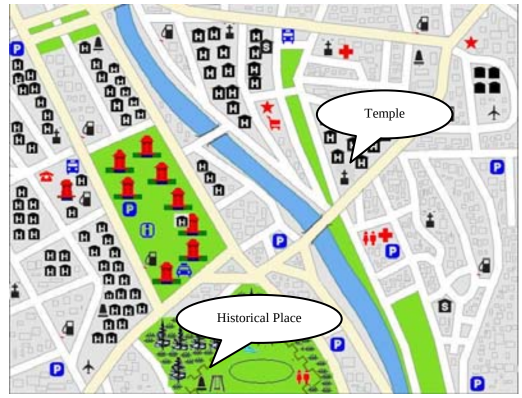

Figure 6: Map with Housing Building

Further this rule reconsiders for removal features that have been retained after the application of the previous rule. For example a user wishing to locate a particular building, say an industrial complex within a corporate area having many such buildings may wish to do away with them to obtain a simplified route to his location.

4. Algorithm with Object Mapping Rules

To represent the data, simple server-client architecture is followed. A request is sent to a server for the map, and its response is displayed by the user's device. However, low data rates may hamper the process. Handheld devices would in particular suffer from low bandwidth. A possible fix is to apply ignorance rules outlined above before sending the request to the server, thereby downloading only what is required. Otherwise data would need to be discarded at the client side, implying a waste of bandwidth. The complete procedure may be outlined as:

Step [1]: Open GML file.
Step [2]: Select a Spatial object.
Step [3]: Perform Rule Checking and update object presence.
Step [4]: Repeat the step 2 and 3 until all objects are processed.
Step [5]: Update the Map.
Step [6]: Exit.

4. Conclusions

The basic object elimination technique which removes the map objects simply based upon their sizes affects the map's legibility. A modification over the existing technique is proposed that takes into consideration the density of the area surrounding the object to be deleted. Besides ignorance rules have been defined to retain historical buildings and landmarks that serve as reference points in a map.

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