A GENERIC APPROACH TO BUILDING TYPIFICATION

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Abstract

Building typification which diminishes the number of buildings while conserving the pattern of the building groups concerning density, size and orientation is an inevitable operation for building generalization. To manage the map congestion problem two different selection based methods are developed for point features at medium scale that preserve the initial pattern of distribution. In this study these two newly developed methods, namely -"Length and Angle (L&A) Methods" are presented. In order to dissolve insufficient outputs away, both methods instead of one are successively applied to the same building groups. The method which selects proper number of buildings among the group according to Topfer rule is chosen for the application. The results of these two methods have been evaluated and seemed to be quite encouraging in different cases. Studies for the improvements of these two methods are still going on.

Keywords: *Building Generalization, Typification, L&A Methods*

1. INTRODUCTION

In a digital environment, the generalization process has been decomposed into many operations and several map generalization operators may be applied to resolve the map congestion problem. Recently, new methods have been developed to improve the representation of maps which is automatically generalized. In this context generalization of buildings and built-up area constitute a vital process in medium scale topographic map production (Başaraner and Selçuk, 2008).

Most of the buildings are represented with point geometries at medium (1:25K-1:100K) scale standard topographic maps (STM) in Turkey, especially in rural areas. Buildings having point geometries at basic (1:25K) scale data sources, are mostly overlapped when symbolized at smaller scales and these building groupings will only be related to such generalization operations as aggregation, simplification, elimination, and typification (Figure 1) (Li et al., 2004).

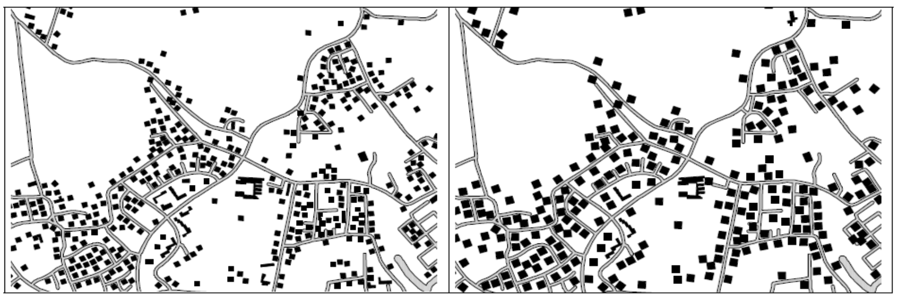


Figure 1. Typification (Sester, 2004)

The operation of reducing the number of buildings while preserving the pattern of the group is referred to as typification (Christophe and Ruas, 2002). Typification constitutes an important process in topographic mapping, especially in the selection of buildings. The aim is to preserve the pattern as much as possible, preserve similarities and differences between the groups with regard to density, size and orientation of buildings (Regnauld, 2001). This paper introduces two novel approaches for typification of buildings which automatically performs the detection of building groups and execution of the typification process.

2. BUILDING TYPIFICATION

Generalization of building groups is a bit different from generalization of other geographic features. During the detection of the building groups and recognition of their structures, other geographic features (such as roads) should be taken into account as well.

The generalization of building groups includes multi level analysis and operations. The first step is about building grouping based on the conflict detection, the distribution pattern recognition and the Gestalt nature cognition (Ai and Zhang, 2007). It is a decision making step before the execution of typification process and there are many researches on detection of building groups. Hangouet (1998) detects buildings aligned along roads, Regnauld (1998) detects close buildings organized along a graph using Minimum Spanning Tree (MST), Anders and Sester (2000) put forward a parameter-free cluster detection method used in spatial databases, Boffet and Rocca-Serra (2001) detect and aggregate triplets of buildings to constitute building alignment using a bottom-up approach. Christophe and Ruas (2002) detected building alignments using straight-line templates. Building alignments are identified from the templates. The alignments are then characterized by a set of parameters such as proximity and similarity, and only those perceptually regular buildings are retained. Rainsford and Mackness (2002) have also used the template matching technique for building grouping. Li et al. (2004) combine the urban morphology and Gestalt theory presenting a method to group building cluster. Chaudhry and Mackaness (2005) develop a method to generate the city boundaries by buffering building features and by deriving single polygon surrounding clusters.

As for the second step, it is about typification that replaces a large number of similar objects by a smaller number of representative objects, while conserving the typical spatial structure of the object arrangement (Anders, 2006). Since 1990, various researches have been made on the building typification subject. Müller and Wang (1992) use mathematical morphology to typify natural areal objects. Their principle is to enhance big objects and reduce small ones – unless they are not important. Ruas (1999) groups buildings by means of a network (Delaunay triangulation) and progressively removes the ‘worst building’ by means of a cost function based on size, density and directional proximity (Christophe and Ruas, 2002). Sester and Brenner (2000) describe an approach based on self organizing maps called Kohonen Feature Maps which try to preserve the original structure by moving the remaining objects in the direction of the removed one to minimize a certain error measure (Anders, 2006).

3. METHODOLOGY

The typification algorithm has to find a way that preserves the original patterns as much as possible. Therefore many researches have been made on typification algorithms caring about alignments of buildings and recognizing the geometric structures they construct. Structural knowledge which tries to detect geometrical structures in the object groups is used in these algorithms.

Consecutively, L&A methods detect the building groups and typify them in order to generalize the buildings having point geometries using structural knowledge and taking care about the symbol size, as well.

3.1. Detecting Building Groups

However digital data usually have no information about the relation and distribution of the objects, it is important to identify such information in order to generalize buildings in an urban area successfully (Regnauld, 2001).

The action of grouping is usually based on some similarities in criteria. Things that "look the same" can be grouped together. This definition of perceptual groups comes from the Gestalt theory (Christophe and Ruas, 2002). Gestalt principles have been applied for the recognition of spatial distribution patterns for many years (Weibel 1996), in both digital and manual generalization (Li et al., 2004). These principles are proximity, similarity, closure, continuity and common fate. Three more factors are added to this list later. These are common region (Palmer 1992), element connectedness (Palmer and Rock 1994) and common orientation (Li et al., 2004). Three of them - proximity, similarity and continuity, drawn from Thorisson (1994) - are relevant to the distribution of buildings.

Following the way of Gestalt theory many grouping methods exist. In this application clustering with buffer polygon have been used in detecting the building groups. Resource data is only composed of buildings having point geometries which are afterwards converted to the polygon geometries, using the symbol sizes of buildings at derived scale and the buffering distances. Half of the minimum distinction distance which is different for each scale (ie. 10m. for 1/100K) is used as criterion to build the buffer polygons of these points (Figure 2).

(a) Points in Original scale *(b)Points in Derived Scale* *(c) Buffer Polygons*

Figure 2. Constructing buffer polygons

These polygons are then merged with each other and construct one polygon. The polygon is separated into new polygons according to the transportation network. By means of these new clusters, the number of polygon within the cluster and the relations between buffer polygon and cluster are determined.

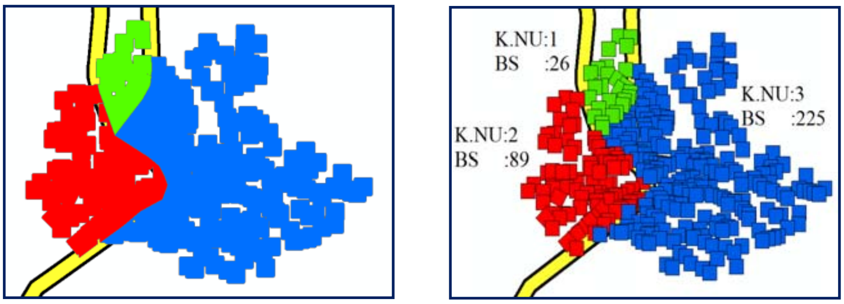


Figure 3. Grouping of buildings by taking into account the transportation network.

3.2. L&A Method at Building Typification

In order to develop the methods on building typification, simple patterns have been taken into consideration at first. An example of three buildings located side by side is taken as a simple pattern of building distribution and depicted at Figure 4. These three buildings at original scale (1:25K) overlap at derived scale (1:100K), due to the space covered by the symbols increased comparing with the actual area covered by the buildings in real world. It is apparent that the building in the middle should be eliminated when the typification of these buildings is the case.

(a) Original Scale *(b) Derived Scale* *(c) Building typification*

Figure 4. *Appearances of the building objects at original and derived scales.*

In this study the typification is carried out by means of two novel methods namely L&A methods. During the application one of them, which select proper number of buildings according to the rule designated by Topfer (1966), is chosen [1], [2]. The topic how they select is described below.

$$m_H < 100\,000 \qquad \Rightarrow \qquad n_H = n_K \sqrt{\frac{m_K}{m_H}} \qquad [1]$$

$$m_H > 100\,000 \qquad \Rightarrow \qquad n_H = n_K \frac{m_K}{m_H} \qquad [2]$$

m_H : Derived scale factor
m_K : Original scale factor
n_H : Number of features at derived scale
n_K : Number of features at original scale

3.2.1. Length Method

In similar cases, selecting the buildings farther to building groups' centers which they belong to and eliminating the buildings, whose symbols overlap the symbols of these selected buildings, has given cartographically encouraging results. This method described is called Length Method.

After the detection of building groups, following steps shown in Figure 5 should be pursued to implement the Length Method. This method performs the selection process correctly, preserves the dispersion and copes with the overlapping problem successfully (Figure 9).

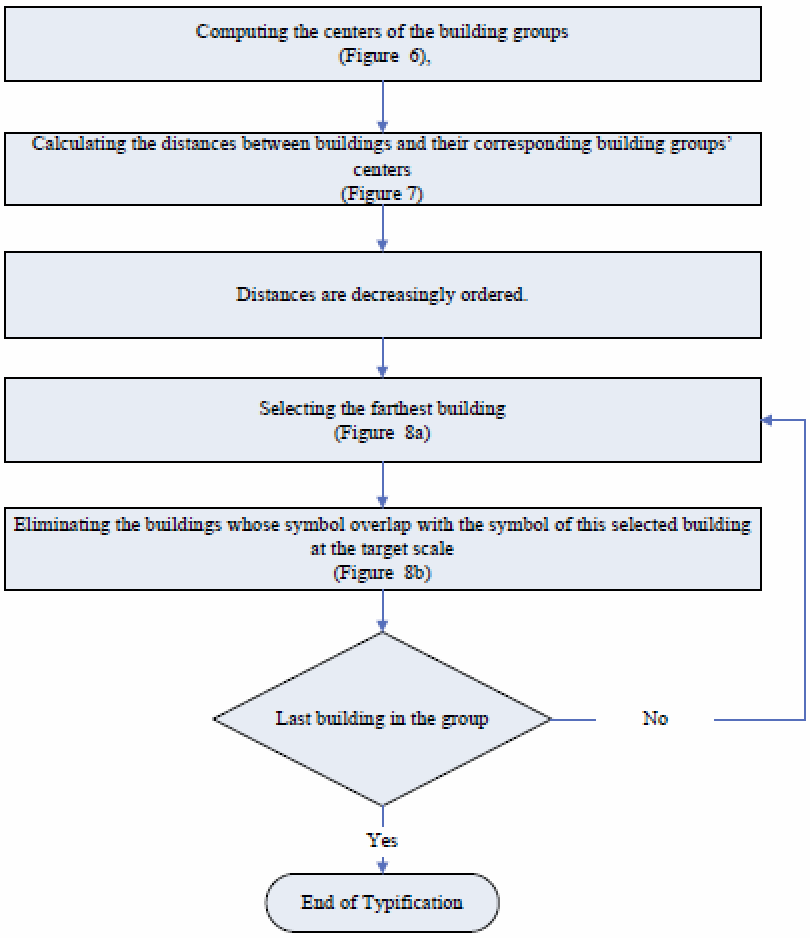


Figure 5. *Length method.*

Figure 6. *Blue point represent the centers of the building groups.*

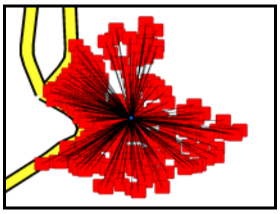
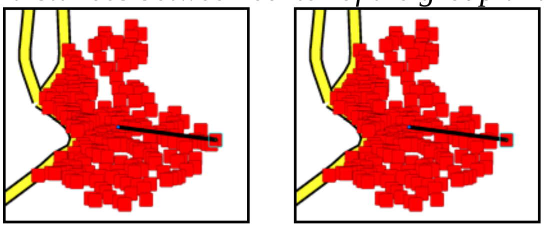


Figure 7. *The distances between center of the group and each building*



(a) (b)

Figure 8*. (a) Selecting the farthest building, (b) Eliminating the overlapped building*

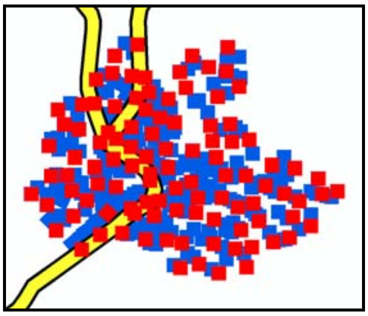


Figure 9*. Building typification with Length Method.*

3.2.2. Angle Method

The shapes that the building groups construct on the earth are mostly not simple geometric shapes. However the shapes of the building groups are desired to be preserved at the derived data through typification. In Figure 10, a building group of triangular shape is depicted. After the typification process, it is expected that the typified data preserve the triangle shape of building group at the derived scale.

Selecting the buildings at the corners of the building group and deleting the buildings whose symbols overlap the symbols of these selected buildings at derived scale, give the desired solution. This method is called Angle Method and follows the operation steps shown in Figure 11.

(a) Original Scale *(b) Selected Buildings* *(c) Typified Buildings*

Figure 10. *Typification of building group with triangle shape.*

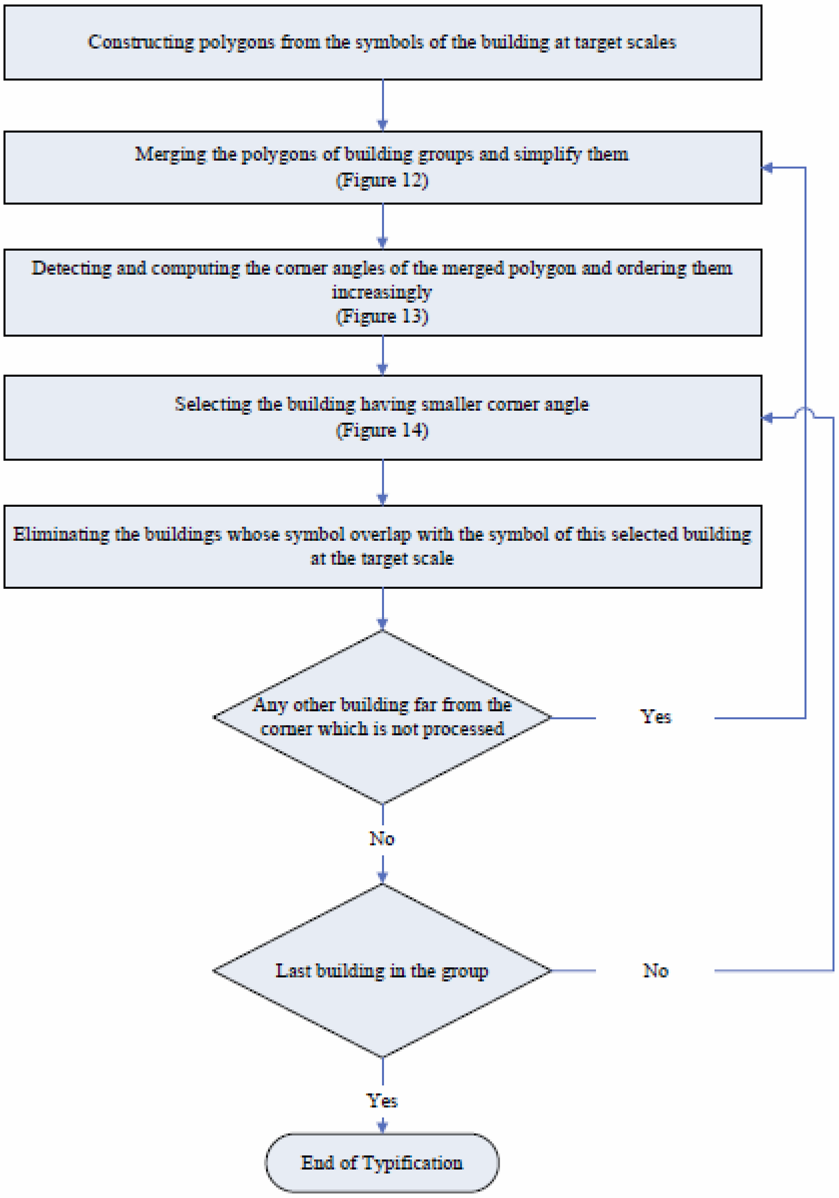


Figure 11. *Angle method.*

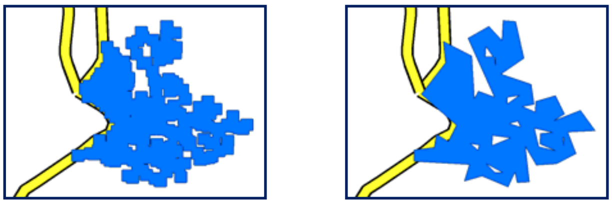


Figure 12. *Merging and simplification of the polygons derived from the building symbols.*

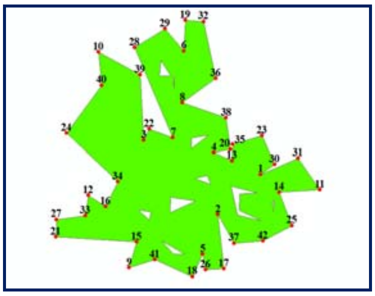


Figure 13. *Detecting the smallest corner angle*

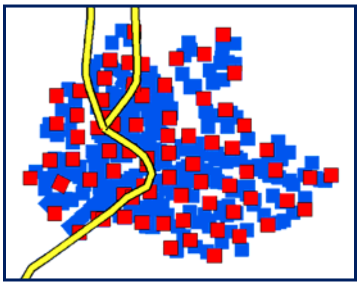


Figure 14. *Building typification with Angle Method.*

Applications including L&A methods are performed in five different 100K scaled maps and shown in Table 1. According to these results, selection process is carried out in a different time period in respect of the building numbers and gives a proper selection rates for these maps, as well.

Table 1. *The typification results of five maps.*

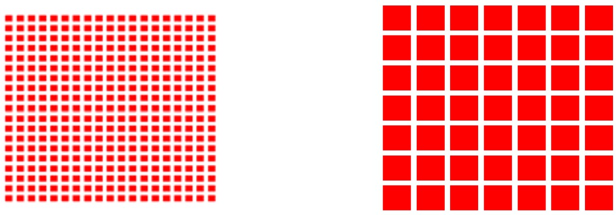
Maps (100K)	**Before the process (Building numbers)**	**After the process (Building numbers)**	**Selection Rate (%)**	**Duration (h:m:s)**
G41	52737	23683	44.91	04:09:44
H41	17824	5828	32.70	00:49:11
İ37	10906	3176	29.12	00:28:42
J40	6910	2551	36.92	00:21:46
J49	11697	4512	38.57	00:44:20

4. CONCLUSION

Through the generalization workflow, 1:50K and 1:100K scale STMs are derived from 1:25K based scaled STMs which have the same standards with 1:50K and 1:100K in Turkey. During the derivation process some congestion problems are raised up and several map generalization operators can be applied to resolve them, too. Particularly, generalization of buildings has a vital importance through this process.

In addition to the existing buildings having point geometries, most of the polygon buildings having smaller area values than the criteria are also transformed into point geometries via generalization. Since the symbol sizes are alike in 1:25K, 1:50K and 1:100K scaled STMs, the symbols overlap when depicted at smaller scales. This make typification of buildings is an inevitable process. In this paper two new approaches for the typification of buildings called L&A Methods are described.

Many researches have been developed for typification of buildings as mentioned in the second part however few of them are related with point geometries and none of them are concerned with the symbol sizes and scale factor. These deficiencies inspire us to develop L&A methods. By means of these methods, the typical pattern of the point feature is stored while removing some points and the symbol sizes according to the scale factor are taken into consideration. As well as they preserve the spatial pattern of building distributions of building groups having regular geometric shapes (Figure 15). Although the results of these methods are evaluated as quite encouraging and satisfactory for our derived map production line, the methods are applied only for the buildings having the same attributes and geometries. For the time being the two methods do not take into account the buildings having polygon geometries and different attributes. Researches are still being kept to cover those points.



(a) Original Scale *(b) Derived scale*

Figure 15. *Building typification.*

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