AUTOMATIC RECOGNITION OF BUILDING CLUSTER PATTERNS FOR SPATIAL SCALE TRANSFER

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Building patterns are salient urban and rural structures for map readers (e.g. urban geographers and tourists) to understand the organization, function, history and development of a city or city parts (Lévi-Strauss, 1963). To represent and preserve the patterns at various scales for different applications has always been a challenge for cartographers, as it requires knowledge and experience on the implicit patterns and also skills to generalize them. It is even harder for computers to automate the generalization of city maps where building patterns are one of the major structures, because the patterns are not explicitly stored in geospatial datasets. Therefore, automatic recognition of building patterns from geospatial data is required to better support the automated generalization of city structures.

Apart from its application in automated generalization and automated evaluation of generalization output, the recognized building patterns can be use to mine deeper geographic knowledge and to infer higher-level geospatial semantics (e.g. terraced house in Lüscher et al., 2009).

This paper studies how to recognize building patterns from existing spatial datasets that contain huge amounts of information and knowledge being either explicitly and, as in the case of building patterns, implicitly encoded. A challenge is to find ways to make this implicit knowledge explicit. This work analyses both ungeneralized and interactively generalized data to convert the important characteristics on building patterns into computer understandable format.

Previous research initiatives on recognizing building patterns for automated map generalization limited themselves on only a few specific patterns. For example, collinear alignments have been extensively studied (e.g. Boffet & Serra, 2001; Christophe & Ruas, 2002; Ruas & Holzapfel, 2003); grid pattern (Anders, 2006) was shown to be detectable based on a relative neighbor graph. These studies confirm on the one hand the importance of building patterns on topographic maps – indeed, salient building patterns are required to be preserved during the generalization process while unnecessary details can be removed. On the other these previous research shows that further investigation is required to characterize and detect other types of building patterns (e.g. other linear and nonlinear patterns) that can be found on topographic maps (and in the physical world).

In this work, the authors firstly propose a typology of the typical building patterns. The typology is based on the study of the cartographic data and literature and is also based on the theory of visual perception, consisting of collinear, curvilinear, align-along-road, grid-like, and unstructured patterns. All these building patterns are characterized in order to enable the quantification and qualification of the recognized patterns. Then, starting from this typology, this paper presents a method that automatically recognizes and characterizes various types of building patterns in real data.

The automatic recognition method is briefly described as follows.

Basic computational models are Delaunay triangulation and Minimum Spanning Trees (MST). The former is a widely used structure in automated generalization to represent spatial proximity between objects and to model contextual knowledge such as orientation and distance relationships. In our approach, the result of applying Delaunay triangulation is a proximate graph where vertices represent individual buildings and edges connect those proximate buildings. By cutting those locally inconsistent edges (Zahn, 1971) from the MST of the previously obtained graph, the buildings become distinguishable clusters.

The focus of the recognition method is on further refining the clusters to the detection of different types of building patterns. The underlying idea is to integrate Gestalt principles of visual perception (Wertheimer, 1924) into the recognition process. In this method, the principles like proximity (e.g. spacing), similarity (e.g. size, orientation, shape) and good continuity (e.g. straightness, smoothness) are realized through computational procedures.

The proposed method was tested against real topographic datasets and the recognition results are promising. Meanwhile, the quality of recognized building patterns are discussed and illustrated according to their measured characterizations.

As a conclusion, the proposed method is an effective way to recognize building patterns in geospatial vector data. Although some other methods are also appropriate for recognizing certain types of patterns, this work provides firstly a more generic framework that identifies a pattern typology, and then a more extensive method that can recognize and characterize additional pattern types. The recognized building patterns can be applied in the fields of automated map generalization and spatial data mining.

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