Automatic Delineation of Urban Blocks from Topographic Maps

Sebastian Muhs*, Gotthard Meinel*, Dirk Burghardt**

* Leibniz Institute of Ecological Urban and Regional Development, Dresden, Germany
** Institute for Cartography, Technical University of Dresden, Germany

Abstract. Large-scale, ex-post analyses of urban dynamics on base of time series is of significant relevance for evaluating the success of settlement policy goals. Of particular interest are urban blocks, streets, and buildings representing elementary objects of urban structure. Digital data about urban structure in Germany, at the level of urban blocks, have been supplied comprehensively since 1997 by the ATKIS® Basis DLM Stage 1. However, to assure the meaning of those time series analyses, data from earlier time periods are necessary. To supply these, we present an object-based concept for an automated delineation of urban blocks from topographic maps at a scale of 1:25,000, which have been proven as an alternative for a comprehensive study of urban structure of pre-digital times at low cost, using techniques of digital image processing. Moreover, this approach corresponds with the worldwide trend to digitize knowledge that can also be observed with topographic maps. The approach has been developed using the binary base layer (black layer) of the German raster-based digital topographic map DTK25-V. It contains elementary objects of the urban structure in addition to border lines in general, symbols, fonts and digits. Following the Anglo-American definition of an urban block as smallest entity of (built up) plots bounded by street lines, the delineation of urban blocks from maps arises from the depiction of the street network. Instead of street lines, an urban block can also be enclosed by other topographic borders such as railways for trains or trams, rivers, tracks, or parcel plots. According to this definition, an urban block´s outline can be modeled geometrically as a closed

polygonal line. In turn, closed polygonal lines can be transformed to polygons and therefore to area objects. In consequence, the algorithm for an automated delineation requires explicitly the separation of urban-block objects as well as the geometrically correct plotting of the blocks as closed polygonal line. However, both requirements are usually not fulfilled for the whole map. The competing use of those different content layers of the base layer can result in an overlap of information with regard to plotting. According to the cartographic model and the priority of the overlapping content compared to the urban structure layer, this can result in joining of single urban blocks or the fragmentation of one block into multiple pieces due to exemption. Therefore, it is necessary to recognize and remove joining and exempting map elements (interfering objects) using knowledge-based rules. The actual delineation of the urban block is achieved by a three-step algorithm. In a first step, all objects of the remaining map content are transformed to polygons using a region fill method. Then the polygons are evaluated in terms of plausibility regarding a given geometric model for urban blocks (form, size, etc.) with erroneous and unconnected fragments of the urban block structure remaining. In a second step, these are tested for the possibility of gap closing for up to two fragments followed by the block evaluation module. This way, a temporary block structure is obtained and given the urban block definition, a simplified copy of the street network can be determined by calculating the inverse of the block structure. This network, in turn, can be used to recognize and correct erroneously closed objects or to indirectly identify not yet closed blocks by a network tracking/correction module. Results of our approach are presented and discussed for three case study maps of Dresden, Hannover and Krefeld.

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