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Focusing on individual buildings within urban contexts through generalisation levels: an interdisciplinary approach to the visualization of 3D-city models

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Abstract:

To support architectural-historical research on the spatial impact of historic transformation processes within an urban context, a visualization approach was developed in an interdisciplinary team (architecture, 'Baukultur' and geovisualization). Regarding the time dimension, a representation of the same urban focus area before and after the construction of specific buildings was developed. The visualization approach aims to ensure the independence of influencing factors such as the terrain or specific building combinations so that it can be transferred to other urban areas of interest. Exemplary areas with different terrain, different functional areal and building (re)use, and contexts were selected for illustration. The defined visualizations create a useful representation of a city section with a special focus on selected buildings in the context of their immediate urban surroundings. The implementations find a sensible balance between the necessary depth of detail and the lowest possible data volume.

Adequate representations of 3D city models are becoming more important with the increasing availability of 3D data at different levels of detail (LOD) (Kada, 2011). However, detailed 3D city model representations comprise large amounts of data but, depending on the application, such high levels of detail may not be necessary and more generalised representations are useful. Trapp et al. (2008) showed approaches and visualization proposals for the generalisation of city districts as well as the gradation of different levels of detail and generalisation in an urban context (Trapp et al., 2008; Trapp, 2013). They used so-called lenses in their visualizations. Each lens represents a level of generalisation which directs the viewer's attention to the focus region, i.e., the model inside the lens, and at the same time maintains the context information, i.e., the model outside the lens (Trapp et al., 2008). Besides the detailed building information, roads, rivers, or other infrastructure networks can be used to group individual buildings into blocks to create different levels of generalisation (Glander & Döllner, 2008). Also buildings can be abstracted by using extrusions of floorplans (Greuter et al., 2003). In addition to the generalisations, so-called landmarks are important. Landmarks, like churches, bridges, or squares, make it easier to find your way around space (Trapp et al., 2008). In addition, linear infrastructures such as roads and rivers can also help the viewer to mentally structure the city (Lynch, 1996).

Including historical aspects in 3D visualizations is more difficult, as geometric data of historic buildings are rarely available. But analogue plans and photos from archives may be used. Based on this information, reconstruction of the buildings is attempted and, depending on the information available, more or less detail can be visualized (Lin et al., 2023). Simple geometric shapes are used to coarsely recreate the former building stock. Interdisciplinary discussions showed that strong generalisation is acceptable for historic settings but building or building complex features that are important for the architectural and functional analysis need to be shown or indicated. An abstracted representation is not a 1:1 representation of reality, but still enables the visualization of the buildings, their surroundings, and their functions at the time. Based on the approach of Trapp et al. (2008) and interdisciplinary discussions regarding the aim of the visualizations, three different levels of detail were developed to represent the highly detailed buildings, generalised buildings and perimeter blocks defined by streets. A range of buildings designed by the Swiss architectural office Suter & Suter serve as application examples in the city of Basel and other selected building sites were implemented in other cities to ensure the transferability and independence of the approaches. The buildings in Basel were newly constructed in the 1960s and 1970s, replacing historical building stock. They are in heterogeneous terrain and characterize their surroundings in functional and urban planning terms. Figure 1 shows a snippet of an exemplary implementation in a browser-based interactive application.

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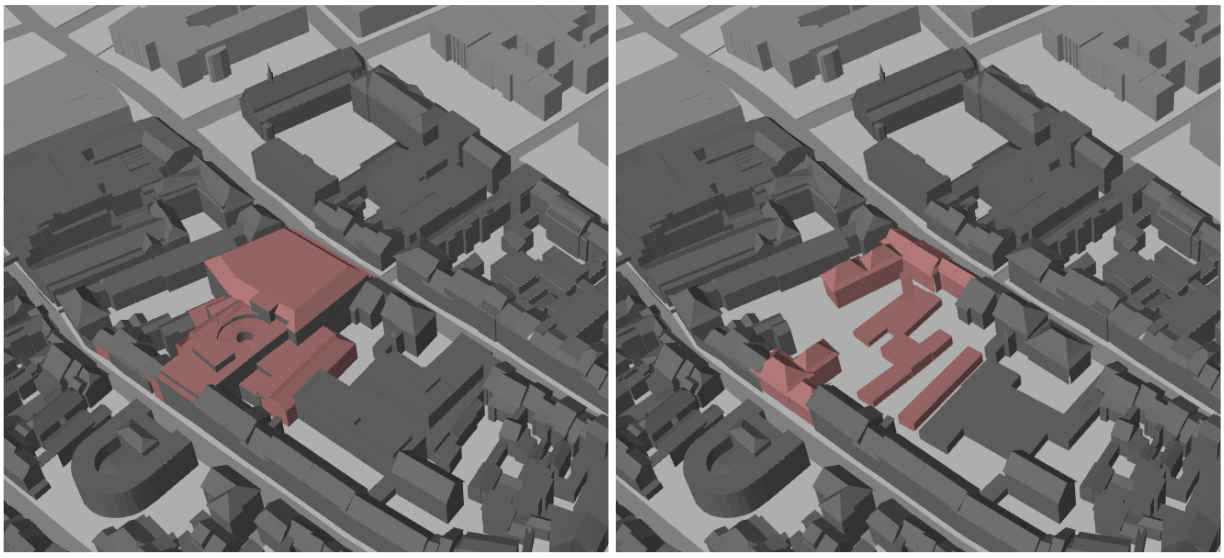

Figure 1. Left: Visualization of the Jelmoli building in Rebgasse, Basel in 2023
with architectural colour concept and different levels of generalisation in focus and context areas.
Right: Context-based coarse reconstruction of the urban context before 1960

The implemented visualizations showed that, despite the interactive application and large amounts of data, a focus can be set on specific buildings while still indicating the important contexts of the immediate surroundings and the entire city. The colour coding as well as the different levels of generalisations visually guide viewers to the area of interest. The integration of contextual information (e.g., landmarks) in more detail helps navigation for viewers with city knowledge. The interdisciplinary discussions have shown that the highest level of detail is not always necessary for representations even though this is often the first approach when detailed data is available. Our visualizations show selected areas and objects in detail and generalise the surroundings and the wider city context. The transferability of the approach to other focus areas on different terrain and different city block structures has exemplarily been tested.

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References

Glander, T., & Döllner, J. (2008). Techniques for Generalizing Building Geometry of Complex Virtual 3D City Models. In P. Van Oosterom, S. Zlatanova, F. Penninga, & E. M. Fendel (Eds.), *Advances in 3D Geoinformation Systems* (pp. 381–400). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-540-72135-2_21

Greuter, S., Parker, J., Stewart, N., & Leach, G. (2003). Real-time procedural generation of `pseudo infinite’ cities. *Proceedings of the 1st International Conference on Computer Graphics and Interactive Techniques in Australasia and South East Asia*, 87. https://doi.org/10.1145/604471.604490

Kada, M. (2011). Aggregation of 3D Buildings Using a Hybrid Data Approach. *Cartography and Geographic Information Science*, *38*(2), 153–160. https://doi.org/10.1559/15230406382153

Lin, Y., Li, J., Porr, A., Logan, G., Xiao, N., & Miller, H. J. (2023). Creating building-level, three-dimensional digital models of historic urban neighborhoods from Sanborn Fire Insurance maps using machine learning. *PLOS ONE*, *18*(6), e0286340. https://doi.org/10.1371/journal.pone.0286340

Lynch, K. (1996). *The image of the city*. The MIT Press, Massachusetts Institute of Technology.

Trapp, M. (2013). *Interactive Rendering Techniques for Focus+Context Visualization of 3D GeoVirtual Environments*.

Trapp, M., Glander, T., Buchholz, H., & Döllner, J. (2008). 3D Generalization Lenses for Interactive Focus + Context Visualization of Virtual City Models. *2008 12th International Conference Information Visualisation*, 356–361. https://doi.org/10.1109/IV.2008.18