Rendering 3D City for Smart City Digital Twin

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Abstract

3D city modelling has attracted a growing interest for representing the city digital twin, providing interactive visualizations of building infrastructures integrated with a wide range of data typically produced in a Smart City environment. The main goals are not only to provide a more immersive visualization experience of the city, but also to enhance and improve the decision making processes based on the analysis of urban data. This work presents a method for producing a 3D city model with photorealistic rooftop textures extracted from aerial images, as well as the integration of the 3D city model into an open-source Smart City framework.

Main contributions

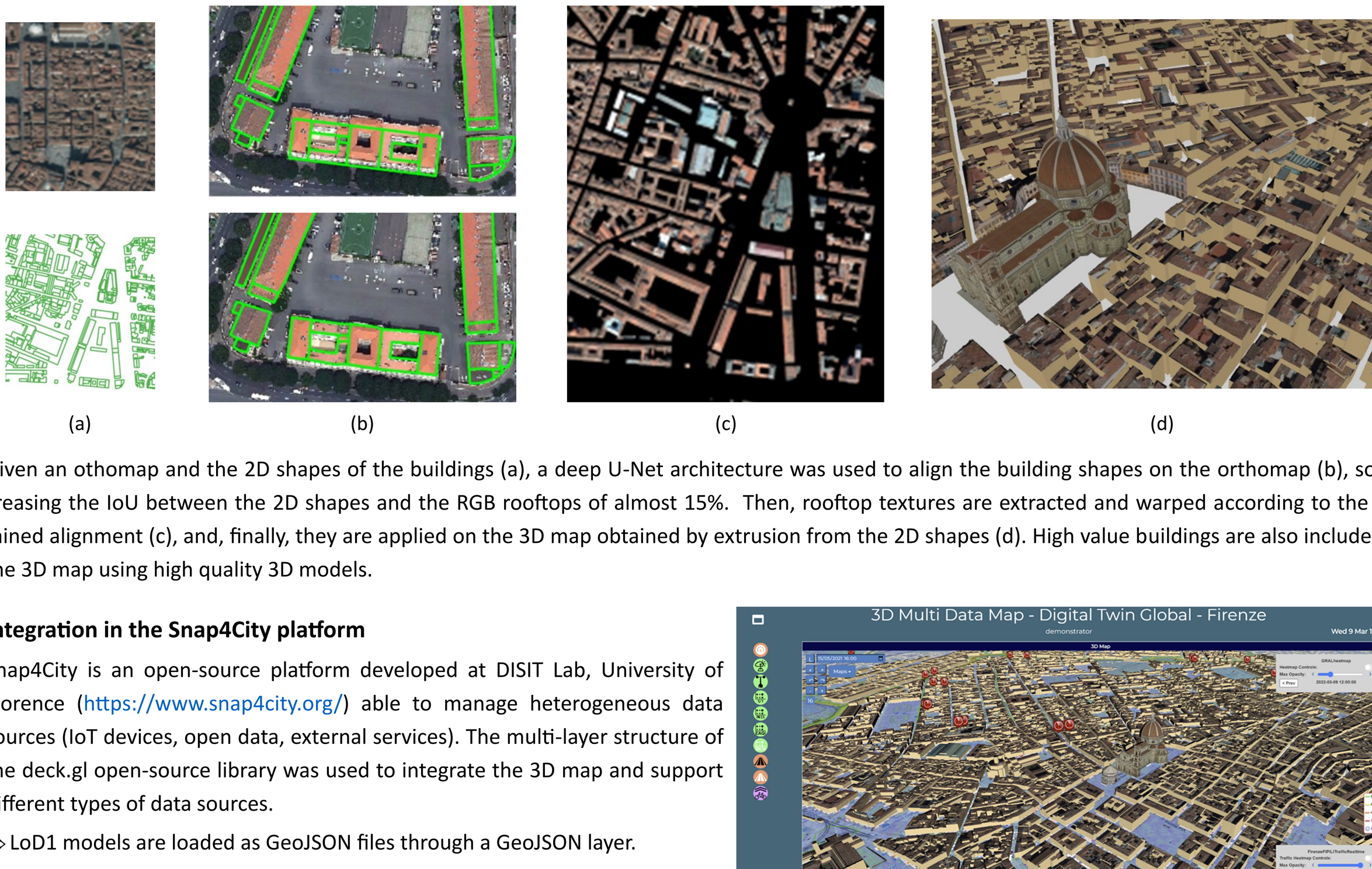
⇒ production of a full functional 3D map with LoD3 model support by creating a LoD2 building models from a LoD1 building type enriched with rooftop textures, with the possibility to pick single city elements or buildings on map, and inspect their data and attributes.

⇒ the integration of the 3D map into a Smart City framework (the open-source Snap4City platform), in order to provide a smart environment and applications for visualizing city entities and IoT related data.

Requirements

1) production of a photorealistic 3D city model as an interactive map.
2) the map must support the retrieval and visualization of the many different data sources collected in the Snap4City Smart City platform.
3) LoD1, LoD2, LoD3 building types support.
4) WMS support.
5) customizable orthomap.

3D Map Texturing



(a) (b) (c) (d)

Given an othomap and the 2D shapes of the buildings (a), a deep U-Net architecture was used to align the building shapes on the orthomap (b), so increasing the IoU between the 2D shapes and the RGB rooftops of almost 15%. Then, rooftop textures are extracted and warped according to the obtained alignment (c), and, finally, they are applied on the 3D map obtained by extrusion from the 2D shapes (d). High value buildings are also included in the 3D map using high quality 3D models.

Integration in the Snap4City platform

Snap4City is an open-source platform developed at DISIT Lab, University of Florence (https://www.snap4city.org/) able to manage heterogeneous data sources (IoT devices, open data, external services). The multi-layer structure of the deck.gl open-source library was used to integrate the 3D map and support different types of data sources.

⇒ LoD1 models are loaded as GeoJSON files through a GeoJSON layer.

⇒ LoD2 models are deployed with the SimpleMeshLayer using OBJ files.

⇒ LoD3 models uses the SceneGraphLayer loading glTF and GLB files.

Conclusions and future work

A system for implementing a 3D city model with photorealistic texture integrated into a Smart City framework has been presented. The roof texture extraction follows a deep learning approach based on U-Net to detect the rooftops from orthomaps and align them with 2D building shapes. The solution is implemented in the open-source Snap4City platform as a multi-layer 3D map.

As a future work, an automatic procedure to apply photorealistic texture also to building facades is going to be developed.

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SNAP4CITY