Geophysical Research Abstracts
Vol. 21, EGU2019-4888-1, 2019
EGU General Assembly 2019

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article

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January 10, 2019

Abstract

Large-scale Urban Building Energy Modelling (UBEM) is a nascent field. Local governments are increasingly interested in these models in order to support the development of strategies for energy efficiency and district-level intervention. They are motivated to reach the targets of energy consumption reduction and resource efficiency stipulated by their national authorities. The potential of UBEM lies in the hourly estimation of energy and water demand for each building in an urban area and the possibility to evaluate different scenarios. A major obstacle in the wide-spread use of UBEM is the difficulty to obtain the necessary building information, such as three-dimensional, watertight building envelops and building systems. Previous UBEM efforts have resulted in the utilization of a low Level of Detail (LoD), as well as the application of labor-intensive and propitiatory methods/data, respectively.

In this study, we propose a workflow to automatically generate a city model with LoD3, including explicit roof and fenestration information. The workflow employs publicly accessible tools and data. Public Light Detection and Ranging (LiDAR) point clouds are combined with building footprints from OpenStreetMaps (OSM) to derive a detailed geometry of the buildings. A watertight mesh of the roof is created by the Screened Poisson surface reconstruction algorithm from an oriented and unstructured point cloud, which had initially been denoised. The region growing method subsequently simplifies and smooths the mesh. Convolutional Neural Networks (CNN) are used to identify the building archetypes according to the EU TABULA project based on aerial urban photographs. The EU TABULA project assessed the European building stock and created national residential building typologies with information on materials, construction, windows, thermal transmittance, heating, ventilation, and air conditioning (HVAC), etc. The fenestration surfaces are recognized by the means of an iterative parsing approach applied on aerial urban photographs. This workflow provides the necessary building information for Building Energy Modelling (BEM), such as the US DOE EnergyPlus simulation program. The German city of Aachen with its approximate 40.000 residential buildings has been chosen for a case study. Lack of a sizeable training set to classify the buildings according to building archetypes remains a considerable challenge.

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