Artificial Intelligence based Building Attributes Enrichment in OpenStreetMap using Street-view Images

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Abstract:
OpenStreetMap (OSM) is a Volunteered Geographic Information (VGI) project aiming to create a worldwide base map accessible for everyone. Building information in OSM includes geometric information such as location and shape and semantic attributes such as height, age, type, material, ownership, and more. In recent years, due to the increasing quantity of remote sensing images and the rapid development of deep learning techniques, buildings have been detected, segmented, vectorized, and mapped from local to even global scales (Li et al., 2020, Li et al., 2022), which will greatly contribute to the enrichment and upgrading of OSM. However, these studies predominantly focus on geometric shapes and hardly attend to the semantic attributes of buildings. Using convolutional neural networks, Kang et al. (2018) conducted pioneer work that classifies building instances from street-view images. Hoffmann et al. (2023) recently employed social media images to classify building functions in 42 cities, demonstrating the semantic mapping potential utilizing street-level data on a large scale. However, both works deal with only building functions. Street-view images contain rich attribute information on buildings. For instance, texts indicate building functions, numbers mark house numbers and occasionally the construction years, and signs, such as red crosses, convey crucial messages beyond the linguistic barrier. All the above information, if properly extracted and mapped, will enrich OSM building attributes and enhance the realization, operability, and management of cities.

This work aims to improve OSM building attributes using street-view images. As OSM data are open and street-level photos can be taken with standard cell phones, our approach is neither geospatially restricted nor economically discriminated. In addition, crowdsourced platforms, such as Flickr, Unsplash, and Mapillary, provide huge amounts of street-view images that contain valuable building attribute information. We seek to facilitate open data and citizen science and encourage people to map for their communities.

Figure 1. Example results of 6 buildings on Graham Road, Cape Town. (left) Information recognized (shown in yellow boxes) from street-view images and mapped on OSM by location. (right) Extracted building information and attributes for OSM enrichment.
Our method extracts information from street-view images and subsequently maps them to corresponding OSM building footprints. The developed workflow comprises three parts: first, information recognition from street-view images using the state-of-the-art deep neural networks; second, information clustering to categorize extract information to pre-defined attribute classes; and finally, information integration into OSM building footprints to enrich the semantic attributes. Figure 1 shows examples of our results, in which semantic information is recognized by neural networks from street-view images (shown in yellow boxes) and mapped to 6 buildings on Graham Road, Cape Town, where building information is missing in OSM (the base map).

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References


