International Cartographic Association
Association Cartographique Internationale

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

Yao Sun [a,*], Stefan Auer [b], Liqiu Meng [c], Xiao Xiang Zhu [a]

[a] *Data Science in Earth Observation, Technical University of Munich, Germany, yao.sun@tum.de, xiaoxiang.zhu@tum.de*
[b] *Remote Sensing Technology Institute, German Aerospace Center, Germany, stefan.auer@dlr.de*
[c] *Chair of Cartography and Visual Analytics, Technical University of Munich, Germany, liqiu.meng@tum.de*
* Corresponding author

Keywords: OpenStreetMap, Building Attributes, Street-view Images, Artificial Intelligence

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.

#	Information Extracted	Attributes Mapped
1	43	House number
2	Migdal	Building name
3	VICTORY COURTE	Building name
4	B&B	Function: hotel
5	PUNTA DEL MAR	Building name
6	Deauvilla	Building name
	SKY RIDERS PAINTING WATERPROOFING	Other

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.

Abstracts of the International Cartographic Association, 6, 250, 2023.
31st International Cartographic Conference (ICC 2023), 13–18 August 2023, Cape Town, South Africa.
https://doi.org/10.5194/ica-abs-6-250-2023

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).

Acknowledgements

The work is jointly supported by the German Research Foundation (DFG) under the grant ZH 498/14-1 and ME 1846/16-1 for the project OpenStreetMap Boosting using Simulation-Based Remote Sensing Data Fusion (Acronym: OSMSim) and by the Technical University of Munich (TUM) Georg Nemetschek Institute under the project Artificial Intelligence for the automated creation of multi-scale digital twins of the built world (Acronym: AI4TWINNING).

References

Li, Q., Mou, L., Hua, Y., Sun, Y., Jin, P., Shi, Y. and Zhu, X.X., 2020. Instance segmentation of buildings using keypoints. In IEEE International Geoscience and Remote Sensing Symposium (IGARSS) 2020.

Li, Q., Mou, L., Hua, Y., Shi, Y. and Zhu, X.X., 2022. CrossGeoNet: A Framework for Building Footprint Generation of Label-Scarce Geographical Regions. International Journal of Applied Earth Observation and Geoinformation, 111, 102824.

Kang, J., Körner, M., Wang, Y., Taubenböck, H., & Zhu, X. X. 2018. Building instance classification using street view images. ISPRS journal of photogrammetry and remote sensing, 145, 44-59.

Hoffmann, E.J., Abdulahhad, K. and Zhu, X.X., 2023. Using social media images for building function classification. Cities, 133, 104-107.