Chair of Computational Modeling and Simulation
TUM School of Engineering and Design
Technical University of Munich

Modeling:
Mathematics:
Programming:
Science:

Software Lab:

PC2LCA: Reconstructing point clouds and enriching images for retrofitting

Description

To enable the effortless creation of this information for a large building stock, a robust methodology to automatically create semantically rich 3D models for calculating the life cycle assessments (LCA) of retrofitting variants based on different input data. Robustness is achieved by providing flexibility towards input data; geometric reconstruction can be performed based on different data sources; point clouds from single sources or merged from heterogeneous sources, such as airborne or mobile laser scans, UAV-based photogrammetric point clouds, or using other, readily available 3D representations, i.e. in the form of building models provided by services such as Google Maps. Similarly, various image sources shall be used as input for further semantic enrichment beyond geometric aspects: Surface material and window detection should be investigated using state-of-the-art conventional and AI-based methods, taking manually acquired images, UAV-based images, or Google Street View images into account. In the final step, geometric and semantic information needs to be aggregated in a structure matching the requirements of actual tools for LCA calculation. In this project, this will be achieved through the creation of a JSON file ready for input in the CAALA software to calculate embodied and operational emissions.
The overall goal of this project is to implement an automated workflow of different steps of geometric reconstruction and semantic enrichment based on existing tools and packages and create semantic enriched 3D models as input for existing LCA tools.

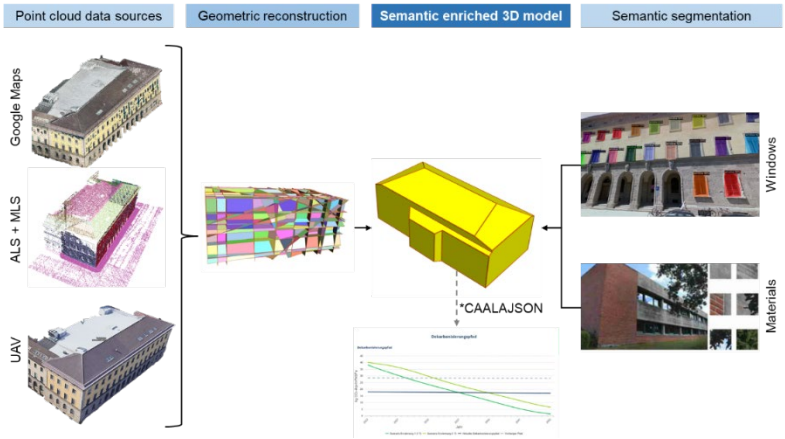

Figure 1: From Pointclouds (left) and images (right) to semantic enriched 3D models for LCA

Task

GENERAL INSTRUCTIONS:

- Perform a literature review to identify state-of-the-art ML and heuristic-based methods for the required steps (semantic and instance segmentations of windows and facades, material detections, and geometric reconstruction).
- Design an end-to-end workflow and implement it by bringing together existing solutions for individual steps and your own code.
- Test and validate the implementation with case study buildings of TUM Stammgelände

Supervisor

Kasimir Forth & Florian Noichl, Chair of Computational Modeling and Simulation

References

[1] Selimovic, E.; Noichl, F.; Forth, K.; Borrmann, A.: Retrofitting Potential of Building envelopes Based on Semantic Surface Models Derived From Point Clouds. Journal of Facade Design and Engineering 10 (2), 2022, 127-139