Chair of Computational Modeling and Simulation
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Modeling:
Mathematics:
Programming:
Science:

Software Lab:

Tri-modal Point Clouds for Digital Twin Enrichment

Description

Point clouds and conventional RGB images, are intensively investigated as data to create, and enrich Digital Twins (DT) with as-is information and maintain their value across the building lifecycle. Complementary to the two data modes, thermography captures the infrared light spectrum, giving insight into the temperature distribution on an object's surface, and allowing a diagnosis of the as-is energetic health of buildings beyond what humans can see. Computer Vision (semantic segmentation) has led to an increased amount of recognized semantic building elements. Major structural elements (wall, slabs etc.) can be extracted from point clouds [1] and smaller objects (fire detector, signs etc.) can be detected in images [2]. The power of sensor fusion allows to 1. use detected semantics from one source to better understand a second source (e.g. thermographic images are better understood with RGB contours) or 2. increase the amount of recognized building elements in the Scan-to-DT pipeline (pipes can be distinguished as "supply" vs. "return" temperature), see Figure 1.
We have built a custom tri-modal sensor system to acquire feature-rich point cloud data. In this SWL you will work with this system (see Figure 2) to acquire data and leverage semantic segmentation across sensor modes. The goal is to investigate the recognition and reconstruction of the following subtypes: Walls (exterior, interior, load-baring, partitioning...), Pipes (supply, return, …), Electronics (cables, …) (see Figure 1).

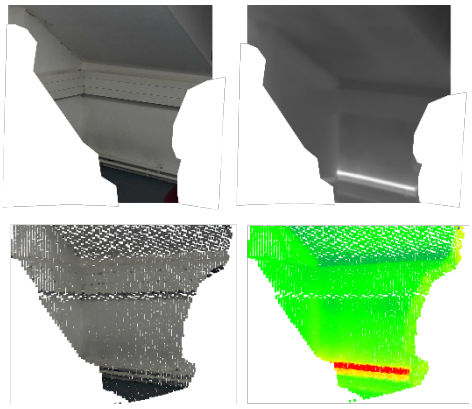

Figure 1: RGB and TIR image modes (top row), enriched point cloud (bottom row). The semantics of the thin pipes can be detailed as supply vs. return.

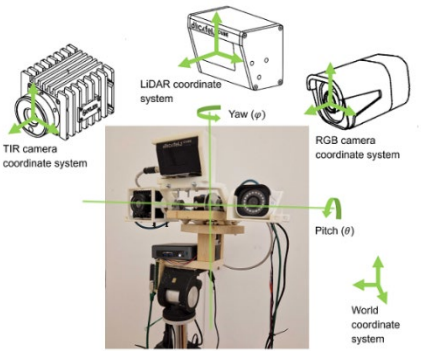

Figure 2: Tri-modal scanning: Setup

Task

- Literature review on benefits of thermography for increase level of detail in Scan-to-DT
- Familiarize with **LiDAR, RGB, and Thermal Infrared** sensors.
- Understand and improve the **sensor fusion**.
- Deploy **semantic segmentation** (e.g., PointNext) on point clouds or images (e.g., Mask_RCNN) across sensor modes.
- Acquire data and **reconstruct** primitive shapes for subtypes.

Supervisor

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References

[1] Mehranfar, M., Braun, A., Borrmann, A., 2023. Automatic creation of digital building twins with rich semantics from dense RGB point clouds through semantic segmentation and model fitting. Proc. of the 30th Int. Conference on Intelligent Computing in Engineering (EG-ICE).

[2] Pan, Y., Braun, A., Brilakis, I., Borrmann, A., 2022b. Enriching geometric digital twins of buildings with small objects by fusing laser scanning and AI-based image recognition. Automation in Construction, 140(0926-5805), 104375