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

Master Thesis Proposal

BIM-based 3D LiDAR and Image Place Recognition

The increased usage of LiDAR sensors for mobile robotic applications creates unforeseen opportunities for accurate 3D mobile mapping. On the other hand, the growth in digitalization in the built environment contributes to the creation of digital twins in almost every building and city, making 3D digital models available for most of the current architecture.

These two aspects raise the question of how a system could automatically capture aligned 3D data leveraging a georeferenced digital representation of a facility.

While many systems focus on outdoor environments for place recognition (e.g., with the KITTI dataset), there are only a few studies on indoor GPS-denied environments for the same task using digital models.

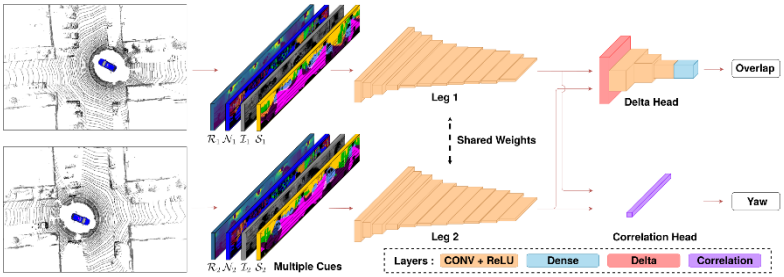

Figure 1. Pipeline overview of OverlapNet: A Siamese Network for Computing LiDAR Scan Similarity with Applications to Loop Closing and Localization (Chen et al., 2021)

Whereas in most outdoor environments, the initial position of the sensor could be retrieved using a GPS, in indoor spaces another source of information is mandatory. Additionally, symmetric spaces and heavily cluttered indoor buildings rise the complexity of the problem. Furthermore, current state-of-the-art algorithms usually use dense, heavy point clouds as a reference map to localize the sensor, rather than a light 3D mesh representation of the environment such as a BIM or a GIS model.

This thesis aims to develop a method that uses BIM models to localize the sensors (LiDAR and Camera) quickly and accurately, with and without information about its initial approximated position.

Task

1. Literature review on the state-of-the-art place recognition methods.
2. Implementation of a suitable workflow that:
   - Integrates not only LiDAR but also cameras to find the correct pose of the sensor in the BIM model.
   - Couple the developed method with an existing LiDAR Visual Odomety algorithm.
3. Evaluation of the algorithms in real and simulated data.

You have:

Programming skills (C++ or Python) and motivation to develop a fast system for accurate localization.

As a plus: Experience with SLAM, ROS, and deep learning frameworks (e.g., PyTorch, Tensorflow).

Supervision

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