Chair of Computing in Civil and Building Engineering
TUM School of Engineering and Design
Technical University of Munich

Master's Thesis Topic

A Comparison of Graph-Based Task Allocation and Assignment for Robotic Construction: Properties vs Knowledge

Construction robotics is an attractive research area, integrating technologies such as Building Information Modeling, Artificial Intelligence, and Additive Manufacturing into task execution. Limited attention is paid, however, to the question of which robot performs what task, in other words task allocation. Not all robots have the same capabilities, or might perform better in some, worse in others. Finding the best match for a given task is therefore an optimization problem. This thesis proposes to model the task allocation process using graph-based representations, comparing property graphs and knowledge graphs as frameworks for reasoning and optimization. The comparison can focus on e.g., inference capabilities, flexibility, or query complexity.

Problem Statement

- Most construction robotics research emphasizes execution, while higher-level decision-making such as allocation and assignment remains underexplored.
- Existing sources like BIM are not structured to directly support robotic task allocation, requiring transformation into richer representations.
- Existing task allocation methods rely on fixed rules or optimization. Graph-based representations may enable richer reasoning and adaptation to changes such as robot failures, shifting requirements, or new tasks.
- The literature largely addresses single-task specialized robots, with limited attention paid to heterogeneous or multi-purpose robots.

Preliminary Research Questions

1. How can task allocation in construction robotics be modeled using graph-based representations?
2. What are the differences in expressiveness, reasoning capabilities, and adaptability between property graphs and knowledge graphs for task allocation?
3. How do property graphs and knowledge graphs compare in terms of query complexity, computational efficiency, and scalability for allocating tasks?
4. Can graph-based task allocation support heterogeneous or multi-purpose robots more effectively than current approaches?

Related Works

- https://doi.org/10.1016/j.aei.2022.101838
- https://doi.org/10.1016/j.autcon.2021.103778
- https://doi.org/10.1016/j.autcon.2024.105426

Requirements and Eligibility

Students applying for this topic should have a decent understanding of graph modelling, as well as fundamental coding skills. Successful participation (i.e.,grades better than 2.3) in the modules *Semantic Modeling of Built Facilities* and *Engineering Databases*, and/or *Professional Software Development/Engineering* are expected.

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