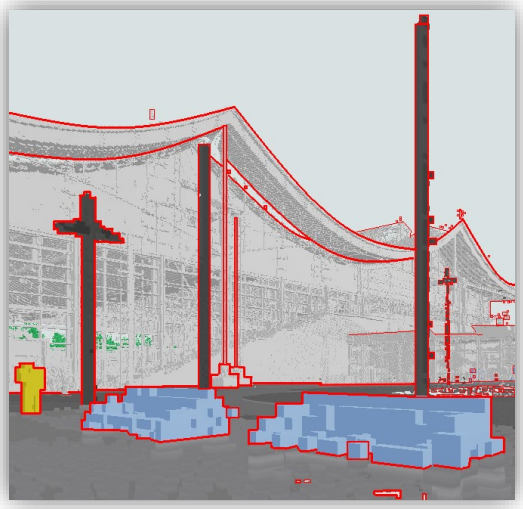
Dynamic Urban Digital Twin Representation via Spatio-Temporal Voxel Meshing.

Master thesis at ikg (language: EN)

Introduction



Urban digital twins are virtual models that integrate real-time data to simulate and analyze cities, providing valuable insights for urban planning, traffic management, environmental monitoring, and disaster response. A common approach for creating these 3D models is voxel-based representation, where urban environments are represented by small cubic units (voxels). While offering high resolution, updating such detailed models in real time can be computationally expensive, especially for large urban areas. In highly detailed voxel models, updating each individual voxel—such as in a 10 cm resolution grid—can become inefficient, especially when many areas of the city remain stable over time.

To address this challenge, this thesis proposes an approach using spatio-temporal voxel meshing for dynamic urban digital twins. Rather than updating each voxel individually, the method combines neighboring voxels into larger, puzzle-like surface segments representing stable parts of the city. These units require updates only when changes occur, such as new buildings or modifications to roads, reducing computational load. When changes are detected, the larger puzzle is broken down and reorganized to reflect the updated environment, while preserving the information, attributes, and semantics of each individual voxel. This ensures that the model remains accurate and consistent even as it is restructured, enabling real-time updates without the need for constant individual voxel processing. This approach offers a more efficient and scalable way to represent the dynamic, evolving state of cities in 3D, making real-time urban modeling more feasible.

Tasks

1. Review relevant literature.
2. Conduct a spatio-temporal analysis of voxel data across different timestamps.
3. Develop an approach for voxel union and disassembling according to their spatio-temporal characteristics, attributes, and semantics.
4. Visualization and evaluation of the results.
5. Prepare the documentation and write the final report

Resources

3D voxel data of urban environment in different timestamps.

Requirements

- Programming language, such as Python.
- Knowledge of 3D visualization tools will be beneficial.

Contact

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