Enhancing Simple Geometrical Holes in Fused 3D Building Model using the Laplacian Method

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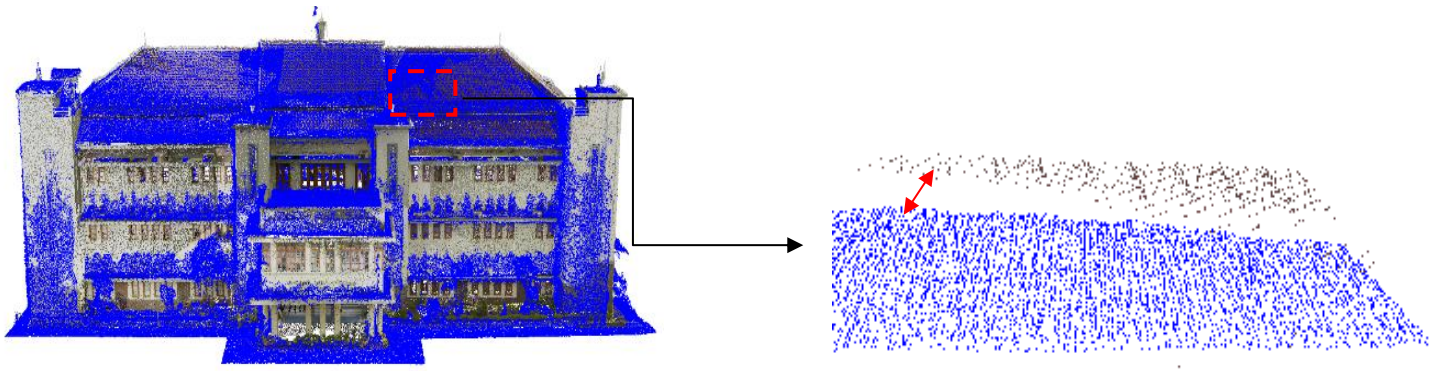
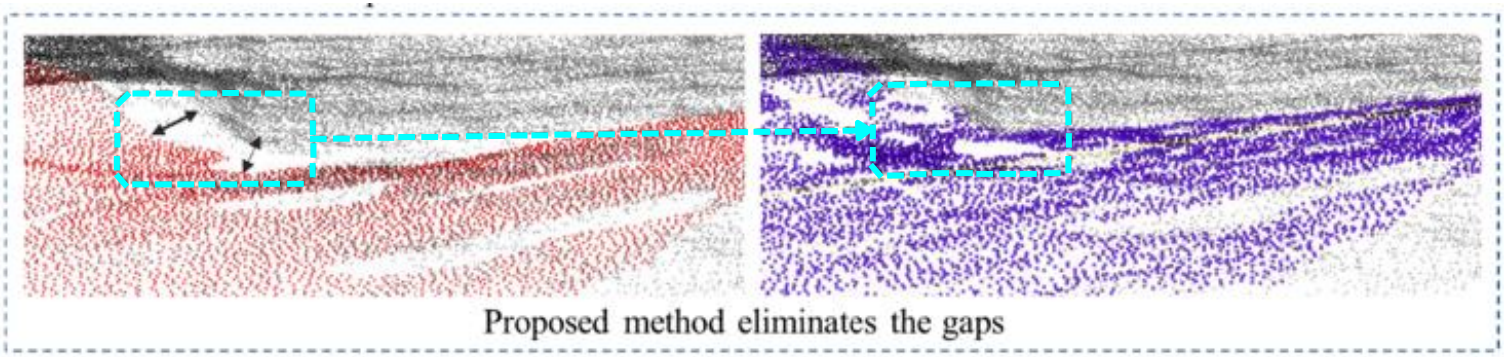
Introduction

- Data fusion is one of the ways to **integrate** diverse datasets.
- It generates 3D fused building model from several point cloud datasets.
- The fused 3D building model reveals discrepancies in **distances** between datasets, i.e., indicated by the red arrow in figure below.



Introduction

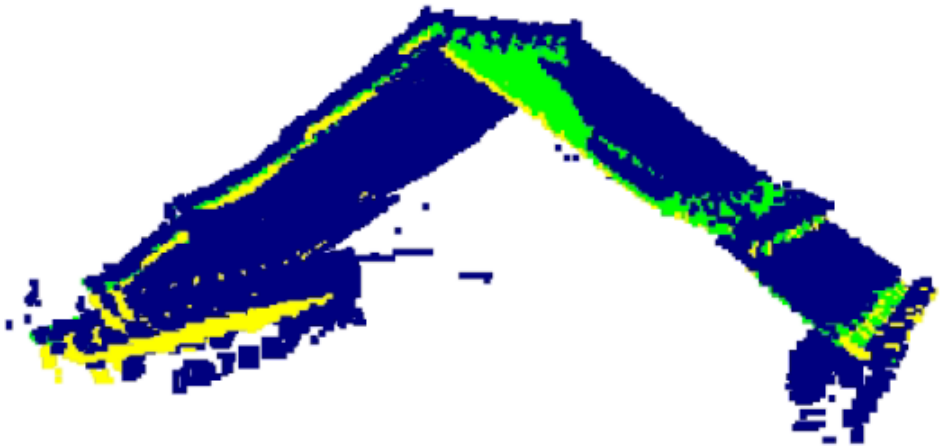
- A detail enhancement process was proposed by Li et al. (2021) using the Laplacian method.
  - Enhance details by addressing simple geometrical holes.
  - Eliminate the gaps.



- Simple holes:
  - small, regular, and easy to identify.
  - on planar surfaces, such as the roofs and walls of buildings.

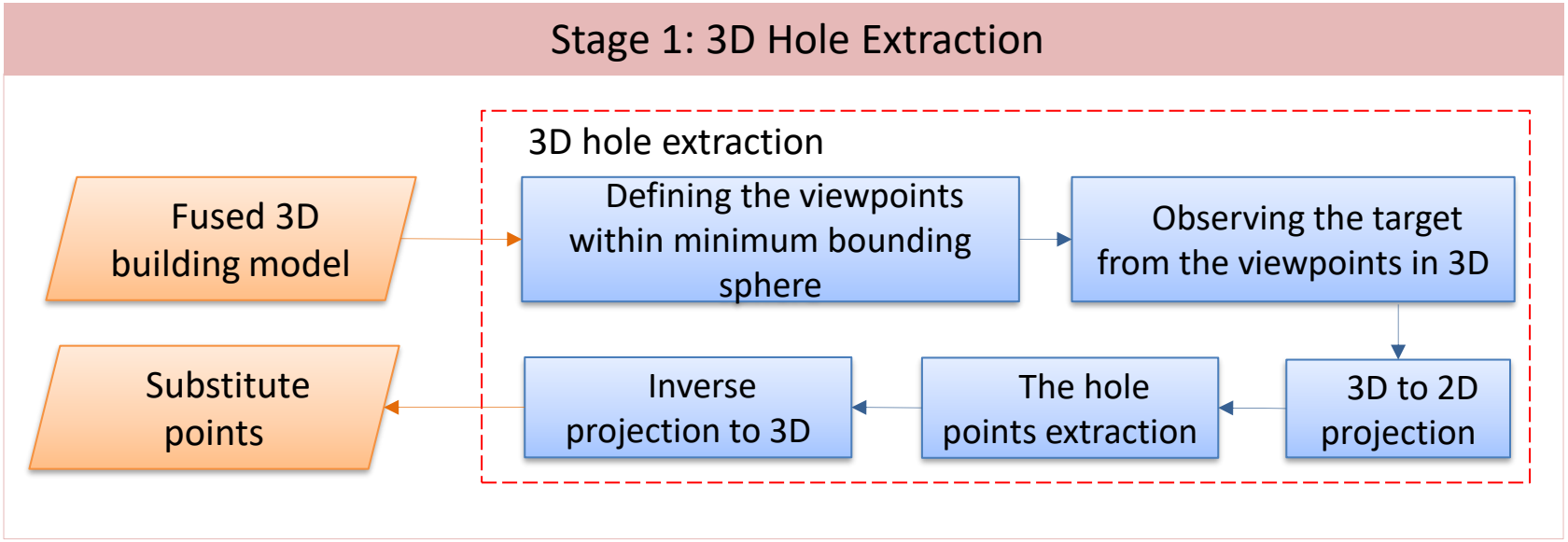
Methodology

- The data: the **fused** 3D building model.
  - Terrestrial laser scanning (**TLS**) point → blue.
  - Airborne laser scanning (**ALS**) point → green.
  - **Image-based** point → yellow.



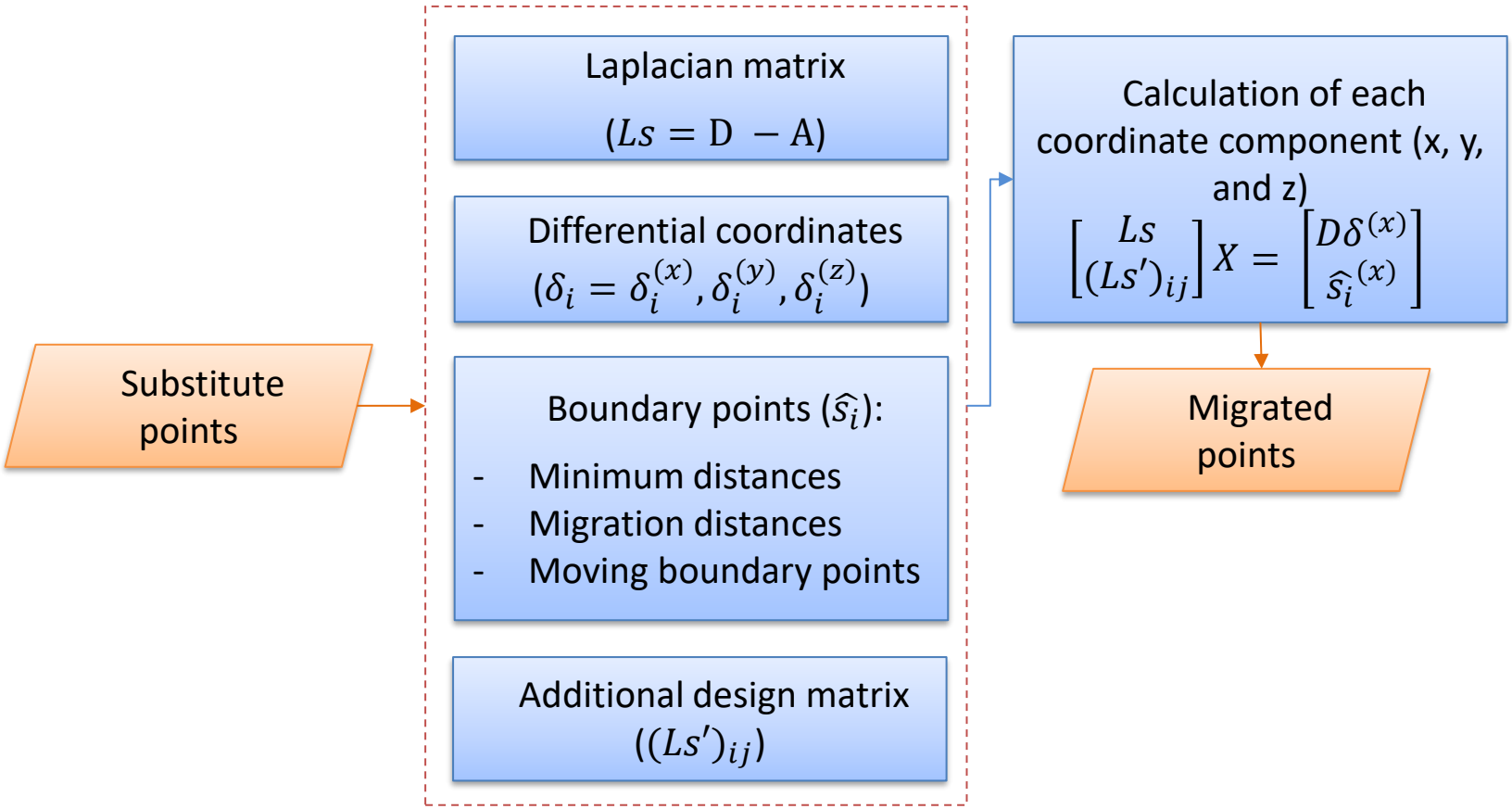
Methodology

- The Laplacian method
  - This method is designed to detect and repair holes through two main stages: **3D hole extraction** and **Laplacian data fusion**.



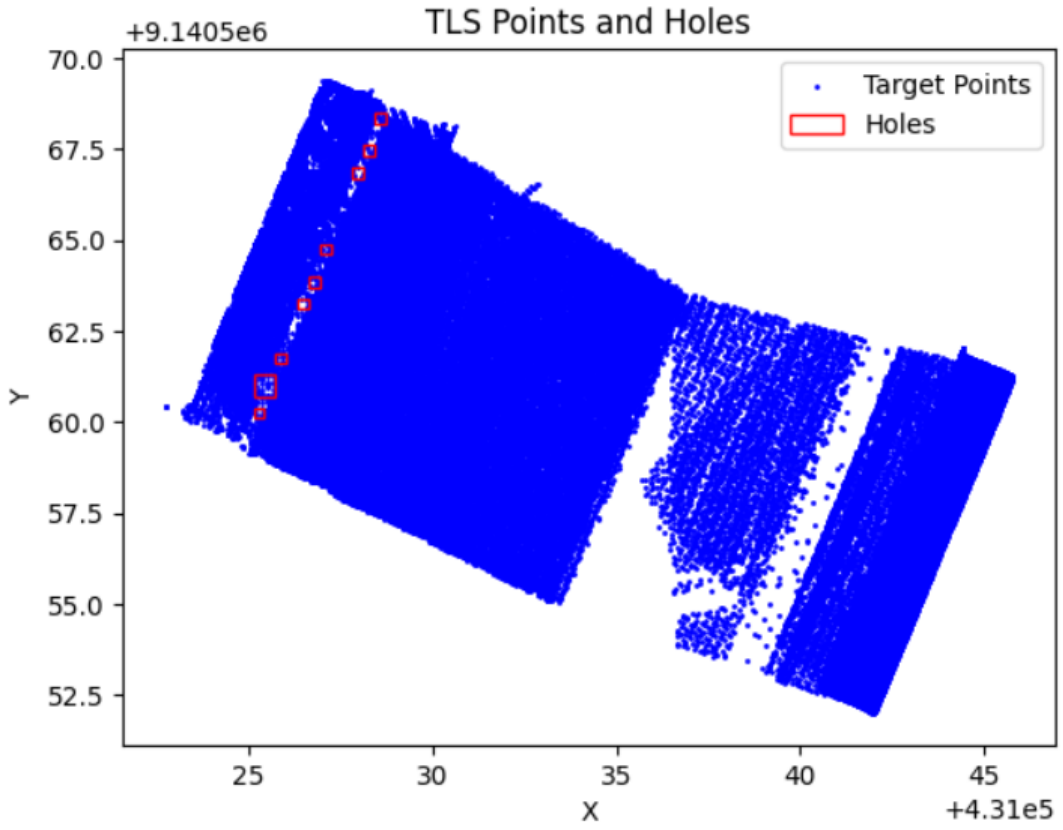
Methodology

Stage 2: Laplacian data fusion



Results and Discussion

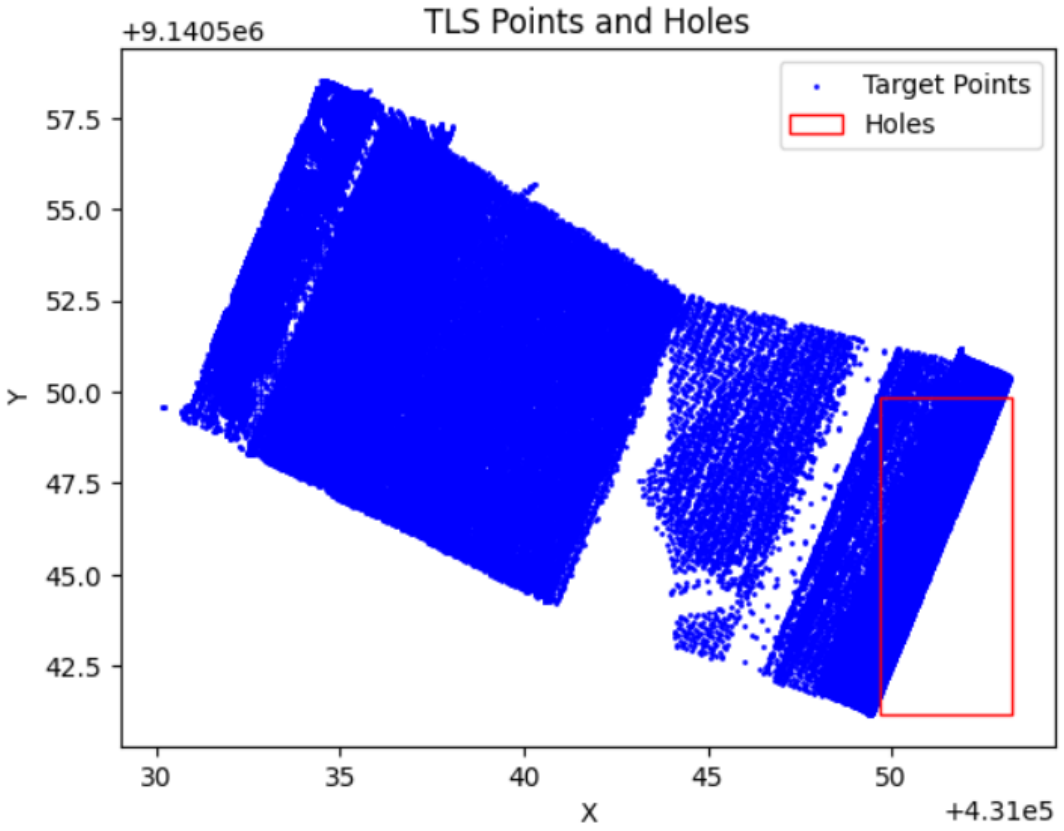
- Extraction of the holes



- The **target** model was observed from **a viewpoint** on a planar surface (2D).
- A point density **threshold** is set to 20 points.
- Number of holes: **19** holes.

Results and Discussion

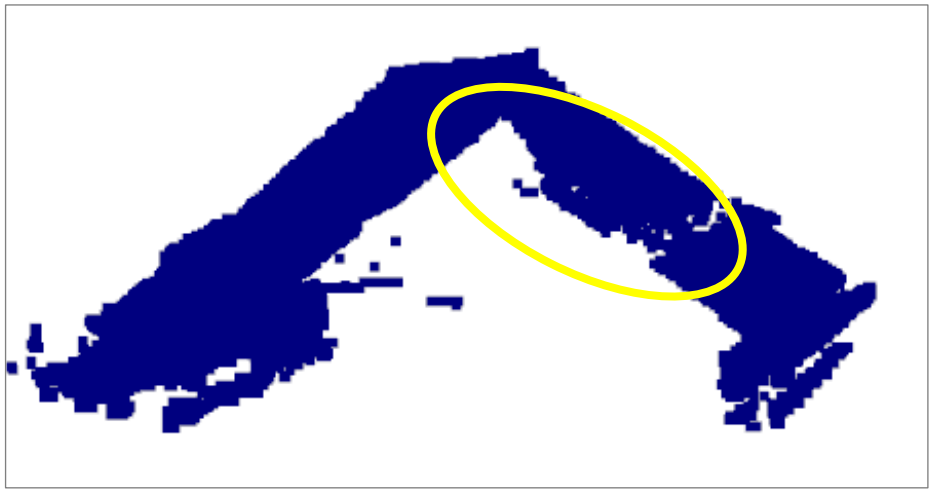
- Extraction of the holes

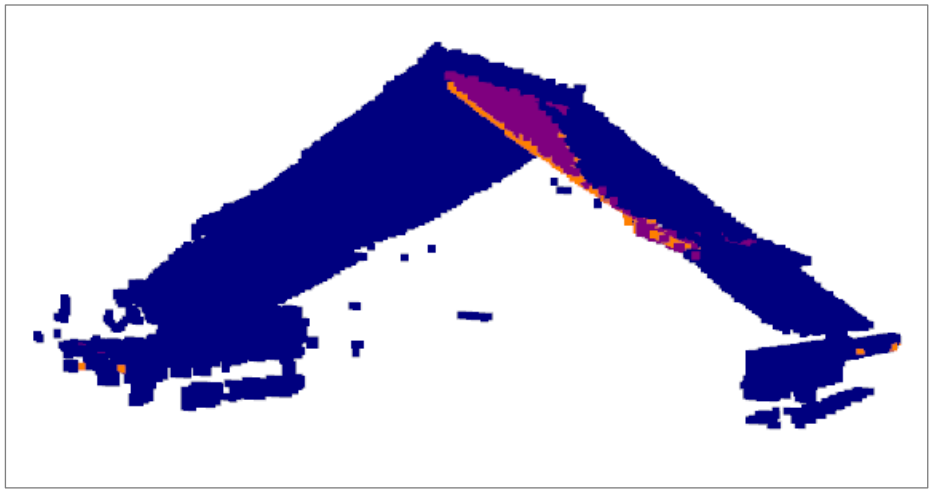


- Some holes are **not** considered as actual **holes** because they are outside the model.
- They can be eliminated during the overlapping process.

Results and Discussion

- Enhanced holes of the 3D model





- Substitute points are **migrated** closer to the target model and cover the hole.
- Hole on a **planar** surface, as shown in yellow circle, has a **simple** geometric shape.

Results and Discussion

- Evaluation of distance metric
  - Using cloud-to-cloud distance tool.
  - **Mean distances** between the target and the substitute points were calculated **before** and **after** enhancement process.

Data Pair	Mean Distance Before Enhancement (metre)	Mean Distance After Enhancement (metre)
TLS – ALS	0.45	0.29
TLS – image-based point	0.53	0.31

Conclusions

- Detail enhancement process using Laplacian method could lead to a **complete** 3D building model.
- Utilising **additional data** could potentially **reduce** the number of **viewpoints** required.
- Future work – **addressing** the issue of **complex holes** could improve the completeness of the 3D building model.

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Thank You