

# The ISPRS Benchmark Test on Indoor Modelling

## Report of Scientific Initiative 2019

### Investigators <sup>1</sup>

Kourosh Khoshelham (Principal Investigator)

Department of Infrastructure Engineering, School of Engineering, University of Melbourne.

Lucia Díaz Vilariño (Co-Investigator)

Applied Geotechnology Research Group, School of Mining Engineering, University of Vigo.

Zhizhong Kang (Co-Investigator)

Department of Remote Sensing and Geo-Information Engineering, School of Land Science and Technology, China University of Geosciences, Beijing.

Sagi Dalyot (Co-Investigator)

Environmental Crowdsourcing Laboratory, Faculty of Civil and Environmental Engineering, Technion - Israel Institute of Technology.

### Project Goals

The overall aim of the ISPRS Benchmark Test on Indoor Modelling was to stimulate and promote research on automated indoor modelling, with an emphasis on the reconstruction of geometric elements and semantic attributes needed for indoor navigation. To achieve this aim the project team organised a benchmark test to evaluate, compare, and benchmark the performance of indoor modelling methods. The specific aims of the benchmark test were to:

- Experimentally evaluate and compare the performance of indoor modelling methods using a benchmark dataset and a unified evaluation framework;
- Disseminate the evaluation results using a dedicated ISPRS web page (which is continuously updated with the results of new submissions) and several publications.

### Activities and Results

The project team extended the benchmark dataset that was created in the previous scientific initiative (2017) by adding a new point cloud of a complex indoor environment (Grainger Museum). The current dataset comprises six point clouds captured in indoor environments representing different levels of complexity. For each point cloud a 3D model was generated manually to serve as reference for the evaluation of automatically reconstructed models. Figure 1 shows the benchmark point clouds and the corresponding reference models. The benchmark dataset is made publicly available via the ISPRS website: <http://www2.isprs.org/commissions/comm4/wg5/benchmark-on-indoor-modelling.html>.

As part of the scientific initiative, the project team developed a framework for comprehensive quality evaluation and comparison of indoor models. The evaluation framework was presented at an ISPRS

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<sup>1</sup> All investigators are officers of ISPRS WG IV/5.

conference (Khoshelham et al., 2018) and published in the ISPRS Journal of Photogrammetry and Remote Sensing (Tran et al., 2019). The evaluation framework was used for the evaluation and benchmarking of submitted models in the benchmark test.

We organised the benchmark test and distributed a call for participation using different communication channels including the ISPRS website for the benchmark, email lists, ResearchGate, and in ISPRS events such as the Geospatial Week 2019. So far we have received eight submissions, of which six are evaluated. Table 1 provides a summary of the six submissions which have been evaluated. Some participants submitted only one model (Previtali et al. and Cui et al.), while other participants submitted several models for evaluation. Only one participant submitted a model for Grainger Museum; however, this submission has not been evaluated yet.

The current evaluation results are published on the ISPRS website for the benchmark test: <http://www2.isprs.org/commissions/comm4/wg5/benchmark-test-on-indoor-modelling.html>. The results are presented both in tabular and graphical form and enable comparison between the methods for each dataset and comparison between the datasets for each submission. Figure 2 shows a screenshot of evaluation results for TUB1 dataset and Figure 3 shows an example of results for an individual submission. The project team will present the preliminary results of the benchmark test during the ISPRS Congress in June 2020 in Nice. We also plan to publish the final results in the ISPRS Journal of Photogrammetry and Remote Sensing.

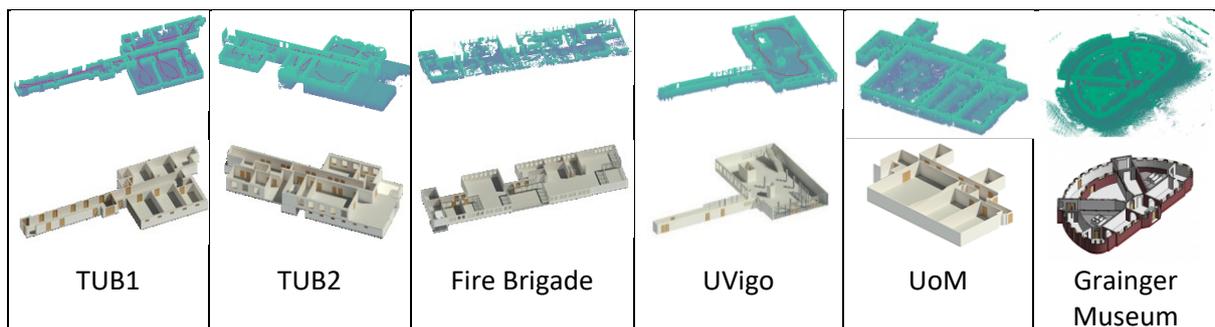


Figure 1. The benchmark point clouds (top) and the corresponding reference models (bottom).

Table 1. List of submissions.

Authors	Affiliation	Reconstructed model					
		TUB1	TUB2	Fire Brigade	UVigo	UoM	Grainger Museum
Cui et al.	Shenzhen University	–	✓	–	–	–	–
Ochmann et al.	University of Bonn	✓	✓	✓	✓	✓	–
Maset et al.	Udine University	✓	✓	✓	✓	✓	–
Previtali et al.	Polytechnic University of Milan	✓	–	–	–	–	–
Tran et al.	University of Melbourne	✓	–	✓	✓	✓	–
Tran & Khoshelham	University of Melbourne	✓	–	✓	✓	✓	–

## TUB1

Authors	Affiliation	Completeness @ 10 cm	Correctness @ 10 cm	Accuracy (cm) @ 10 cm
Ochmann et al.	University of Bonn	0.93	0.36	1.79
Tran & Khoshelham	University of Melbourne	0.91	0.84	5.66
Tran et al.	University of Melbourne	0.85	0.30	1.34
Maset et al.	Udine University	0.83	0.47	1.80
Previtali et al.	Politecnico di Milano	0.78	0.49	2.22

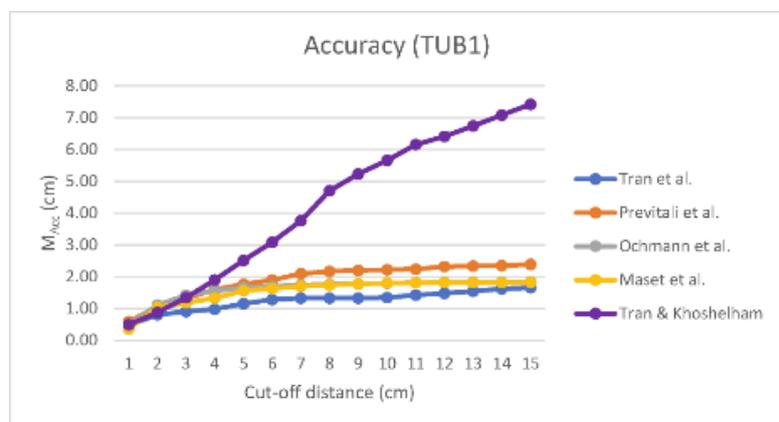
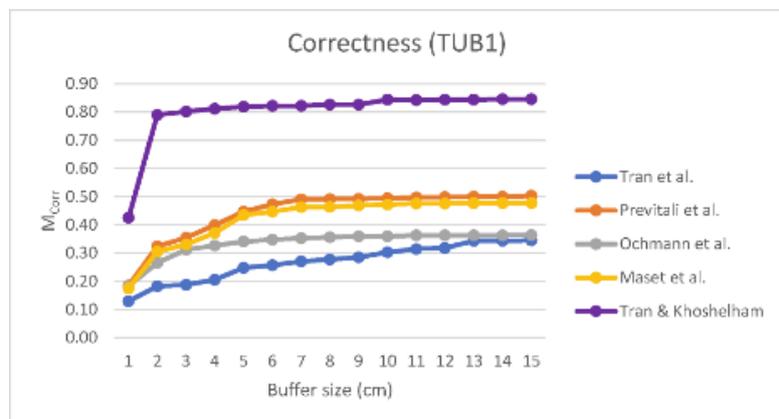
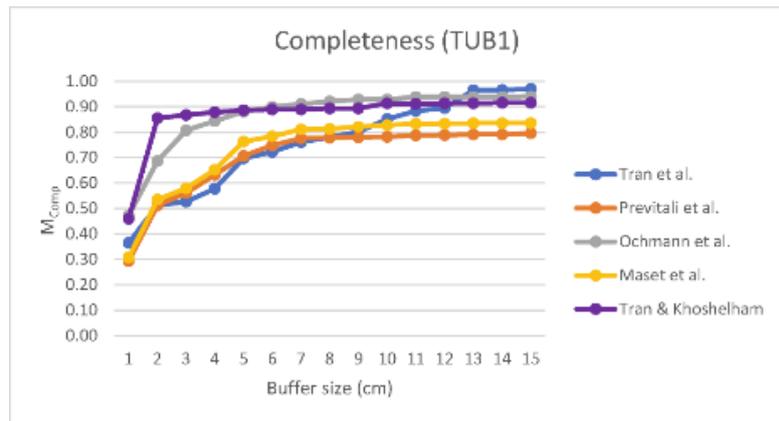


Figure 2. Evaluation results for dataset TUB1.

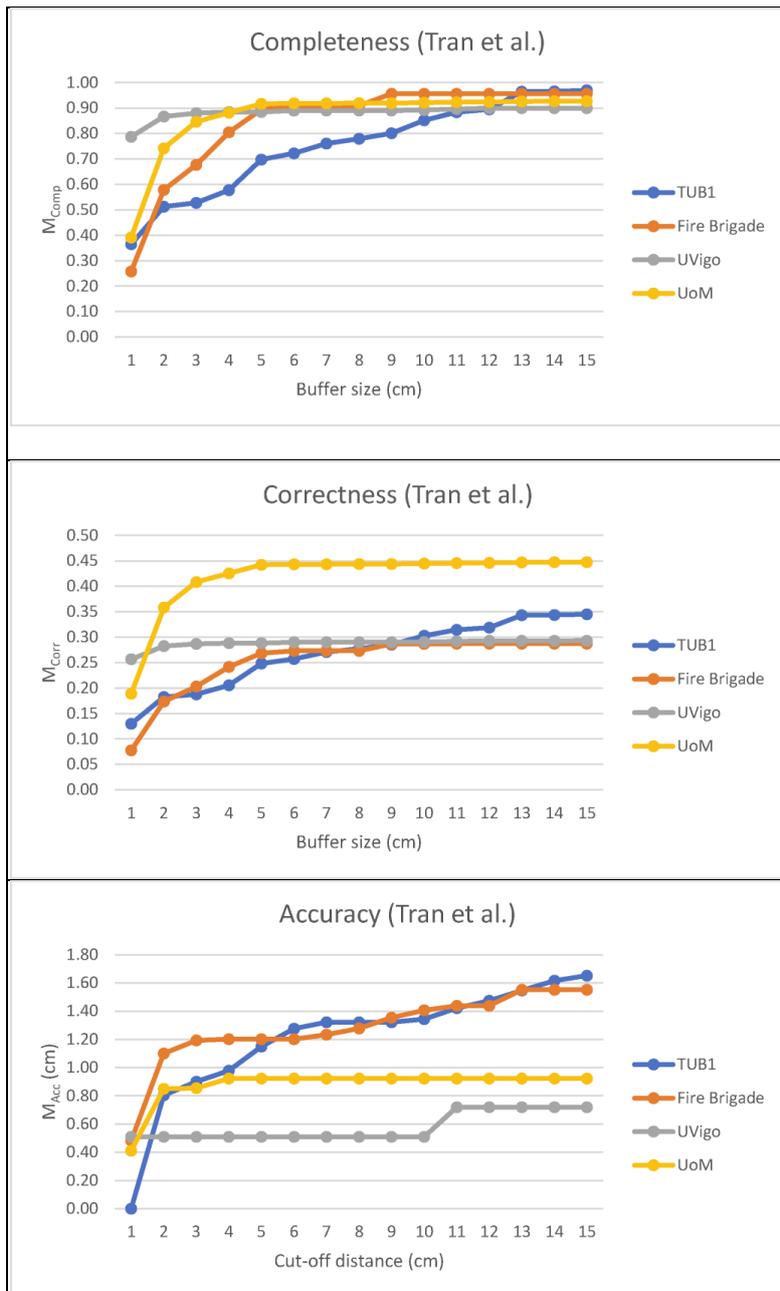


Figure 3. Evaluation results for submission Tran et al.

### Project Expenses

The total grant received from the ISPRS for this project was CHF 10,000.00. The following is a breakdown of the project expenses.

- Acquisition of the point cloud of Grainger Museum CHF 600.00
- Generation of reference model for Grainger Museum CHF 1,100.00
- Evaluation of submitted models CHF 6,300.00
- Preparation and updating of benchmark test website CHF 1,000.00
- Travel CHF 1,000.00

**References:**

- Khoshelham, K., Tran, H., Díaz-Vilariño, L., Peter, M., Kang, Z., Acharya, D., 2018. An Evaluation Framework for Benchmarking Indoor Modelling Methods, *Int. Arch. Photogramm. Remote Sens. Spatial Inf. Sci.*, Vol. XLII-4. Copernicus Publications, Delft, The Netherlands, pp. 297-302.
- Tran, H., Khoshelham, K., Kealy, A., 2019. Geometric comparison and quality evaluation of 3D models of indoor environments. *ISPRS Journal of Photogrammetry and Remote Sensing* 149, 29-39.