3D Modelling Approach for Ancient Floor Plans' Quick Browsing

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Objectives

3D modelling of historical monuments from ancient floor plans. It may:

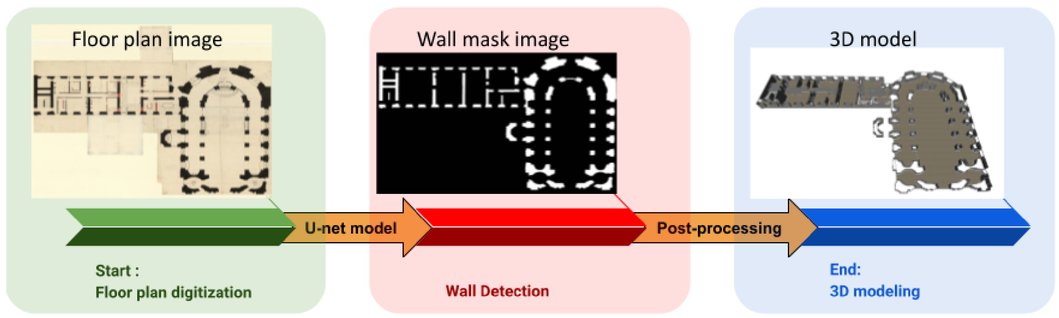
- help to restore certain modified, disappeared or never-built parts of the monument by reconstructing the 3D models using their floor plans;
- interest experts as well as the general public.

Challenges

This study is focalized on the old floor plans of the palace of Versailles (1680–1780). Such floor plans are difficult to interpret: no real graphic standards, digitization artefacts, *etc.*

Method

From an old historical floor plans to a simple 3D model through fully automated wall detection:



The quality of the output 3D model depends on the quality of the wall detection process

Assessment

For most of the old floor plans, the real building no more exists. So, it is not possible to compare the obtained 3D models to a real reference. To solve this problem, we considered as 3D ground truth models for these floor plans the 3D models obtained by the interactive VERSPERA application.

Evaluation protocol

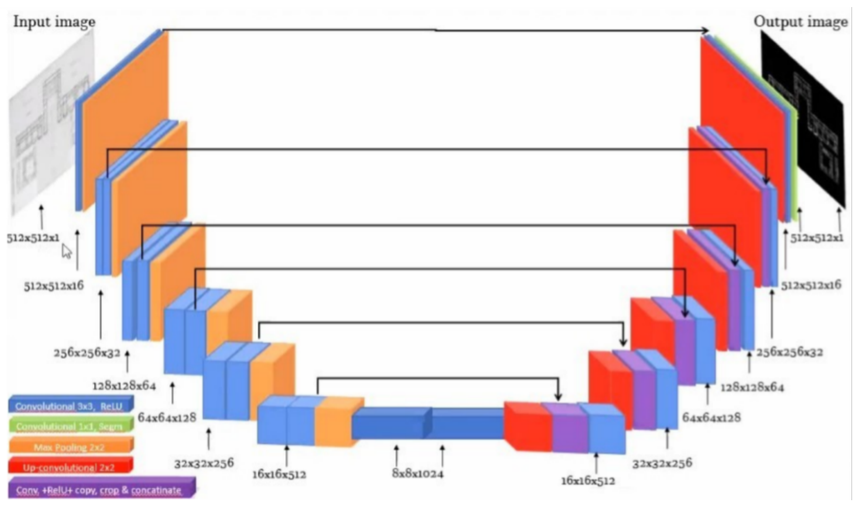
- The elapsed time to build the 3D model.
- The IoU scores computed on the 3D models top views (walls' edges images).

Wall detection

Learning a U-net based convolutional neural network for achieving the wall detection task:

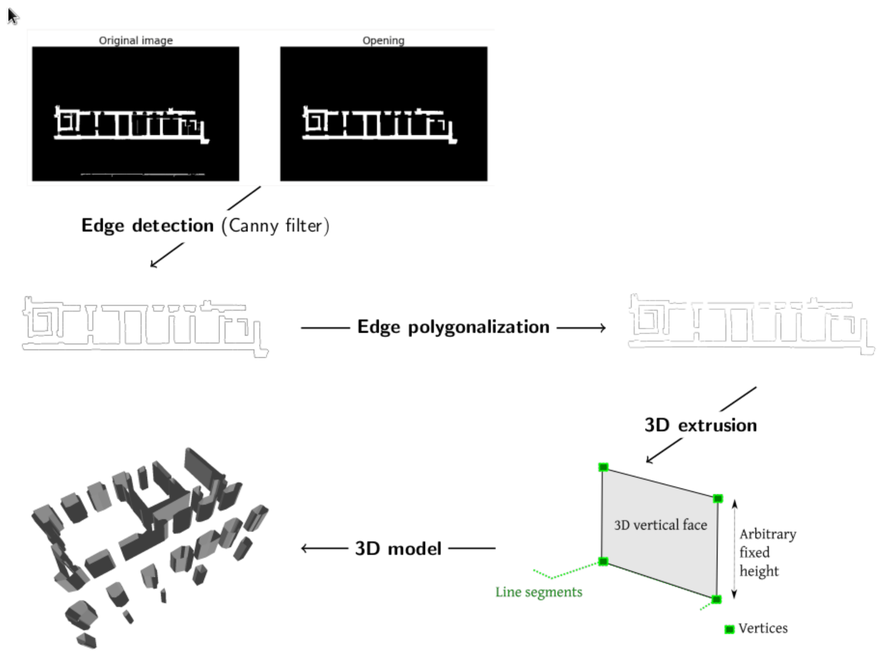
1. Two-steps sequential learning: first on CVC modern dataset, then on Versailles-FP dataset;
2. Data autgmentation: Horizontal and vertical shifting and in & out zoom;
3. Learning rate decaying, RMSProp optim. and Dice loss are applied with batch size of 25:

$$L_D = 1 - \frac{2 \times |A \cap B| + 1}{|A| + |B| + 1}$$



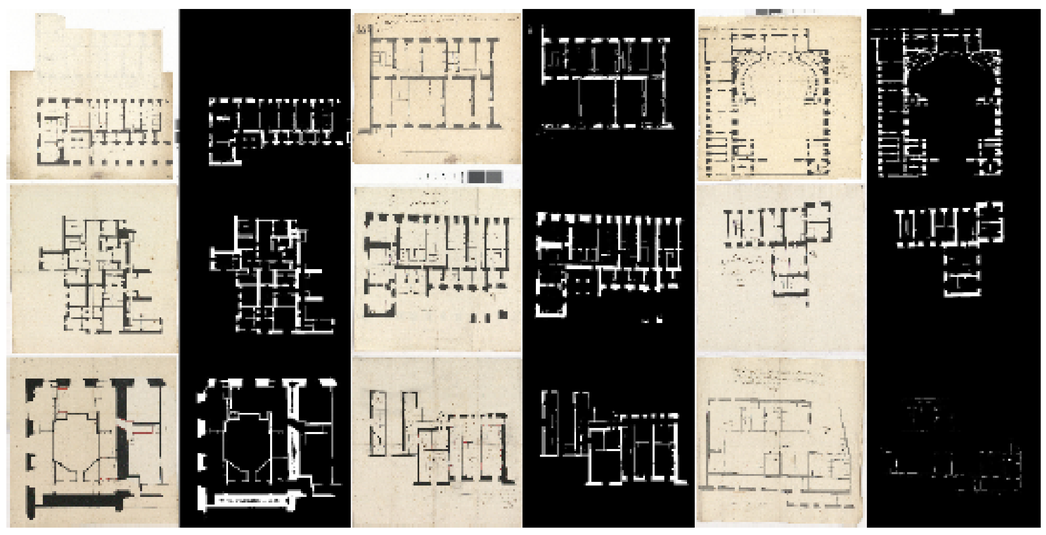
3D modelling

The 3D model is computed from the wall mask using a set of well-known image processing techniques:



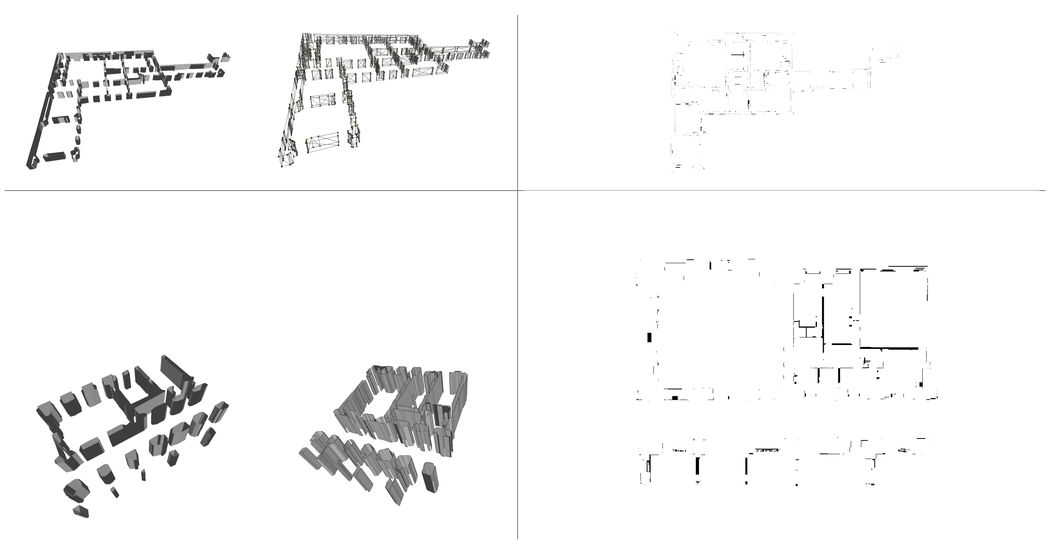
Wall detection results

Some of good and bad wall mask produced by the Unet model for some of Versailles-FP dataset images:



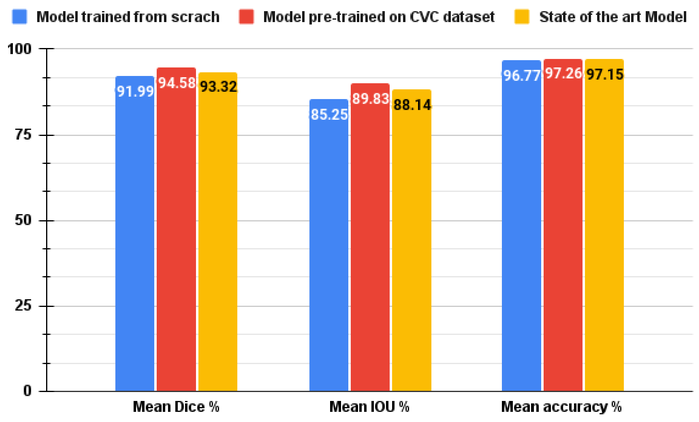
3D modelling results

Comparison of the reference 3D model obtained by VERSPERA interactive application (left), our automatic and fast approach (center), and the 3D model's top view difference image (right):



Wall detection evaluation

SOA model: W. Swaileh, D. Kotzinos, S. Ghosh, M. Jordan, N.-S. Vu, and Y. Qian, *Versailles-FP dataset: Wall detection in ancient floor plans*, in Document Analysis and Recognition - ICDAR 2021, J. Lladós, D. Lopresti, and S. Uchida, Eds. Cham: Springer International Publishing, 2021



3D modelling computation times

Method	VERSPERA software (interactive)	Our method (fully automatic)
Nb of images	15	500
Overall time	120 min	20 min
Time *per* image	8 min	2.4 sec

3D modelling IoU scores

Min	Max	Average	Std dev.
0.780	0.906	0.842	0.041

Comparison of interactive and fully automatic computation of 3D models of 15 floor plan images.

Thanks to

Take a picture to browse the **VERSPERA-FP dataset**.