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 focused 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:

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 augmentation: Horizontal and vertical shifting, and in & out zoom;
3. Learning rate decay, RMSProp optim., and Dice loss are applied with batch size of 25:
   \[ L_D = 1 - \frac{2 \times |A \cap B|}{|A| + |B| + 1} \]

Wall detection results

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

Wall detection evaluation


3D modelling

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

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):

3D modelling computation times

<table>
<thead>
<tr>
<th>Method</th>
<th>VERSPERA software (interactive)</th>
<th>Our method (fully automatic)</th>
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<tbody>
<tr>
<td>Nb of images</td>
<td>Overall time</td>
<td>Time per image</td>
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<tr>
<td>15</td>
<td>120 min</td>
<td>8 min</td>
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3D modelling IoU scores

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

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).

Thanks to

Take a picture to browse the VERSPERA-FP dataset.