SAFE: Structure-aware Facade Editing

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Motivation

• Need of high-quality & customized facade textures
• Model-by-example: Facade editing
• Structure-aware editing
Properties of Facade Structures

- Abundance
- Irregularity
- Symmetry
- Alignment
- Hierarchy
Related work

• Single, optimized editing output
• But this **single output** might not match design intent!
Diversity of Editing Outputs
Objective

• Explore editing variations.
• Huge space of variations - How?
Sources of Variation

Continuous Changes

Discrete Changes

Editing Areas
Our approach

- Select Editing Areas
- Explore Discrete Variations
- Adapt Element Size

- Step-wise exploration of discrete variations
Our approach

How to generate discrete variations?
Facade decomposition

- [Musialski Eurographics 12]
- City engine
Generalized Grid

- Non-identical elements
- Non-equal spacing
- Missing elements
Hierarchy of Grids
Discrete Variation Generation

Grid Selection  Topological Jump  Spatial Optimization

• What and where to insert?
• Element size?
Top. Jump - Challenge

Bibliothèque nationale et universitaire, Strasbourg
Top. Jump - Challenge
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Synthesize neighborhood!
Neighborhood Graph
Neighborhood Synthesis
Edge Insertion
Edge Insertion

- **Horizontal**
- **Vertical**
Edge Insertion
Spatial Optimization

Grid Selection    Topological Jump
Spatial Optimization

Grid Selection
Spatial Optimization

- Separate horizontal & vertical optimization

- Quadratic programming

\[
\begin{align*}
\text{minimize} & \quad E(x) = \|W(x - x_{orig})\|^2 \\
\text{subject to} & \quad C_{\text{hierarchy}} x = 0, \quad C_{\text{align}} x = d_{\text{align}} \\
& \quad C_{\text{others}} x = 0, \quad x > 0
\end{align*}
\]
Spatial Optimization

Non-aligned

Aligned
Iterative Editing Example

User selects active grid(s).
Results

Input  Step 1  Step 2  Step 3
Main grid

Subgrids

Main grid & subgrids
No dominant grid
Contributions

• **Iterative editing process**: explore ambiguity while avoiding combinatorial explosion of editing results.

• **Generalized grids** capture irregular and hierarchical structures.

• Neighborhood synthesis via **neighborhood graph** provides consistent facade outputs.
Limitations & Future work

- Combining with other facade parsing methods
- Extension to 3D
- Clustering variations based on *structural similarity*
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nmdang.com/safe.html

Thank you!