A Brief Primer on Inverse Procedural Modeling

CS334

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Recall: Procedural Modeling

- Apply algorithms for producing objects and scenes
- The rules may either be embedded into the algorithm, configurable by parameters, or externally provided
#1: Inverse Procedural Modeling by Automatic Generation of L-systems

O. Šťava, B. Beneš, R. Měch*, D. Aliaga, P. Krištof

2D Vector Image → Analysis → L-system → Modifications

\[ R(m) \rightarrow A[-(\alpha)f(d) \ast (s)-(\beta)R(m-1)] \]
\[ +(\alpha')f(d') \ast (s')+ (\beta')R(m-1) \]
Rule R3(A) = {
  ... 
  R1(subdivide(2,1,2,D));
  R1(subdivide(2,1,2,F));
}
Pipeline

$T = \{\text{triangles}\}$

$T \rightarrow T_k = \{\text{subspaces}\}$

$T_k \rightarrow Z = \{\text{components}\}$ and $C = \{\text{types}\}$

[Demir et al. 2015]
Search Process

$T_k \rightarrow Z=\{\text{components}\}$ and $C=\{\text{types}\}$

$Z \rightarrow \text{Combinatorial Optimization} \rightarrow M=\{\text{components}\}$ and $C=\{\text{types}\}$
Clustering and Components

(a) Initial Triangles

(b) Components

(c)
Example Output

• Automatic

[Demir et al. 2016]
#3: Photograph to Proc. Model

G. Nishida, A. Bousseau, D. Aliaga

- Given an image of a building and its contour, generate a 3D procedural model similar to the input.
System Pipeline

- Input
- Building mass + camera stage
- Façade stage
- Window stage
- Output
Building Mass + Camera Stage

- Building mass
- Camera stage
- Facade stage
- Window stage
- Output
Building Mass + Camera Stage

- Target Building + Silhouette
- Building mass recognition CNN
- Building mass parameter estimation CNN
- Refinement by optimization
- Camera parameters + building mass
Building Mass Grammar
Façade Stage
Façade Simplification

- Façade
- Façade grid parameter estimation CNN
- Image-based refinement
- Subdivision
- Window recognition CNN
- Window parameter estimation CNN (position/size)
- Detected windows
Façade Grammar Generation

- Façade
- Simplified facade
- Façade recognition CNN
- Façade parameter estimation CNN
- Generated Facade
Façade Grammar

• The same color denotes the same non-terminal.
Window Stage

- Input
- Building mass
- Camera stage
- Façade stage
- Window stage
- Output
Window Style Recognition

- Maximum votes for the same non-terminal to select a window grammar.
Photo to 3D Results
Aerial Images

- Still works but camera parameter estimation is less accurate due to the weaker perspective of the images.