Inverse Procedural Modeling for Architecture

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Abstract

This paper presents a visualization system showing the construction of Chinese architecture through the use of inverse procedural modeling. The models were first constructed using Google SketchUp, and passed to a program implemented with the combined use of inverse procedural modeling with shapes grammars developed with the OpenGL C++ framework. The result allowed us to create different models that maintained the same symmetry as the original model.

Keywords：inverse procedural modeling, geometry synthesis,

1. Introduction

The field of computer graphics is one that is increasingly pervasive in society today, especially in the realm of 3D modeling and rendering. As such we decided to work on one of the foremost techniques used to construct 3D models.

In this study, we used inverse procedural modeling to construct an elaborate 3D palace.

Inverse procedural modeling：We first examined the example geometry and created a set of rules that would allow us to create new objects with similar geometric structure.

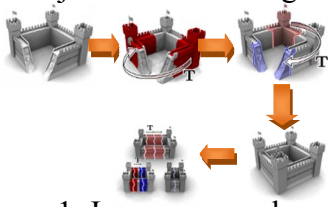

Figure 1: Inverse procedure can be used to create 3D models (Image source: [3])

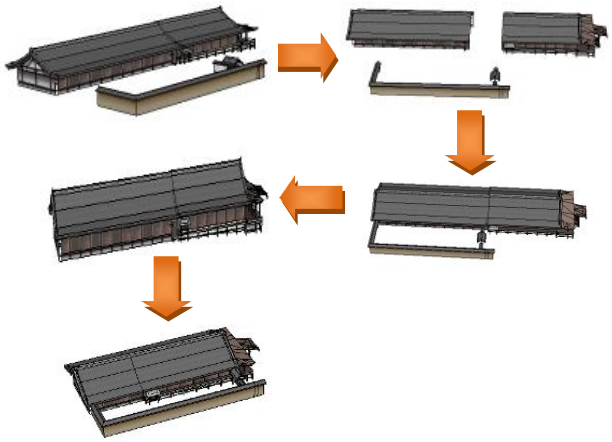

Figure 2: Inverse procedural modeling of Chinese architecture.

We used partial symmetry to derive grammar rules that would be used to perform inverse procedural modeling on Chinese architecture.

2. Related Works

The study of the use of procedural modeling to create 3D buildings has seen a boom in recent years. However, our research focuses on one of the newest methods of creating 3D grammars, inverse procedural modeling. We believe that new technique can be more efficient than traditional procedural modeling methods.

Shape grammars and inverse procedural modeling：After defining our grammar rules, we then applied them to the Horyuji temple, our test model. Our rules allowed us to find symmetric areas that encompass other non-symmetric regions.

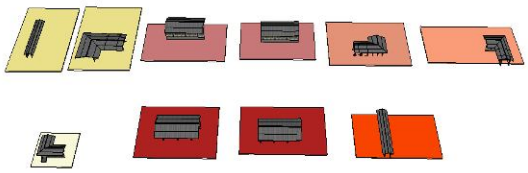

Figure 3: Visualization of the grammar computed for the inner wall of the Horyuji temple.

Symmetric and repetitive pattern analysis: Structures contain patterns that repeat themselves. We used these pattern regions as the basis for the shape grammars.

3. Implementation

We obtain a test set of 3D models. We used the public models available from the Google 3D warehouse. After manually examining the models for areas of symmetry, we created model specific classes and created new models inside the Google SketchUp environment.

After creating the models we developed an OpenGL C++ framework along with our pre-defined shape grammars to synthesize new models.

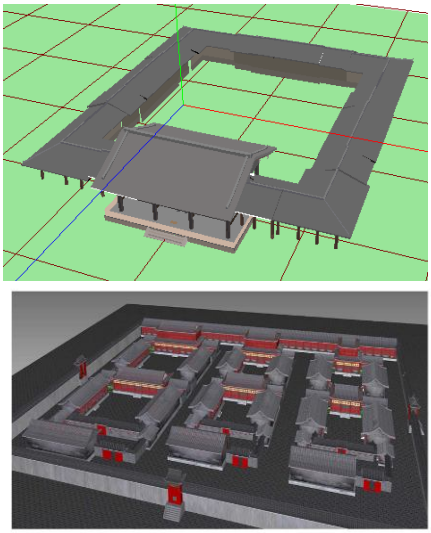

Figure 4: A comparison between our final output (above) and the expected output (below) (Image source: [2])

4. Conclusion

We demonstrated a method for re-modeling 3D structures on an interactive platform. While this paper shows models that have been pre-programmed, we are working on adopting a system that will not require manual analysis.

Reference

[1] P. Mueller, P. Wonka, S. Haegler, A. Ulmer, L. Van Gool, "Procedural Modeling of Buildings," ACM Transactions on Graphics, vol. 25, Issue 3, pp. 614-623, 2006

[2] F. Hou, Y. Qi, H. Qin, 'Drawing-Based Procedural Modeling of Chinese Architectures,' IEEE Transactopms on Visualization and Computer Graphics, vol. 18, Issue 1, pp. 30-42, Jan 2012

[3] Martin Bokeloh, Micheal Wand, Hans-Peter Seidel 'A Connection between Partial Symmetry and Inverse Procedural Modelling' ACM Transactions on Graphics (TOG) – Proceedings of ACM SIGGRAPGH 2010, Volume 29 Issue 4, July 2010

[4] N.J. Mitra, L.J. Guibas, and M. Pauly, "Partial and Approximate Symmetry Detection for 3D Geometry," ACM Transactions on Graphics, vol.25, no. 3, pp. 560-568, 2006.

[5] M. Pauly, N.J. Mitra, J. Wallner, H. Pottmann, and L.J. Guibas,"Discovering Structural Regularity in 3D Geometry," ACM Transactions on Graphics, vol. 27, no. 3, pp. 1-11, 2008.

[6] M. Bokeloh, A. Berner, M. Wand, H.-P. Seidel, and A. Schilling, "Symmetry Detection Using Feature Lines", Computer Graphics Forum, vol. 28, no. 2, pp. 697-706, 2009.

[7] K. Xu, H. Zhang, A. Tagliasacchi, L. Liu, G. Li, M. Meng, and Y. Xiong, "Partial Intrinsic Reflectional Symmetry of 3D Shapes," ACM Transactions on Graphics, vol. 28, no. 5, pp. 1-10, 2008