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Poster

An Interactive Modeling System of Japanese Castles with Decorative Objects

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Abstract

We present an interactive modeling system for Japanese castles. We develop an user interface that can generate the fundamental structure of the castle tower consisting of stone walls, turrets, and roofs. By clicking on the screen with a mouse, relevant parameters for the fundamental structure are automatically calculated to generate 3D models of Japanese-style castles. We use characteristic curves that often appear in ancient Japanese architecture for the realistic modeling of the castles.

CCS Concepts

• ***Computing methodologies*** → ***Shape modeling;***

1. Introduction

Nowadays, computer graphics have become popular as a tool for creating 3D contents. Some applications, such as video games and virtual city navigation, require us to design a city, where we need to generate many architectural objects. Several methods have been proposed to this end [MWH*06, JTC09]. Although these methods can generate different types of buildings, they are not designed for Japanese castles. We propose an interactive and easy-to-use system for generating realistic Japanese castles. The user can generate the fundamental structure of the Japanese castle by specifying only four 3D points by simply clicking on the screen with a mouse. Then the characteristic curved shape of the castle, including roofs and gables, is generated accordingly.

2. Proposed Method

A typical fundamental structure of Japanese castles consists of a stone wall and a castle tower. The castle tower consists of turrets and roofs. A gable is also an important element for modeling realistic Japanese castles. We first describe the method for the fundamental structure and then explain the method for roofs and gables.

2.1. Modeling of Fundamental Structure

We assume that the fundamental structure is symmetric and the turrets can be represented by a stack of cuboids that gradually become smaller at a constant rate. The fundamental structure is generated from four points (see Figure 1). The first two points, P_1 and P_2, represent the diagonal points of the bottom of the stone wall. The other two points correspond to the top of the stone wall (P_3) and the top of the castle tower (P_4), respectively.

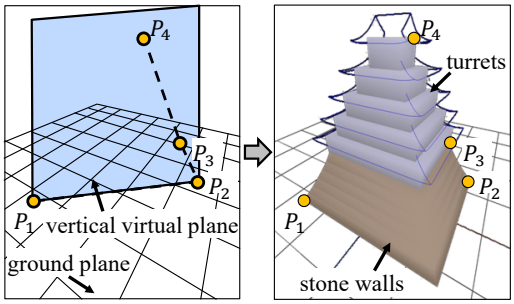

Figure 1: *The fundamental structure and user-specified points.*

The user interactively specifies these points by clicking on the screen with a mouse. We assume that P_1 and P_2 are on the ground plane, and P_3 and P_4 are on a vertical plane containing P_1 and P_2. When the user clicks on the screen, a viewing ray passing through the clicked pixel is calculated by the inverse perspective transformation. The position of each of the four points is determined by computing the intersection of the corresponding ray with the ground plane or the vertical virtual plane. From these four points, our method determines the shapes of the stone walls and the turret, as described below.

The stone wall is generated by using P_1, P_2, and P_3. The bottom of the stone wall is the rectangle determined by P_1 and P_2. The top rectangle of the stone wall is also generated at the height of P_3. The curves connecting the corresponding corners between the top and the bottom rectangles are then generated. We use the method proposed by Fujii [Fuj18] for computing these curves.

The turret is modeled as a stack of cuboids. The size of each

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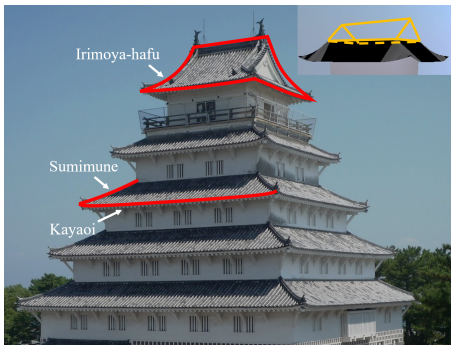

Figure 2: *Name of each roof part*

cuboid is determined by P_3, P_4 and the user-specified number of the stacks. The size of the cuboid at the lowest level of the turret is the same as that of the top of the stone wall. The cuboid at the highest level of the turret touches the rectangle including P_4. The number of the cuboids can be specified by the user.

2.2. Modeling of Roofs and Gables

The roofs are generated for each of the turret cuboids. A gable roof is also generated at the top of the castle tower. The roofs and gables for a Japanese castle has a characteristic curved shape and each part of the shape has a unique Japanese name as shown in Figure 2. We use these names in the following and describe our methods for computing their shapes.

Kayaoi is the outermost part, or eaves, of the roof generated for each of the turret cuboids. This part is almost straight but is slightly curved near the both ends (see Fig. 2). We use the method proposed by Yanai [Yan10] for computing the curved shape.

Sumimune is a ridge curve connecting the roof corner and a point on the corner edge of the turret cuboid. This curve is originally represented by a catenary curve, but we use a parabola for simplicity and efficiency. We generate a parabola curve so that its vertex corresponds to the roof corner. The user can move the position on the corner edge of the turret cuboid along the edge.

Irimoya-hafu is a gable roof at the top of the castle. Our method first generates a prism as a proxy shape for the gable (see the orange object at the top in Fig. 2, upper right). The curved shape of the gable is generated by using the method proposed by [Yan10].

Our system allows the user to generate gables in the same way at an arbitrary position on the roofs of the castle, which is called *Hafu*, one of the important decorative parts for Japanese castle.

3. Results

Some examples of castles modeled by our method are shown in Figure 3. We use pictures of real castles shown in the inset as references for creating these castles. As shown in these examples, our method successfully generates the similar shapes to the real castles. Particularly, the distinct curved shapes of the Japanese castle, such as Kayaoi and Iromoya-Hafu, are successfully reproduced. It typically took several minutes to create these castle models by using our system.

(a) Shimabara castle.

(b) Osaka castle.

Figure 3: *Examples*

4. Conclusion and Future Work

We have presented the method for generating 3D models of Japanese castles interactively. Our method allows the user to easily generate the representative curved shapes.

However, there still remains several issues that should be addressed in the future. Our method does not provide a way to generate more complicated structures nor detailed decorative objects. Our future work thus includes the extension of our system to the modeling of such complex shapes and decorations.

References

[Fuj18] FUJII K.: Stone wall curves of kumamoto castle(written in japanese). *Yokohana City University* (2018). 1

[JTC09] JIANG N., TAN P., CHEONG L.-F.: Symmetric architecture modeling with a single image. *ACM Transactions on Graphics 28*, 5 (2009), 1–8. 1

[MWH*06] MÜLLER P., WONKA P., HAEGLER S., ULMER A., GOOL L. V.: Procedural modeling of buildings. *ACM Transactions on Graphics 25*, 3 (2006), 614–623. 1

[Yan10] YANAI H.: Consideration of roof curve in japanese style architecture(written in japanese). *The Operations Research 36*, 3 (2010), 146–153. 2