Procedural Modeling
Applied to Asian Roofing

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CONTEXT: OUR RESEARCH
Procedural generation of traditional Asian buildings
Real-time Rendering

Procedural generation of traditional Asian buildings
Procedural generation of traditional asian buildings
Procedural generation of traditional Asian buildings
Procedural modeling

Procedural generation of traditional asian buildings
Procedural modeling

Procedural generation of traditional Asian buildings
Cultural Heritage

Procedural generation of traditional asian buildings
Procedural generation of traditional Asian buildings
Urban Physics

Procedural generation of traditional Asian buildings
PROCEDURAL MODELING APPLIED TO ASIAN ROOFING
Historical Reconstruction: Pompeii
Problem: Content Creation

Entertainment - Tokio from Cars 2
Problem: Content Creation

Entertainment – London from Cars 2
Objectives

To develop a *procedural implementation* of a traditional east ancient building.

- Key visual assets for cities like Tokyo, Beijing, Montreal, Toronto, New York and San Francisco
This presentation is based on two different implementations:

- Sergi Nadal Boera & Gustavo Patow (U. of Girona)
- Dapeng Cao (U. of Adelaide)
PROCEDURAL GENERATION OF TRADITIONAL ASIAN BUILDINGS

Sergi Nadal Boera & Gustavo Patow
ViRVIG-UdG
Integration with **skylineEngine** and **buildingEngine**.

- A set of libraries created at the Geometry and Graphics Group at the University of Girona
- For the procedural creation of buildings and cities
This part of the development is based on:

Basic structure of a storey

Roof: Tiles, top ridge, side ridges, diagonal ridges

Top Beams: (Straight, lateral or bracketed), panels

Wall: Portals, pillars, beams

Floor: Rails

Procedural generation of traditional asian buildings
Some basic parts

- Roof margin
- Beam margin
- Pillar margin
- Floor margin
- Railings
- External Pillar
- Wall
Roofs are the most characteristic part.
(1) Regular double-sided roof,
(2) Special case: Length=0, SideEaveStart=0
(3) Special case: SideEaveStart=1 (no side eave)
(4) Special case: SideEaveStart=0
Modeling a curved roof

Circle center, \( C = (-R \cos \phi, R \sin \phi) \)

Circle radius, \( R = \frac{L}{\sin \alpha} \)

\[ \phi = \frac{\pi}{2} + \theta - \alpha \]

\[ \frac{\pi}{2} - \alpha \]

Procedural generation of traditional asian buildings
All curves are based on simple sinusoidal patterns

\[ y = \left( 1 - \cos(\pi \times \frac{i}{n\text{Mostres} - 1}) \right) \times 0.5 \]

\[ x = \text{StartCurve} + \left( \frac{i}{n\text{Mostres} - 1} \right) \times i \]
Design

- BaseCurve
- HighCurve
- R_LateralCurve
- L_LateralCurve
Design

- BaseCurve
- HighCurve
- R_LateralCurve
- L_LateralCurve

Procedural generation of traditional asian buildings
- BaseCurve
- HighCurve
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Procedural generation of traditional asian buildings
- BaseCurve
- HighCurve
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- L_LateralCurve
- Join curves
- Generate surface between curves
- With raised arch and auxiliary perpendicular roofs,
- Modeled after the Himeji Castle
Implementation details (Base Roof)

Procedural generation of traditional Asian buildings
The user can import custom-designed models for decorative roof figurines, ridges and lanterns. Such elaborate designs are common in temples in Southern Chinese style.
Decorations and textures over the base roof
HR_TUB Class

- Generates the tube that follows the HighCurve
- T apply the texture:
  - Sample the curve (e.g., 30 samples).
  - Add the decoration (i.e., a cylinder) at each sample
Add a representative figurine
(Chinese only)
Add decoration at regular distance intervals

Decoration: Lanterns
Final module: thickness and roof endings…
Actual Usage...

Procedural generation of traditional asian buildings
User Interface

Procedural generation of traditional Asian buildings
Persistence

```xml
<rule>
  <predecessor name="pagoda">
  </predecessor>
  <successor>
    <action name="Lib:AsianRoof:AsianRoof">
      <param name="folder1" value="1"/>
      <param name="TopBottomLowered" value="3"/>
      <param name="TopLenght" value="16"/>
      <param name="Width" value="5"/>
      <param name="RaisedArchStartCurve" value="5"/>
      <param name="useSideRoof" value="1"/>
      <param name="RoofMargin" value="0.3"/>
      <param name="Walls" value="0.026"/>
      <param name="BottomLoweredReached" value="3"/>
    </action>
    <param name="RaisedArchEndCurve" value="7"/>
    <param name="useDecoration" value="0"/>
    <param name="BottomLowered" value="1"/>
    <param name="TopLowered" value="1"/>
    <param name="BoxPosz" value="0"/>
    <param name="RaisedArchLenght" value="2"/>
    <param name="BoxPosx" value="0"/>
    <param name="BoxPosy" value="0"/>
    <param name="BoxSzex" value="10"/>
    <param name="BoxSizez" value="5"/>
    <param name="Height" value="30"/>
    <param name="BaseLenght" value="16"/>
    <param name="RaisedArchHeight" value="1"/>
  </successor>
</rule>
```
Walls and pillars follow an (almost) regular pattern
Follow a Repeat-Insert pattern
Walls and Pillars

Procedural generation of traditional Asian buildings
RESULTS
Basic Roof

Procedural generation of traditional asian buildings
Procedural generation of traditional Asian buildings
Results: Generic Building

Procedural generation of traditional Asian buildings.
Inspired on the Temple of Perfect Harmony

• Forbidden City (Beijing)
Results (Temple of Perfect Harmony)
Conclusions

- Procedural tool for ancient east asian buildings
- Easy to use for prototyping
- Integration with `skylineEngine` and `buildingEngine`.

Procedural generation of traditional asian buildings
Cao, Dapeng

CHINESE TRADITIONAL TIMBER STRUCTURE
Up to now we have reviewed how to (procedurally) build the exterior of the roof, walls and columns.

However, some ancient Asian roofs have a complex timber structure, which should also be modeled.
We base our study on

Examples

Procedural generation of traditional Asian buildings
Trace documentation

Procedural generation of traditional Asian buildings

MAIN HALL OF FO-KUANG Ssu · WU-TAI SHAN · SHANSI
Identify structure from old drawings

Procedural generation of traditional asian buildings
Actual timber structure in layers

Future Work

Done

Procedural generation of traditional asian buildings
Basic building unit

Procedural generation of traditional asian buildings
Walls (already done)
Procedural generation of traditional asian buildings
Future Work

- Timber structure!!!
- Add more intuitive handlers
- New textures and decorations
- Generate pagodas with square and octagonal basis
- Special Roofs (exceptions)
- Entrance doors…
Merci Beaucoup!

Questions?
Procedural generation of traditional Asian buildings