A WEB-BASED INTERACTIVE TOOL FOR MULTI-RESOLUTION 3D MODELS OF A MAYA ARCHAEOLOGICAL SITE

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Overview

• The archaeological site of Copan
  – Real-world and modelled

• The “QueryArch3D” tool
  – Why such a tool?
  – Characteristics
  – Implementation status and first results

• Conclusions & Outlook
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• Copan facts:
  – Archaeological area spans over 24 km$^2$
  – Over 3700 structures (ca. 450-850 A.D.)
    • Temples,
    • Palaces,
    • Altars,
    • Stelae,
    • Residential buildings,
    • etc.

• Copan is considered the «Paris of the Maya»
Copan, Honduras

Temple 16

Temple 26, Hieroglyphic stairway

Altar G

Altar Q

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Temple 22 in the East court, its interior doorframe (with skull detail), and the corner mask.
• Variety of objects and sizes...
• ...acquired using various modelling paradigms in the course of time:
  – Tabular data,
  – Images,
  – 2D maps (some of them digitised),
  – 2.5 maps,
  – 3D high-resolution reality-based models,
  – 3D reconstructions
Problem definition

• Problem: How to manage, query, compare, ..., ..., ..., integrate and use all these data together?

• An ideal “tool” should at least

  1. and query of geometries & attributes,
  2. allow 3D interactive visualisation of geodata...
  3. handle multi-resolution models and all “standard data”,
  4. be accessible locally, but also on-line
• An out-of-the-box, unique tool does not exist so far
  – (Web)GIS tools are still mostly 2D-2.5D
  – Several models of the same object (different scales, resolutions, quantities of information)
  – Handling "heavy" reality-based models can be problematic

  – Example: Google Earth
  • Limited query possibilities
  • Geometric models are relatively simple
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Introducing…

The **QueryArch3D** tool

- takes inspiration from existing approaches
- tailored to the needs of Copan

Development steps:
1. Define a conceptual schema for LoDs, geometric and semantic hierarchies (i.e. the part-of-relations)
2. Check & structure existing data accordingly
3. Data integration & homogenisation
4. Develop the visualisation & query front-end
Step 1: LoDs and hierarchies

• 4 Levels of Detail
  – LoD1: Single (or set of) prismatic geometries
  – LoD2: 3D models (only exteriors)
  – LoD3: 3D models (with interiors)
    • Some elements can be (simplified) reality-based models
  – LoD4: 3D high-resolution models or architectonic details (reality-based)
Step 1: LoDs and hierarchies

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Step 1: LoDs and hierarchies

Example of semantic hierarchy for a Copan temple

Temple → Substructure → Platform
  ↓ Axial stairway
  ↓ Salient

Superstructure → Storey#

Exterior → Ext. doorway
  ↓ Ext. walls
  ↓ Ext. sculptures
  ↓ Molding
  ↓ Roof

Interior → Rooms
  ↓ Walls
  ↓ Ceiling
  ↓ Floor

Int. doorway
Datasets used (so far):

- LoD1: extrude 2D features from a shapefile with features height info
- LoD2/3: Temple 22 model from 3ds file
- LoD3: Stelae and arch. elements (reality-based, simplified models)
- LoD4: Stelae and arch. elements (reality-based, high resolution)

Attribute data from dbf, txt files and Filemaker Pro
Step 2: Check & structure existing data

• Data aggregation:
  – Aggregate the LoD1 geometries from over 19000 geometric features to ca. 3700 Copan structures

From over 19000 polygons... ...to ca. 3700 structures
Step 2: Check & structure existing data

• Data disaggregation:
  • Divide LoD2-4 models into subparts
Step 3: Data integration

• All geometries aligned and georeferenced
• Geometries linked to attributes
• All data imported and stored in PostgreSQL/PostGIS

• Currently:
  – LoD1: 3737 obs, 123980 tris
  – LoD2: 14 obs, 2588 tris
  – LoD3: 108 obs, 197791 tris
  – LoD4: 68 obs, 791854 tris
Step 4: Front-end development

- The visualisation and query front-end has been implemented using Unity 3D
  - game engine
  - scripting capabilities (quick development time)
  - has also libraries to access remote databases
  - on-line applications accessible through a free browser plugin

- Data retrieval by a PHP interface between Unity and PostgreSQL
Step 4: Front-end development

• **Navigation:**
  - aerial view (LoD1 only),
  - ground-based view (LoD1-2-3)
  - detail view (LoD4)
Step 4: Front-end development

Walk-through mode for LoD2 and LoD3

Detail view mode for LoD4
• Queries:
  – Attribute queries over the whole dataset ("Show structures built by ruler x", "Highlight all structures belonging to group y"):  
  – Single-object queries, LoD dependent
    • LoD1: only global attributes  
    • LoD2-4: global attributes + subpart info  
  – Distance measurements and line-of-sight analyses between two selectable positions
Step 4: Front-end development

Query on attributes + highlight results

Query on click: LoD1 object

Query on click: LoD3 object

Query on click: LoD4 object
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Conclusions

- A workflow/pipeline has been established
- The QueryArch3D:
  1. can handle multi-resolution models
  2. allows 3D interactive visualisation
  3. allows queries of geometries & attributes,
  4. can be used locally or on-line...
- Initial results fulfil the requirements...
- …but it is still a prototype!
• (Some) future improvements:
  – Further tests and debugging
  – Add more LoD2-3-4 models (and textures!)
  – Complete integration of remaining data
e.g. add multimedia contents
  – Add more query & analysis functions:
    • Switch on/off reconstructed models
    • ......
  – Create user-friendly interface for data administration
Thank you for your attention

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