Tools for Populating Cultural Heritage Environments with Interactive Virtual Humans

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Introduction

Access and Interpretation

Cultural Heritage Data

Data capture

Data visualisation

Introduction

- 3D Virtual Environments - suitable medium:
  - Visual environment suitable for contextualising CH data.
  - Real time - Interactive experience enables exploration of the environment.
- To achieve this = 3D scene + realism (by including natural elements such as virtual humans).
- Challenges as VR environments are melting pot of technologies!

Introduction

- Frameworks are a good solution.
  As they offer ease of:
  - ✓ Reusability of components
  - ✓ Replacements
  - ✓ Extensions
  - ✓ Adaptations
  - ✓ Reconfigurations
  - ✓ Maintenance

- Within EPOCH we aimed to improve and release frameworks that support the development of interactive VR environments. In particular, those which feature virtual human simulation.

Results

- Set of tools to incorporate avatars that react to model metadata adding realism and interest for users:
  - Open source VHD++ kernel and plug-in.
  - Improvement of UEA Scene Assembly Toolkit and its interaction with natural language generation.
- Integration is achieved by using a common data-exchange format and providing plugins for 3rd party frameworks, such as OpenSceneGraph and OpenSG.

VHDPlus

- UNIGE and EPFL have adapting and releasing their core platform vhdPLUS as open-source tool for the cultural heritage community.
- The vhdPLUS Development Framework is a modern, fully component oriented simulation engine and software middleware solution.

Example of a VHD++ AR application

VR Database
- *3D scene*
- *occluders*
- *virtual humans*
- *sounds*
- *face anim.*
- *clothes*
- *plants*
- *scripts*

vhdRuntimeEngine
- AR Blending
- 3D Rendering
- Sound
- Skeleton Animation
- Skin Deformation
- Cloth Physics
- Face
- Speech
- Plants
- Python Scripting
- Scenario
- VRML Loader
- XML Loader

Augmented Scene

Image for camera tracker

FireWire

shared items

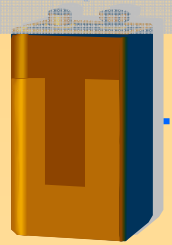
N. Magnenat Thalmann, G. Papagiannakis. **Virtual Worlds and Augmented Reality in Cultural Heritage Applications**. *Recording, Modeling and Visualization of Cultural Heritage - Baltsavias et al. (eds) 2006 Taylor & Francis Group, London, ISBN 0 415 39208X, p. 419-430*. January 2006

Camera matrix

Image for blue box

RT Camera Tracking

Feature tracking DB



Lithium rechargeable battery

Results

- integrating UEA, EPFL and UNIGE virtual human technology (e.g. rendering of virtual humans)
- open-source release of several key software libraries for the VHD++ VR/AR Real-Time Character Simulation framework
- Release of both OpenScenegraph and OpenSG rendering plug-ins for VHD++, as LGPL open-source
- Infrastructure for sharing resources (sourceForge)



Results

- VHD++ main components released as open-source “vhdPlus”
  - Includes following parts:
    - OpenSceneGraph & OpenSG based rendering and rigid body animation
    - VRML97/HANIM1.1 low level parser library
    - Helper library for Virtual Human control: libvhdOSGExt
    - Sourceforge site
      - Includes full source code and setup & “getting started” documentation
  - latest added functionality \
    - Improved 3DSMax OSG exporter
    - Easier installation and build scripts
    - Basic Math library (vhdMath) (with/without SSE instruction)
    - Precompiled third party libraries
    - Python interpreter

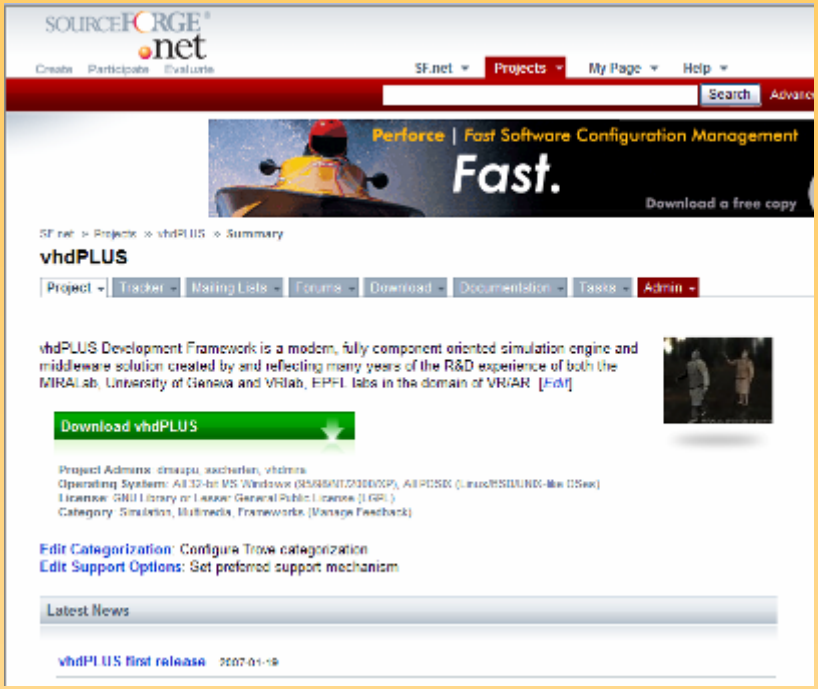
Results

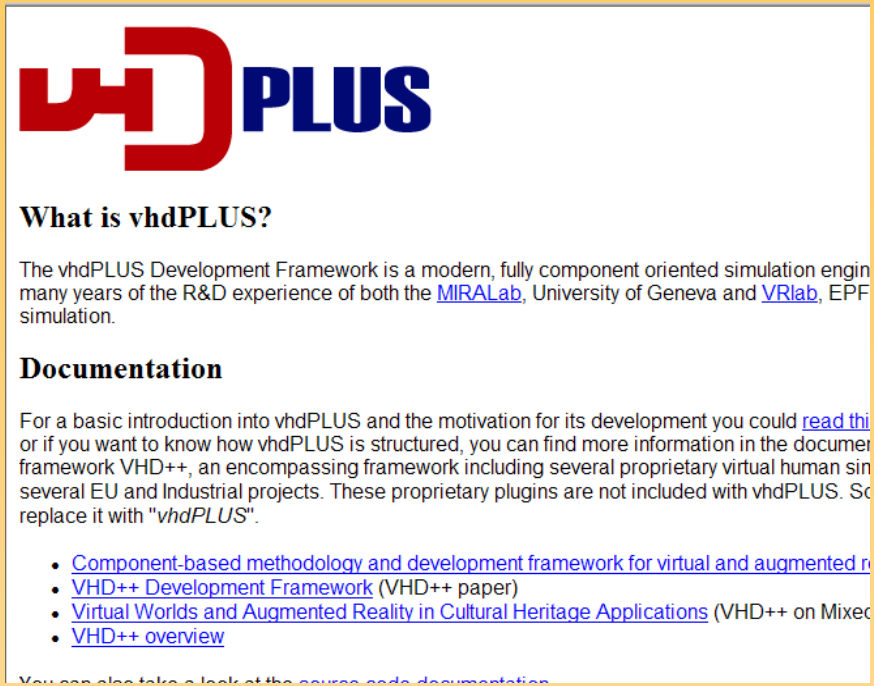
- vhdPLUS documentation distribution
  - Documents detailing vhdPLUS' structure and usage
    - [PON04] , [PPM03] and others
  - Tutorial documents
    - "VHD++ Technical Introduction"
  - Doxygen generated source code documentation
  - Release through Sourceforge platform

[PON04] *Component-Based Methodology and Development Framework for Virtual and Augmented Reality Systems*, Michal Ponder, 2004, Ph.D. thesis

[PPM03] *VHD++ Development Framework: Towards Extendible, Component-Based VR/AR Simulation Engine Featuring Advanced Virtual Character Technologies*. Michal Ponder, George Papagiannakis, Tom Molet, Nadia Magnenat-Thalmann and Daniel Thalmann , In CGI 2003

Sourceforge vhdPLUS availability





http://sourceforge.net/projects/vhdplus

Download of Open Source release of vhdPlus under LGPL license

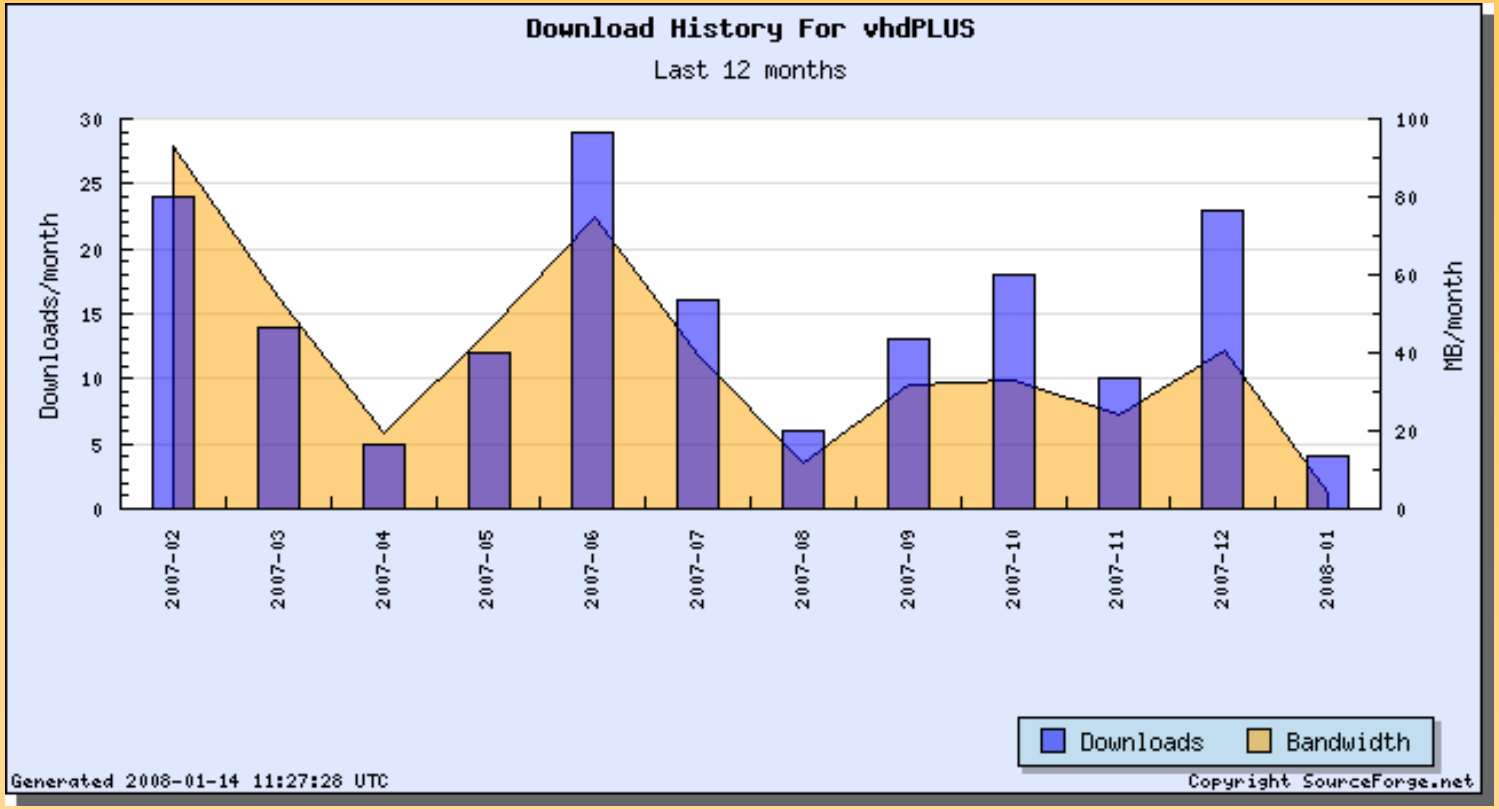
(available since December 2006)

http://vhdplus.sourceforge.net

Installation instructions + full documentation of system structure

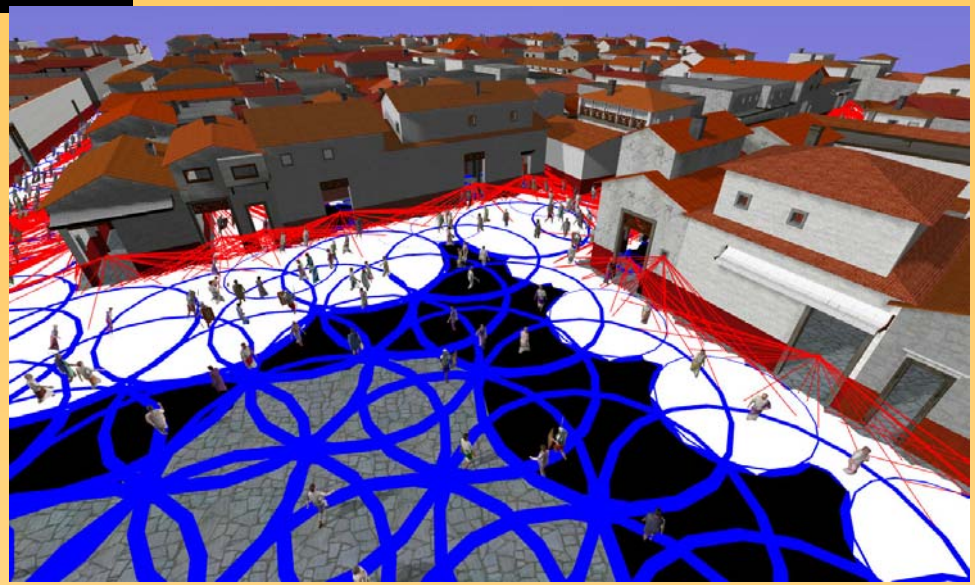
Separate **Acknowledgements** section for EPOCH, NEWTON and Characterize

SourceForge vhdPLUS statistics



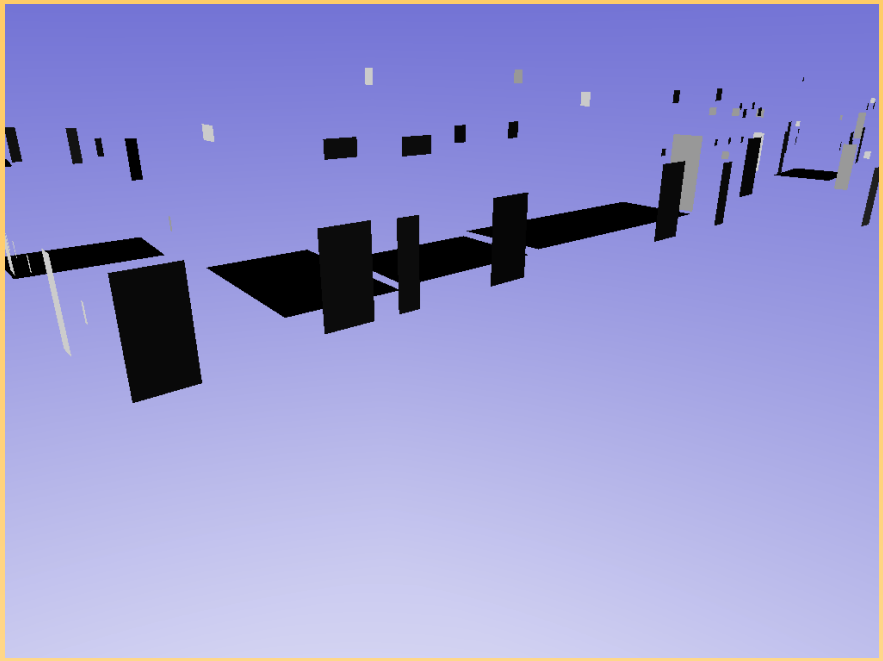
- 198 total number of vhdPLUS framework downloads since January 2007 (ranging from 4 to 29 per month)
- 4 downloads so-far only in January 2008

Roman Crowd Simulation



- Virtual Roman template creation (appearance variety)
- Adapt Pompeii model to crowd engine (real-time + collada)
- Navigation graph creation (path flows)
- Behavior modelling

Pompeii Collada Scene & Semantics Files



Populating Ancient Pompeii with Crowds of Virtual Romans.

Jonathan Maïm, Simon Haegler, Barbara Yersin, Pascal Mueller, Daniel Thalmann and Luc Van Gool.

The 8th International Symposium on Virtual Reality, Archaeology and Cultural Heritage (VAST'07), Brighton, UK, November 26-30, 2007.

Roman Crowd Simulation

Video….

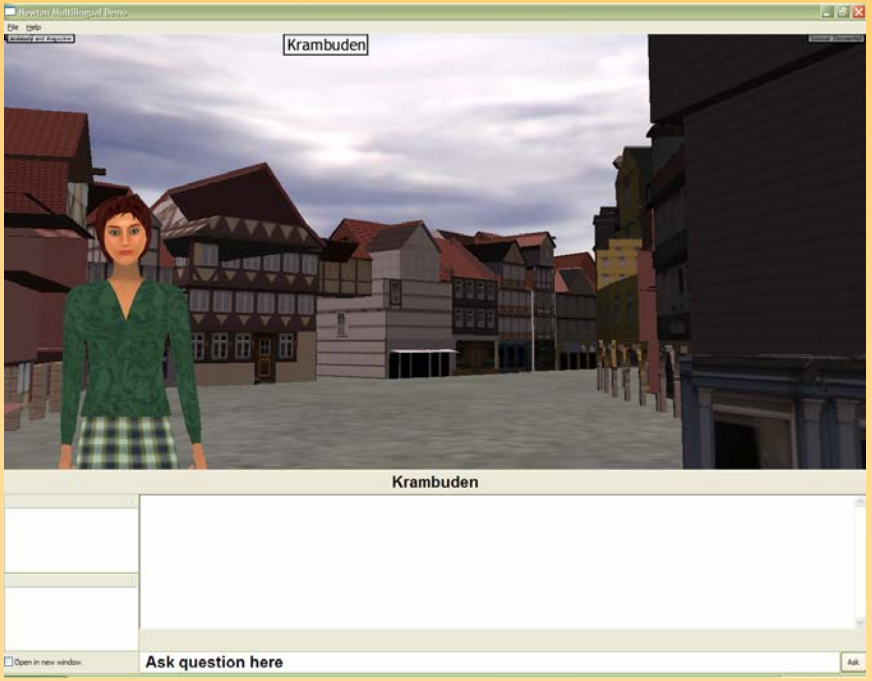
UEA Scene Assembly Toolkit

- Supports the assembly pipeline by offering the following components:

Scene Assembly Toolkit

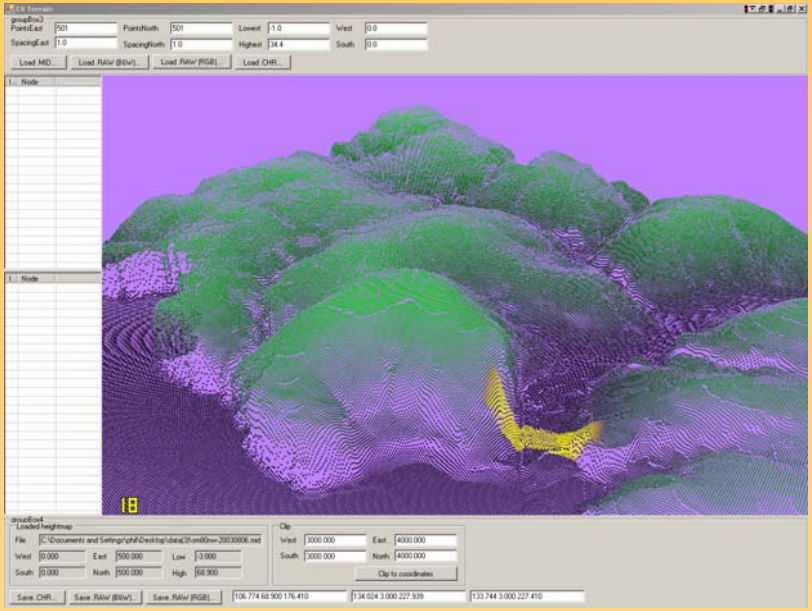
- Terrain converter
- Avatar Research Platform (ARP)
- Scene Assembler
- EPOCH Scene Renderer

Natural Language Module

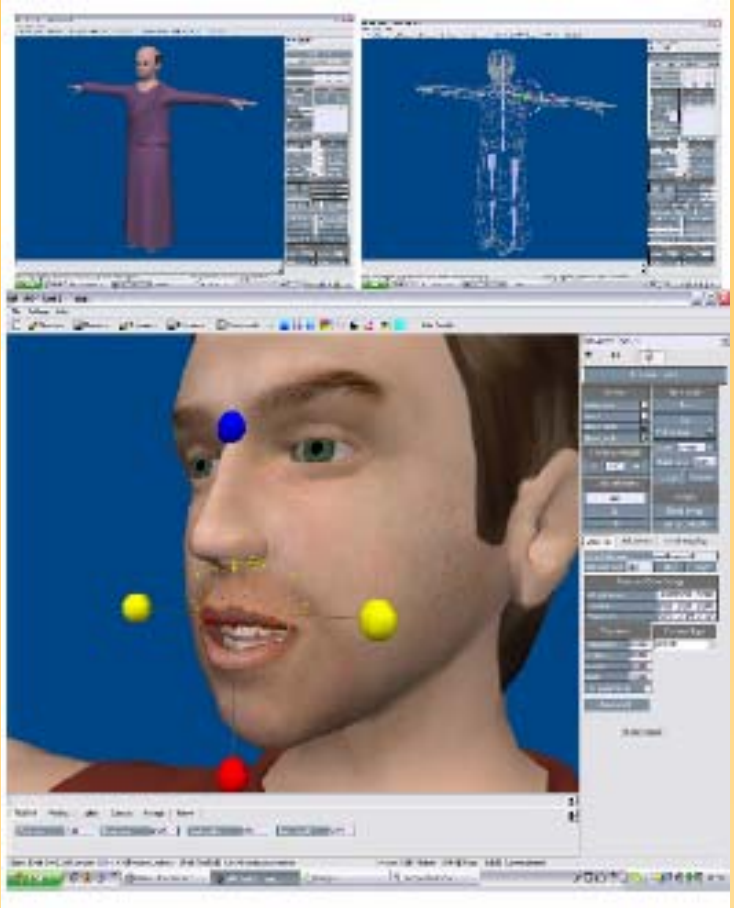


Terrain Converter

- Terrain data is converted from a regular grid to a ground model, beginning the building process.
- Rendering in real time uses ROAM deriving a height map.
- Information is used to drive avatar over the terrain in the environment.

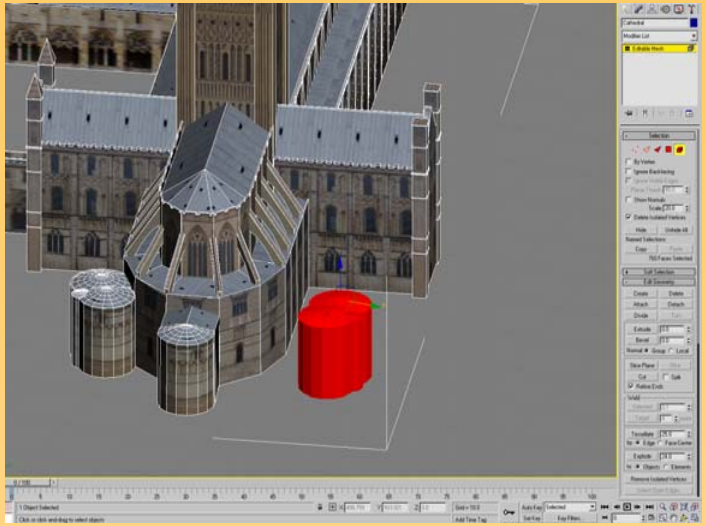


Avatar Research Platform



- Tools for conventional mesh attachment and design.
- Tools for facial morph creation.
- Custom avatar creation.
- Exports to Maya, FBX and Collada.

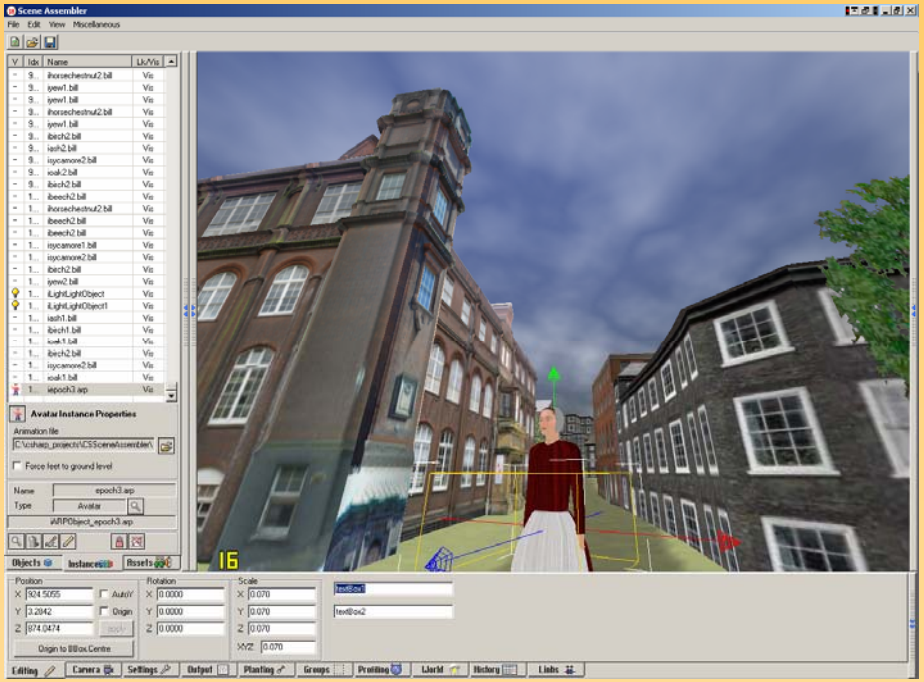
Scene Assembler



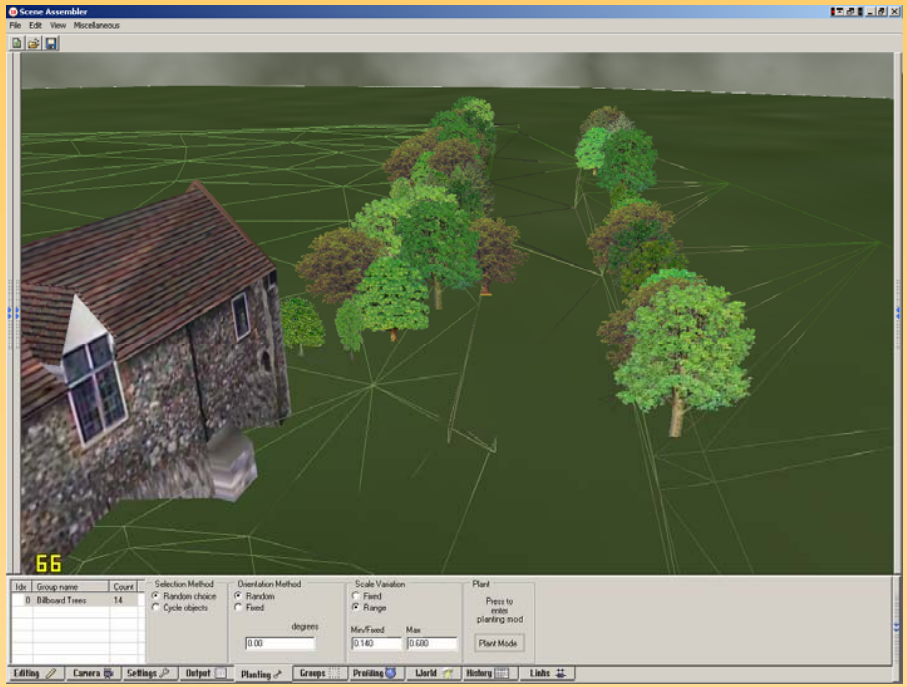
- Creates a final scene.
- Simple static geometry objects are added from popular modelling software (3DSMax, Maya, etc.).
- Billboard objects defined by text to represent trees, lamp posts, and other street furniture.

Scene Assembler

The objects are combined using scriptable operations and allows manual optimization. Exported to COLLADA format.

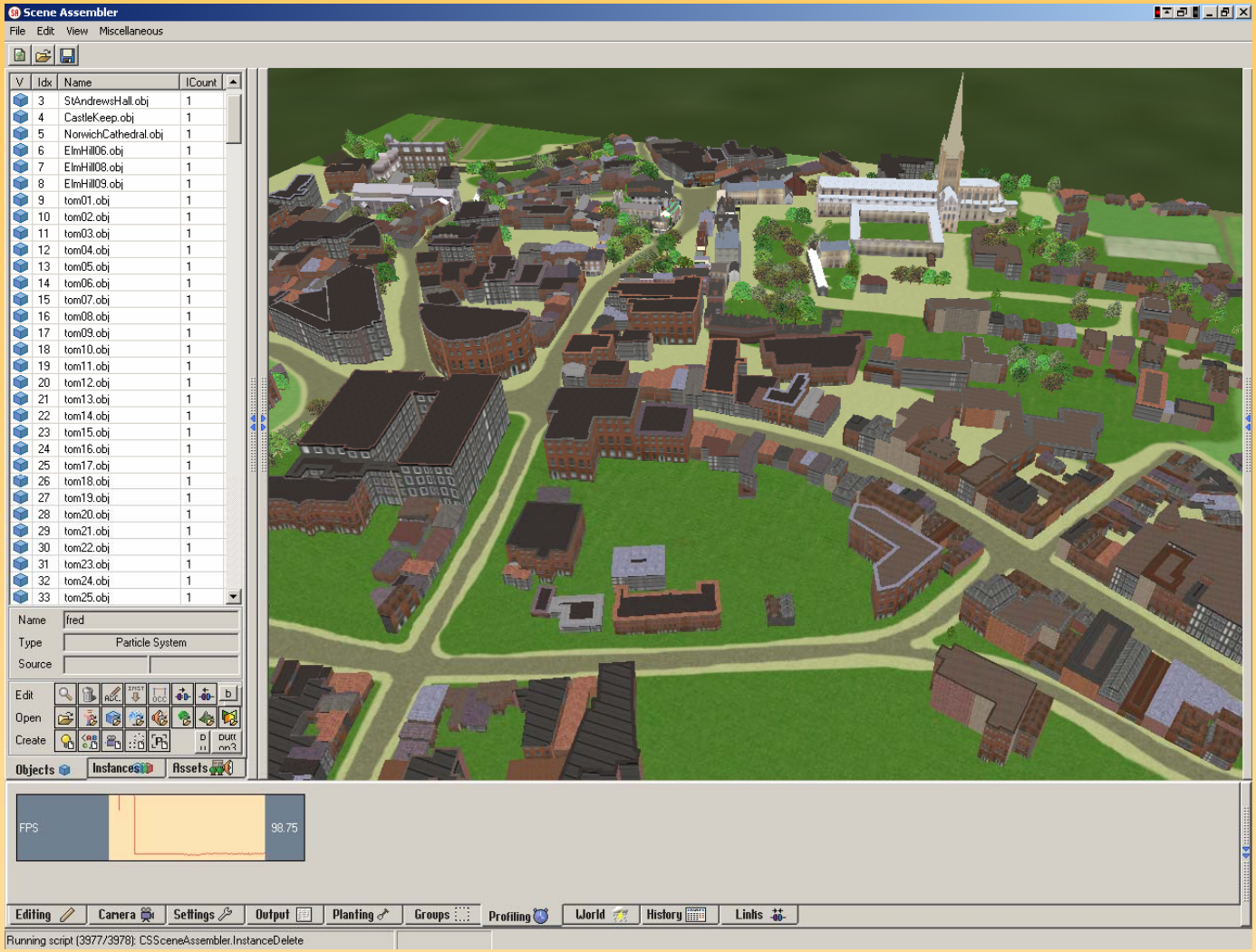


Individual virtual humans are placed in the scene with animations.



Plant a selection of objects from a group with a single click – especially useful for rapidly adding vegetation.

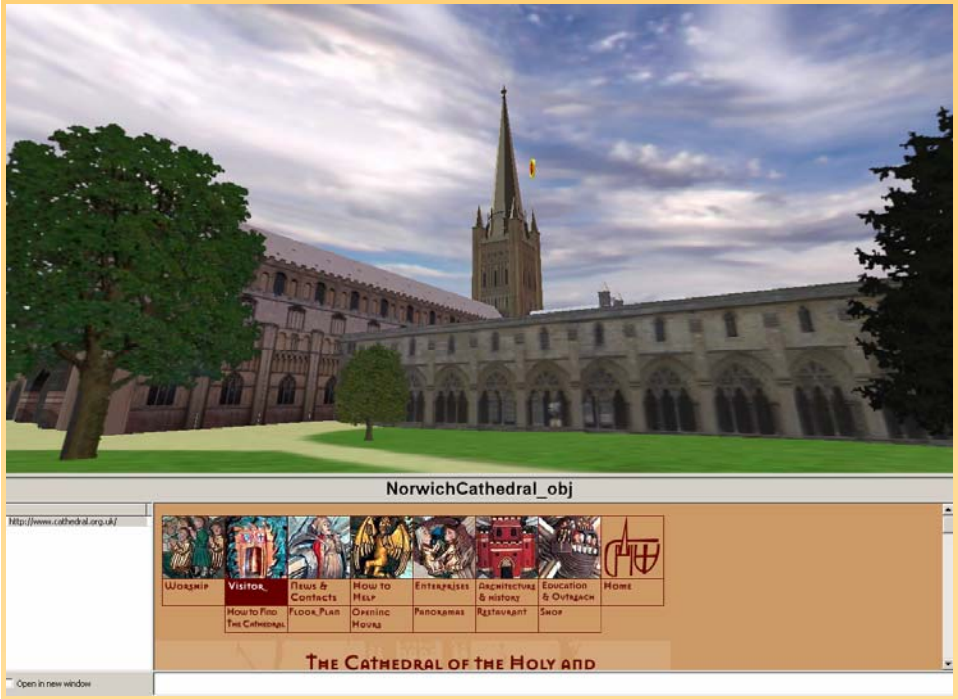
Final scene



An overview of a completed scene (Norwich).

EPOCH Scene Renderer

- The scene is imported to the scene renderer to provide an interactive environment.
- OpenSG based renderer.



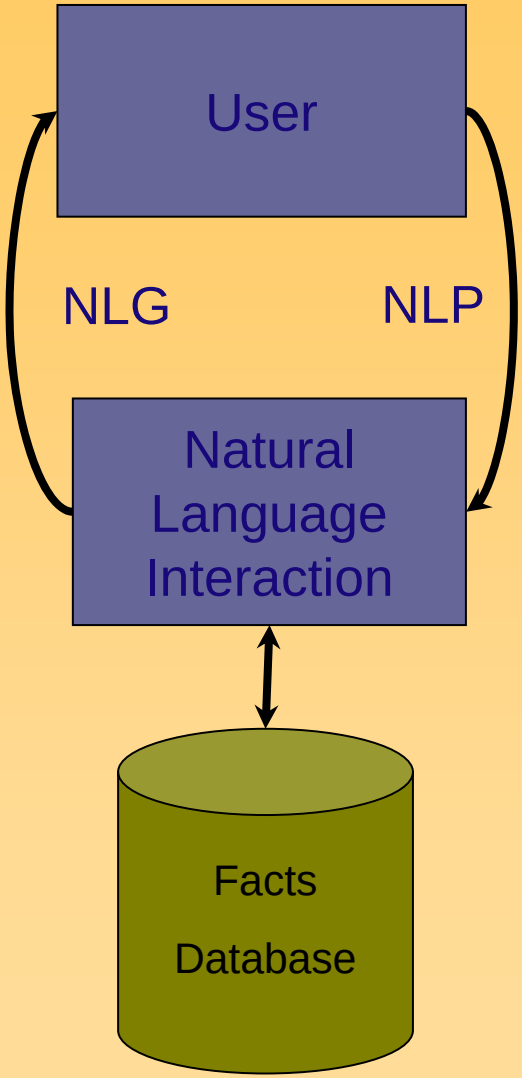
Natural Language Interaction

Can be used to interact with the environment, by:

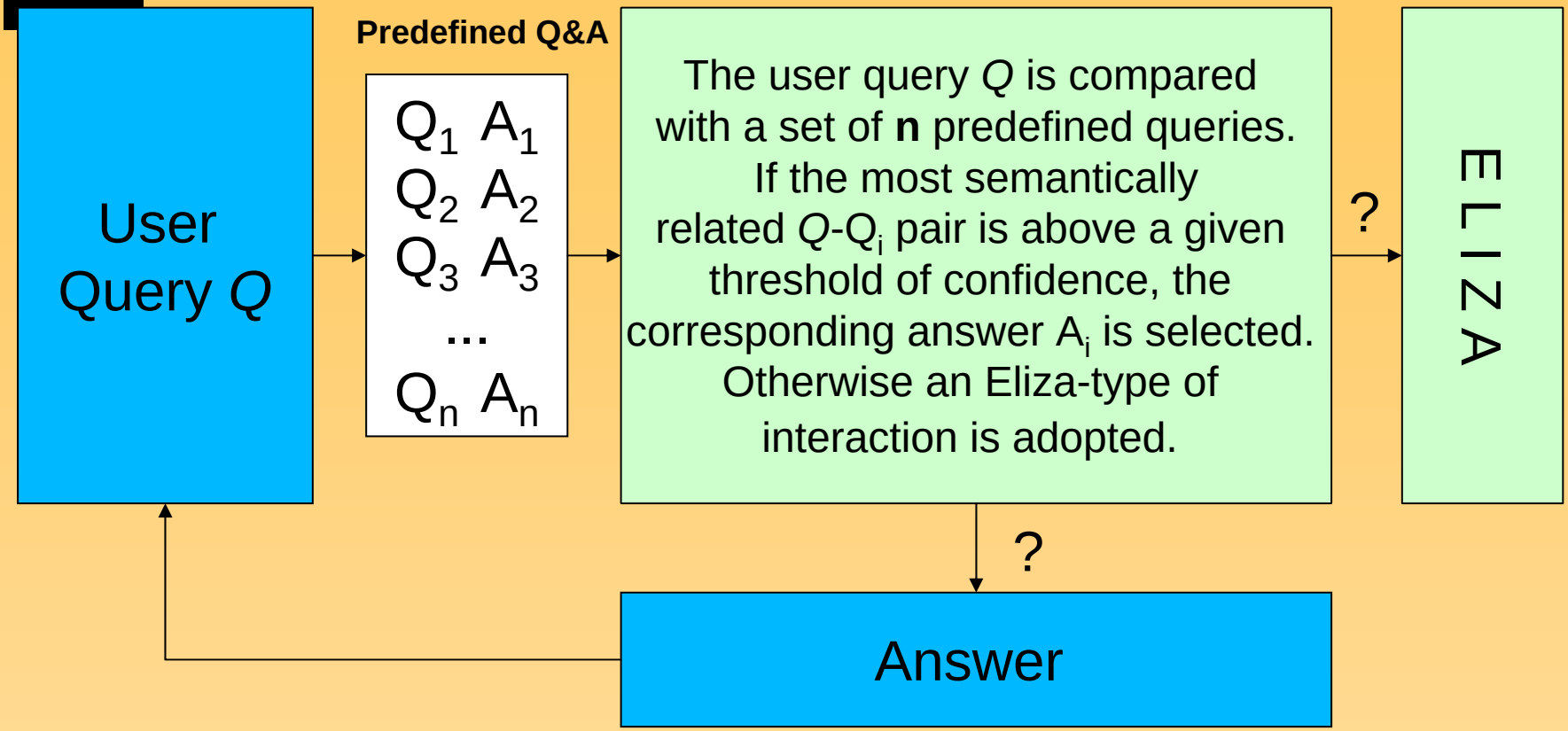
- Allowing user to access information using natural language.
- Providing text for the avatar.
- Fitting the text to different modalities (user's language, knowledge, etc.

Natural Language Process

- Through Natural Language Processing (NLP) and Generation (NLG), users can interact and query databases in CIDOC-CRM.
- Resources are available for a wide range of languages (multilingualism).
- By combining the mining and interactive tools, language technology automates the structuring and querying of heterogeneous and semi-structured information within the framework of CIDOC-CRM.

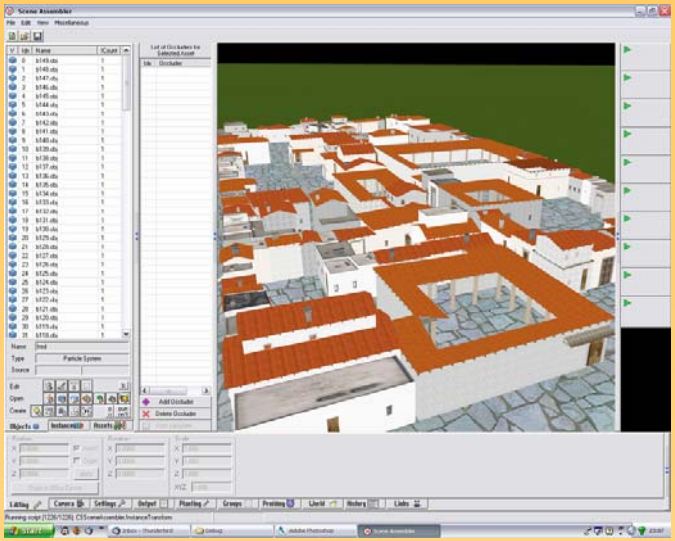


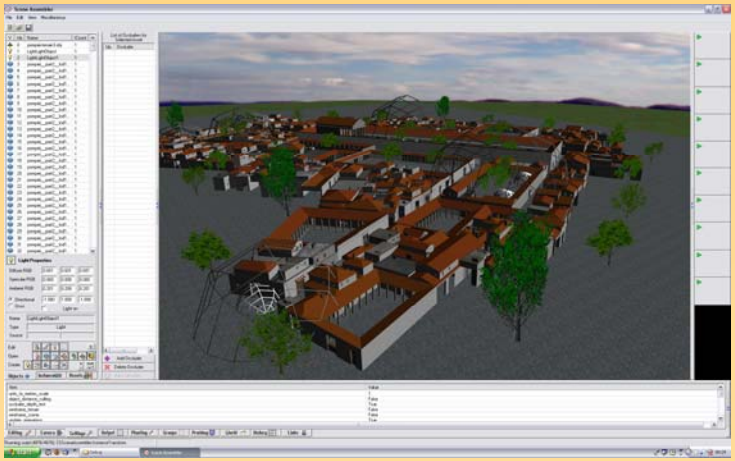
Selecting an appropriate answer: Semantic similarity



Semantic similarity is computed using dynamic programming where deletion, insertion and substitution are given a cost. WordNet provides a measure of the cost for substituting one word for another.

Importing and existing scene: Pompeii





1. Data is imported into the Scene Assembler to enable particular areas in the model to be augmented with metadata.
2. Model saved in COLLADA.
3. Model imported into the EPOCH Scene Renderer.
4. Avatar modelled and imported into Scene Renderer.
5. Interaction is provided via the natural language processing module.

Built a story for the interactive experience

POMPEII (REGIO 7 AND 8) - Path for story

1. Porta Marina
2. Basilica
3. Capitolium Temple
4. Market
5. Bakery
6. Forum Bath
7. House of Pansa

8 locations

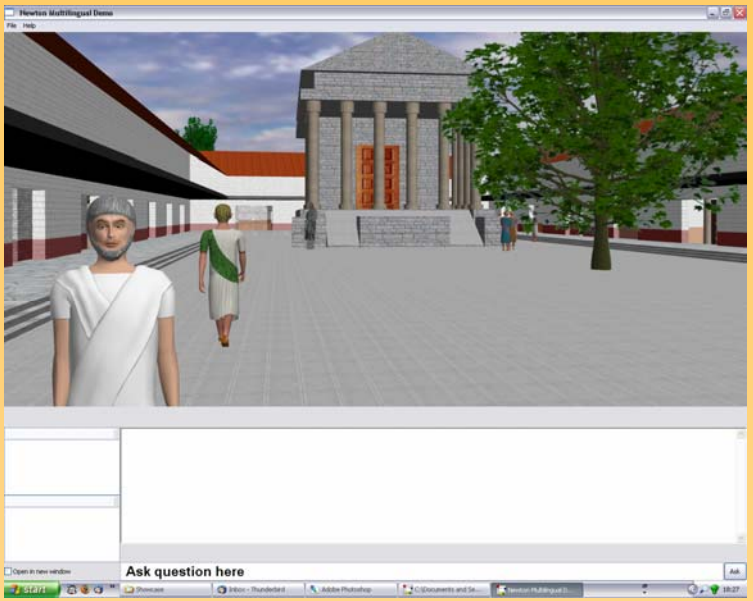
The guide (avatar) is a citizen of Pompeii guiding the visitor around the town.

Story setting

- The story starts in the first location (Porta Marina) and this message will be displayed:
  - *"Today the 14th December of 70 AD, you have been transported in time to visit Pompeii. You will be hosted by one of his citizens, Pansa who has become one of the wealthiest men in Pompeii during the last years. You might ask Pansa questions regarding Pompeii, its inhabitants and the Romans in general. Enjoy the trip!"*

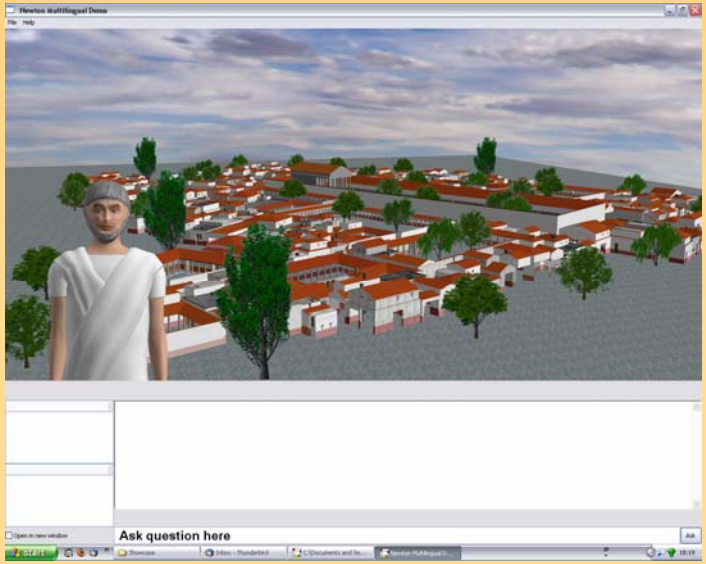
Story setting

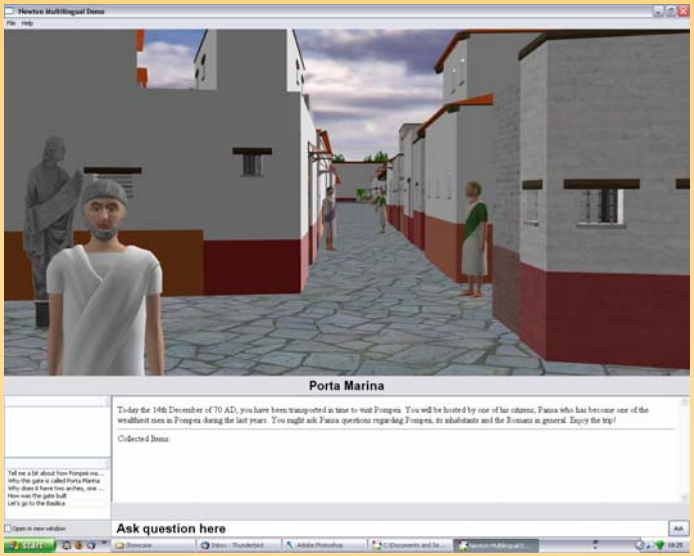
- Guide meets visitor at (1) Porta Marina gate and
- they go to the (2) Basilica to listen to the daily public announcements.
- Then they go to the (3) temple to make an offer to ask for help during the visit.
- After, they go to the (4) market to buy a present for the son of Pansa.
- Pansa remembers that he has to buy some bread before heading home. So they head for the (5) bakery.
- Pansa wants to shows the visitor the newly redecorated (6) bath, so they go there to relax and chat quietly.
- Finally, they head to (7) Pansa house to have dinner with the family.



Further challenges

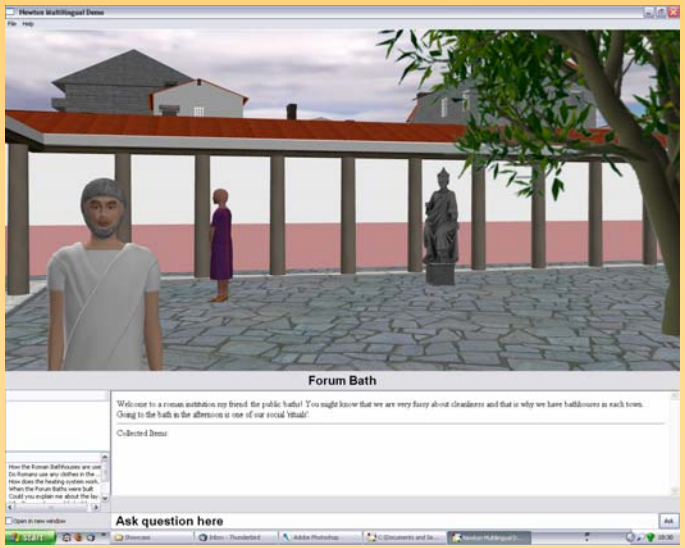
- Using 3D format standards to encompass all the required information.
- Even formats like COLLADA lacks the ability to reuse geometry, or enable higher level of abstraction.

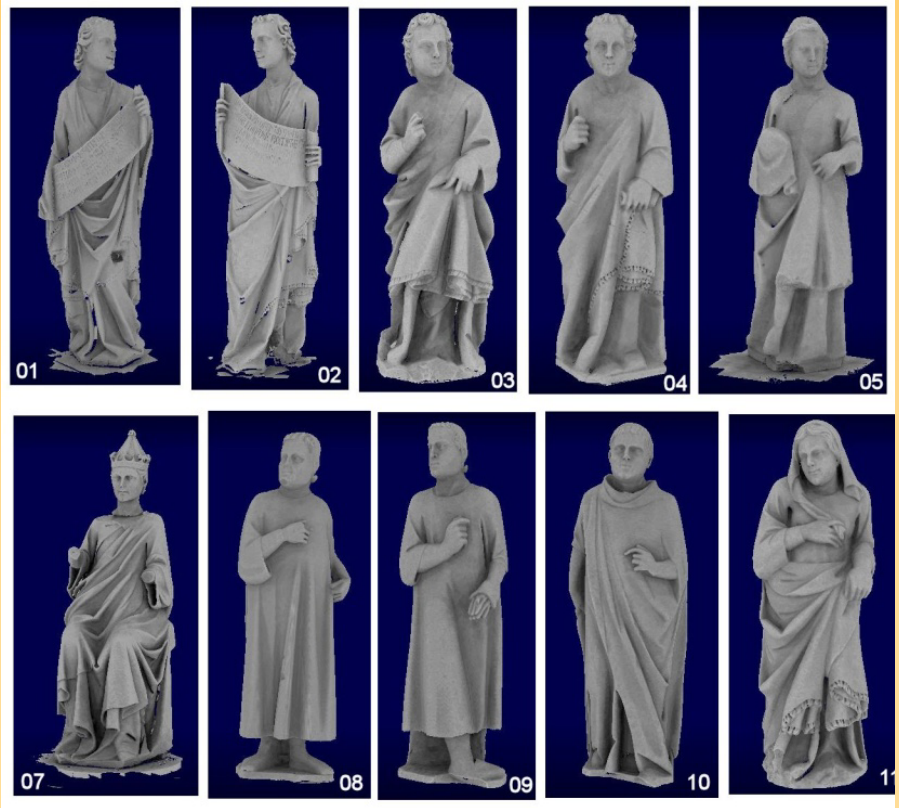




Include Nexus Objects

- Distributed around the virtual environment.
- Viewed by launching EPOCHViewer to inspect in further detail, when the user approaches them.





Usability Testing

Focus group of 12 users, using a Formative Evaluation and Post-hoc Usability Questionnaire

Usability Results

- Multimodality displayed by the system was received with diverse responses, highlighting the struggle in the Virtual Reality domain: that of realism against interactivity.
- Users wanted realism (for which they considered avatars to be an important element) but most importantly they also wanted interactivity.
- Preferred those interaction techniques which had been learned from previous experiences with 3D environment, in particular from games.

Acknowledgments

- Thanks to research teams:
  - University of East Anglia
  - University of Geneva - MIRALab
  - École Polytechnique Fédérale de Lausanne - VRLab
  - University of Brighton