Multimedia Mashups for Mirror Worlds

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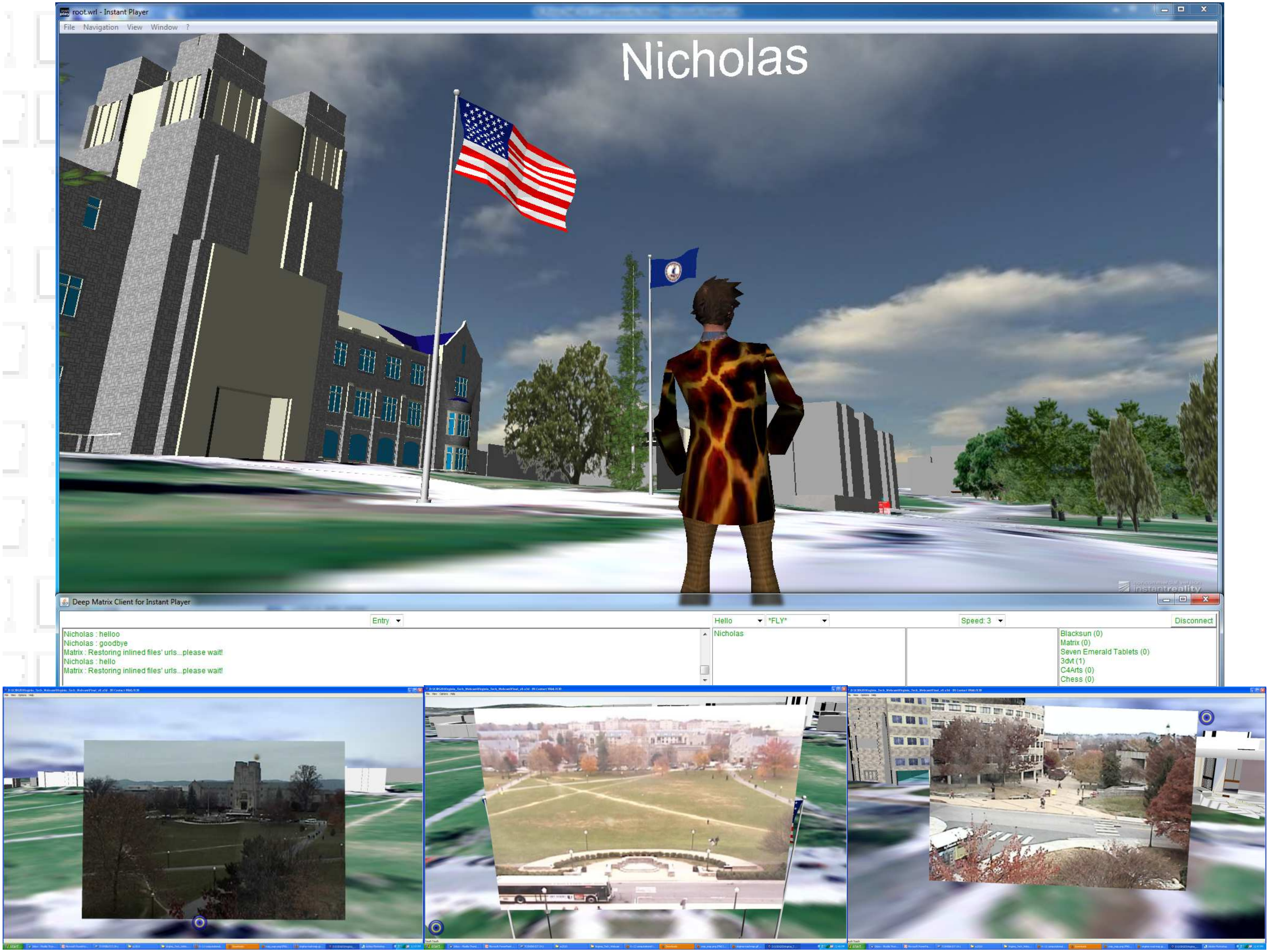
root.wrl - Instant Player
File Navigation View Window ?
Nicholas
Deep Matrix Client for Instant Player
Entry
Hello
FLY
Speed: 3
Disconnect
Nicholas : helloo
Nicholas : goodbye
Matrix : Restoring inlined files' urls...please wait!
Nicholas : hello
Matrix : Restoring inlined files' urls...please wait!
Nicholas
Blacksun (0)
Matrix (0)
Seven Emerald Tablets (0)
3dvt (1)
C4Arts (0)
Chess (0)

Introduction: Mirror Worlds

- Mirror worlds: digital representations of real-world objects and locations.
  - Provide real-time mapping from real world objects to software equivalents
  - Incorporate data from the real world into virtual worlds
- More and more deployments in recent years; several application areas

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Mirror Worlds Applications

Public and private layers:

- Civic maintenance (roads etc)
- Civic planning (new or reno construction)
- Security (sensors, cams)
- Safety (simulation)
- Utilities (electricity, gas, water)

Mirror Worlds at Virginia Tech

- Variety of projects working to expand the concept and reality of mirror worlds.
  - Blacksburg Electronic Village
  - BT Tracker (town buses)
- Most visible example: 3D Blacksburg
  - virtual 3D version for the entire town of Blacksburg
  - ‘Town and Gown’ project

Data from Mixed Sources

- Mirror worlds provide a great integration and accessibility platform for geo-located data
- Natural spatial mapping
- Compelling environment for collection, fusion and dissemination
- 3D Blacksburg is a “mashup” from
  - variety of GIS data sources
  - real time updates from sensor data & cams
  - other multimedia

Toward an Economy of Scale

- Goal: presenting Geo-referenced data in an accessible, scalable, and interoperable way
- Repeatable / Automatable
- Low costs for data acquisition, maintenance and distribution

Key Factors

for Large-Scale Geo-referenced Data Distribution:

- **Accessibility / Portability**
- **Scalability**
- **Mashability / Interoperability**
- **Total Cost of Ownership (TCO)**

Qualities of Mirror Worlds

- Existential Correspondence
- Ontological Correspondence
- Spatial Correspondence
- Temporal Reflection
- Persistence

Content-Model Capabilities

- **Existential Correspondence**
  - Avatar creation, destruction, and control
  - Humanoid animation
- **Ontological Correspondence**
  - Real-time sensor data input
  - Object creation/destruction
- **Spatial Correspondence**
  - Scene-graph transformations
  - Multiple LOD (levels of detail)
  - Terrain and imagery
- **Temporal Reflection**
  - Real-time sensor events
  - Object manipulation
- **Persistence**
  - State-saving

Case Study: Science on a Sphere

- Created by NOAA, displays visualizations on a spherical screen for museum installations
- Data freely available, but requires a museum installation to view properly
- This equals ideal space for mirror world deployment

US National Ocean and Atmospheric Administration: NOAA

Science on a Sphere

Using X3DOM

- Implemented basic SOS world using X3DOM
- X3DOM allows for X3D worlds to be displayed within a web browser, no plugins!
- Proved suitable with workarounds
  - Reformating SOS videos
  - …

Case Study: 3D Blacksburg

- A town & university collaborative led by the Center for Geospatial Information Technology (CGIT) and the Visual Computing Group
- Developing databases and Spatial Data Infrastructure for the campus and the town
- Publish in KML and X3D from ESRI via Python
- Provide the capability for citizens to improve the model

3DBlacksburg.org

- Applications include:
  - community resilience and emergency management
  - town planning
  - social networking
  - university research
- Built from many pre-existing models
  - many with disparate origins
  - Chief requirement: interoperability

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Sources of 3D Models

- Terrain, building and scenery models are result of a variety of pipelines and tools:
  - Terrain and Imagery
  - Landscape & Scenery
  - Massing Models
  - Architectural Models
  - Detailed / textured Models
- Several formats
- Levels of Detail (LODs) align w/ OGC

Initial Solution: KML / Google Earth

- Google Earth proved to be **mashable**
- Licensing and cost issues presented by Google's product and the 3D Warehouse
- Limited ability for extension and customization of the content model
- Some limitations to accessibility (no mobile or immersive client capability)

KML

- \- Accessibility – to hardware and software platforms
- \+ Scalability – to traffic and detail
- \+ Mashability – integration of data and media types
- \- Total Cost of Ownership (TCO)

Moving to X3D

- Extensible 3D (X3D): royalty-free, open standard scene graph and run-time architecture to represent and communicate interactive 3D scenes
- We used several utilities to reduce polygons, flip back and front faces, re-center the model and re-scale the model (Xj3D CADFilters, Chisel, Vivaty)

Tradeoffs and Solutions

- **Tradeoffs Identified**
  - Coordinate system mismatches
  - Jitter
  - No way to automatically refresh webcam feeds
- **Solutions Pursued**
  - Coordinate transformation, truncation
  - Use of Javascript for webcam refresh

Results

- X3D provided suitable content model for the portrayal of the 3D Blacksburg prototype
- Primary advantage: **mashability**
  - Able to include webcam feeds, accurate positions of trees, flags, and other objects, and avatars
- Another advantage: **accessibility**
  - allowed us to display the model on a variety of display devices without modification

Conclusions

- Our work has:
  - Enumerated key requirements for content models representing mirror worlds
  - Explored tradeoffs used in delivering an economy of scale
- **X3DOM** had the highest level of accessibility, but lacked scalability to large worlds and textures
- Overall, the **X3D content model** provided the best in accessibility, scalability, mashability and TCO
- The X3D Blacksburg mirror world presents an excellent beginning for a range of applications and research in 3D web portrayal

Future Directions

- Continue to expand X3D implementation of 3D Blacksburg focusing on managing local detail
- Convert the portrayal coordinate system to use X3D's Geospatial component
- Evaluate how the presence of other avatars would impact the use of the mirror world

Proposed Improvements to X3D

- Spec:
  - Refresh time attribute for **ImageTexture** node
- Tools:
  - Better geospatial coordinate support
  - Better geospatial navigation support

Thank you!

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