Collaborative Mixed Reality Visualization of an Archaeological Excavation

Hrvoje Benko
Department of Computer Science
Columbia University

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Multidisciplinary Team
Excavation is destructive and physically “unreconstructable” process

Need to preserve as much data as possible for analysis

Data interpretation happens off-site

Current tools focus on 2D data and do not incorporate 3D information

Many experts—collaboration is a must!
Archaeological Excavation at Monte Polizzo, Sicily, Summer 2003
Ian Morris, Director (Stanford University)
Working in the field!
Meshed 3D Model (13 scans)
We have a 3D site model, now what?

Real

Virtual
Two Problems

► How to combine all this data in one seamless environment?
► How to make it easy to interact with?
VITA: Visual Interaction Tool for Archaeology

► Multiple users
► Multiple displays
  ▪ Projected tabletop
  ▪ Handheld
  ▪ High-resolution monitor
  ▪ See-through head-worn
► Multiple interaction devices
  ▪ MERL DiamondTouch table
  ▪ EssentialReality P5 gloves
  ▪ Speech input
  ▪ 6DOF tracker
Design Considerations

► Use the most appropriate display for the given data
► Facilitate both human-system and human-human interaction
Modular Architecture

3D Modules

AR Module

AR Module

Message Facilitator

Database

2D Modules

DT Module

SCREEN Module

HANDHELD Module
AR Module Components

- Head Tracker (Intersense IS900)
- Hand Tracker (Intersense IS900)
- Sony Head-Worn Display (LDI-D100B)
- Microphone
- P5 Glove (Essential Reality)
- DiamondTouch Table Connector (MERL)
Life-size Immersive Exploration
Provide natural interaction mechanism for our 3D environment

Modalities
- Speech: IBM ViaVoice 10
- Gestures: EssentialReality P5 glove
- Selection statistics: SenseShapes

Focus on selection
- Based on collaboration with Phil Cohen et al. (ICMI 2003) and SenseShapes (ISMAR 2003)
VirtualTray
Desktop Components

- High-resolution Display
- Touch-sensitive Projective Display (MERL DiamondTouch)
- Handheld Display
World-In-Miniature
Harris Matrix
Enhanced Harris Matrix
Enhanced Harris Matrix
Cross-Dimensional Hybrid Gestures

- Synchronized 2D and 3D gestures
- Facilitate seamless transition across dimensions

To appear in IEEE VR 2005
Cross-Dimensional Hybrid Gestures

Pull
Push

To appear in IEEE VR 2005
Cross-Dimensional Hybrid Gestures

Pull
Pin
Drag
Rotate
Push

To appear in IEEE VR 2005
Cross-Dimensional Hybrid Gestures

To appear in IEEE VR 2005
Handheld Focus-in-Context Display

- Movable high-resolution inset
  - Tracked by DiamondTouch
  - Projection suppressed in its bounds
  - Physical magic lens
Tabletop Interaction
User Feedback

► Overall very positive reaction
► Archaeologists benefited from:
  - Temporal–Spatial connection
  - Aggregated collection of all data
  - Accurate 3D model
  - Simple touch-based interactions
► Potential for increased collaboration
Room for Improvement

► Reduce wires
► Reduce weight
► Eye occlusion hinders communication
► Missing data:
  - More objects, features, notes and pictures
  - More scans during excavation (time-lapse spatial record)
► Missing features:
  - Virtual scale measure (implemented since)
  - Variable site model scaling
  - Improved selection in world-in-miniature
Current and Future Work

► Larger Site:
  ▪ Summer 2004 - Thulamela, South Africa

► Personalized user experience based on expertise

► Environment management
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Questions?