Herding Sheep: Live System Development for Distributed Augmented Reality

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Introduction

• More and more AR systems are built using frameworks:
  – Repo-3D, Studierstube, Tinmith, MR Platform ...
• DWARF framework is unique regarding:
  – Flexibility at runtime
  – Distribution among different hosts/operating systems
  – Introspection facilities
  – Easy adaption of third-party software
• What is SHEEP?
  – The „Shared Enviroment Entertainment Pasture“
  – Distributed multiplayer game with variety of multimodal interactions
• Why SHEEP?
  – AR games are not new: Cow Painting, ARQuake, AquaGauntlet ...
  – Evaluation and refinement of architectural claims
  – Testdrive for new development process
Outline

• The Game
  – Shows the game from the user‘s perspective

• Framework Level
  – System Architecture
  – Subsystem Details

• Process Level
  – Methodology
  – Tools

• Conclusion
Landscape containing virtual sheep is projected onto a table
The Game

Players have a variety of devices for interaction.
The Game

A tangible plastic sheep attracts the virtual sheep
Point-and-Speak is used to create and remove sheep
The Game

Sheep can be scooped and dropped with an iPAQ
A tracked laptop as window to the virtual world
The Game

Color of sheep can be changed by user wearing an HMD
System Architecture (1) - Subsystems
System Architecture (2) - Deployment

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Subsystem Details (1)

- **Sheep Simulation**
  - Based on distributed variant of flock of birds algorithm [Reynolds 1987]
- **Tracking**
  - Dtrack system (ART GmbH) delivers raw pose data
  - Pipe-filter tracking architecture using DWARF event bus
  - Calibration component unifies coordinate systems, one-step calibration using a pointing device
Subsytem Details (2) - Visualization

- VRML browsers with DWARF/EAI adapter
- Two types of browsers:
  - Windows/Intel: Cortona from Parallelgraphics
  - Linux/StrongARM: FreeWRL
- Distributed Scenegraph realized through manual synchronization
- Problematic limitations of:
  - OpenGL/Java on iPAQ
  - EAI
Subsystem Details (3) - Interactions

• User Interface Controller: Conversion of multimodal input into commands
• Internal structure: Petri-Net
  – Graphical output during runtime
  – Based on Petri-net framework jfern (XML and Java)
Development Methodology

- Incremental development of running system
- Continuous integration of evolving components
- System design during implementation
- Jam Sessions: Interaction design and evaluation during runtime
Supporting Tools

- One-step calibration with magic wand
- Monitoring:
  - UI: User Interface Controller
  - Overall system state
- Testing:
  - Tracker simulation
  - Component simulation
Results

• The game:
  – Shown publicly at various occasions, first at ISMAR 2002 in Darmstadt.
  – User Feedback
    • Tangible User Interfaces with magical metaphors are easy to use
    • Direct interaction with head-fixed widgets is bad
    • Immediate feedback is important (graphical and acoustical)

• The framework:
  – Overall concepts validated
  – Single components still need improvement

• The process:
  – Still work in progress
  – Jam Sessions are fun and productive
  – Introspection facilities are very useful for debugging
Future Work

• Game extensions:
  – Saving sheep from wolf and falling off the table
  – Landscape manipulations
• Conduct usability studies:
  – Consolidation of metaphors
  – Runtime usability evaluation tool
  – Interaction library for User Interface Controller
• Process:
  – Formalization and thorough evaluation
  – Further speedup of prototyping with new tools (Python\(^1\))

• Integrate recent DWARF improvements into SHEEP:
  – OpenInventor-based viewer
  – World model: Consistent data storage
  – Better calibration (SPAAM)
  – Middleware: Automatic component startup
  – Mac OS X/Windows support

\(^1\)Special thanks to Joe Newman (TU Wien)
End of Talk

- Why not start with DWARF today?
- Project homepage
  http://www.augmentedreality.de

- Please ask your questions!
  質問をどうぞ！ただし英語でお願いします。