Three Roles for Augmented Reality in User Interface Design

Steven Feiner
Computer Graphics & User Interfaces Lab
Department of Computer Science
Columbia University
New York, NY 10027

Supported in part by NSF, ONR, USMC, NASA, and gifts from IBM, Microsoft, and NVIDIA

VIC Sthlm, Stockholm, Sweden June 4, 2009

Virtual Reality (VR)

- Computer-generated world of virtual objects
  - 3D
  - Interactive
  - Tracked relative to user

Courtesy, Tom DeFanti (UC)
Augmented Reality (AR)

- Computer-generated world of virtual objects
  - 3D
  - Interactive
  - Tracked relative to user
  - Registered in 3D with the perceptible real world
- Unlike VR, virtual world
  - Supplements rather than replaces real world
  - Must be designed to complement real world

Over 40 Years of AR Research....

- Ivan Sutherland, Head-tracked VR/AR (1965–70s)
  - Stereo, see-through head-worn display
  - Synthesized imagery combined with view of real world
Three Roles for AR in UI Design

1. Simulate new UI technologies

2. Serve as a UI in its own right

3. Transform domain objects into UI
Interacting with a Wrist-Worn Projection Display  Gábor Blaskó, Franz Coriand

What kind of interaction techniques would work well with a 6DOF-tracked wrist-worn projection display?

Back in 2005,…

Three years later…

2008 Product: 3M MPro 110

- High-res, full color, bright,… with integrated UI
Projected Augmented Reality Prototype
Gábor Blaskó, Franz Coriand

- Wrist-mounted Touch Sensor
- Orientation Tracker
- Position Tracker

- Retroreflective marker
- Origin Instruments Dynasight 3D tracker

- Synaptics Touchpad
- InterSense InertiaCube 3D
  Orientation Tracker
Projected Augmented Reality Prototype

Gábor Blaskó, Franz Coriand

Wrist-mounted Touch Sensor
Orientation Tracker
Position Tracker
Generation of texture mapping coordinates (projected textures)
Real-time rendering of simulated projection on wall

Basic Simulation
Position-based Interaction

Orientation-based Interaction
2. A UI in its own right

Electronic Field Guide

Help botanists identify new/existing species in the field
- User photographs specimen
- System uses computer vision to rank possible matches
- User explores results

Columbia University, University of Maryland, Smithsonian Institution

P. Belhumeur
S. Feiner
R. Ramamoorthi
N. Dixit
D. Mahajan
C. Macmihal
D. Marino
K. Sundarawdi
S. White
D. Jacobs
G. Agarwal
H. Ling
S. Shridenkar
W.J. Kress
N. Bourg
I. Lopez
R. Russell

herbarium.cs.columbia.edu
Electronic Field Guide
gerbarium.cs.columbia.edu
Columbia University, University of Maryland, Smithsonian Institution

- Physical type specimen collections

Electronic Field Guide Hand-Held Prototypes
S. White, D. Marino

- Tablet PC
  - WiFi / Bluetooth camera

- UMPC
  - Built-in camera
Electronic Field Guide AR Prototypes

- Inspect
- Compare

Hand-held card
- selects species
- can be brought closer to inspect
- is two-sided

Tangible AR

3. Transform domain objects into UI
AR for Maintenance and Repair
S. Henderson and S. Feiner

- Overlay instructions to guide maintainer
- How can we interact with the task domain?

Opportunistic Controls
S. Henderson and S. Feiner, VRST 2008

- Tangible UI harvested from existing domain affordances
- Each opportunistic control comprises
  - Physical affordance
  - 3D widget
  - One or more gestures
Opportunistic Controls
S. Henderson and S. Feiner, VRST 2008

- Tangible UI harvested from existing domain affordances
- Each opportunistic control comprises
  - Physical affordance
  - 3D widget
  - One or more gestures

Opportunistic Controls Prototype

- Maintenance of Rolls Royce Dart 510 turboprop engine
- Tracked overhead camera for gesture recognition
- Tracked stereo video see-through HWD
- Valve Source mod
Opportunistic Controls Prototype

- Maintenance of Rolls Royce Dart 510 turboprop engine
- Tracked overhead camera for gesture recognition
- Tracked stereo video see-through HWD
- Valve Source mod

Opportunistic Controls User Study

- Task: Select observed mechanical condition of engine component from list of candidate conditions
  - BL (Baseline): Five virtual buttons on overlaid plastic panel
  - OC: Five button-based OCs
- 15 participants (11M, 4F), age 20–34, within-subject
- 2 levels × 10 inspections (trials) × 5 locations
Opportunistic Controls User Study

Results
- OC 16% faster than BL
- 73% of users preferred OC over BL
- Users liked ability to do “eyes-free” interactions
Three Roles for AR in UI Design

1. Simulate new UI technologies
   - Wrist-Worn Projector
2. Serve as a UI in its own right
   - Electronic Field Guide
3. Transform domain objects into UI
   - Opportunistic Controls

One More Role…

- Debugging
Acknowledgments

- Hrvoje Benko
- Gábor Blaskó
- Franz Coriand
- Steve Henderson
- Eddie Ishak
- Levi Lister
- Dominic Marino
- Ohan Oda
- Sean White
- Lauren Wilcox
- Chandra Narayanaswami (IBM)
- Electronic Field Guide Team
  - Columbia
  - U. Maryland
    - D. Jacobs, G. Agarwal, H. Ling, S. Shirdonkar
  - Smithsonian
    - W. J. Kress, N. Bourg, I. Lopez, R. Russell
- Peter Allen, Alejandro Troccoli, Ben Smith (scanning and modeling)
- Lynn Meskell and James Conlon (archaeology)
- Ian Morris, Trinity Jackman, and the Stanford Archaeology Center

Any opinions, findings and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.