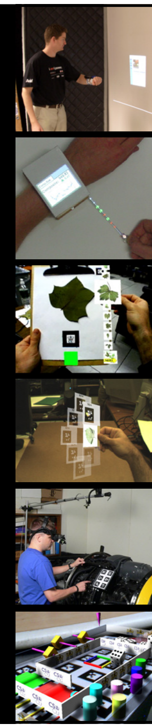
Three Roles for Augmented Reality in User Interface Design



Steven Feiner

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

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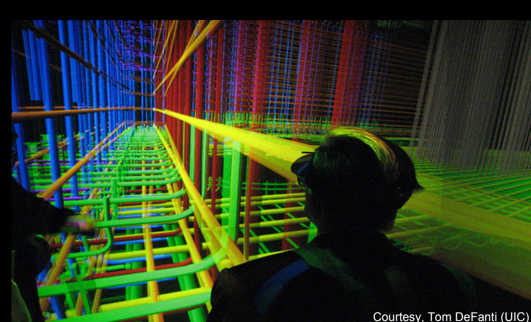
VIC Sthlm, Stockholm, Sweden June 4, 2009

Virtual Reality (VR)

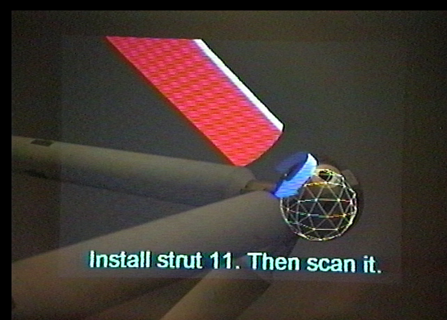
- Computer-generated world of virtual objects
  - 3D
  - Interactive
  - Tracked relative to user



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

Real + Virtual



A. Webster, S. Feiner, B. MacIntyre, W. Massie, & T. Krueger, *Proc. ASCE Congress on Computing in Civil Engineering*, 1996

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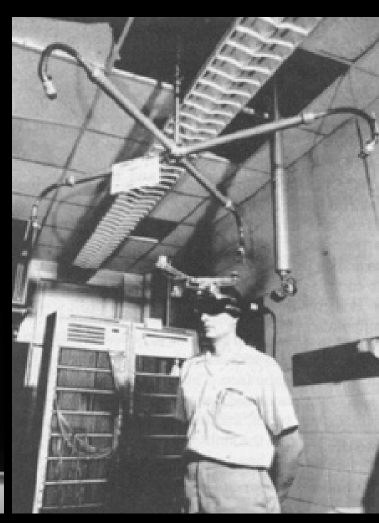
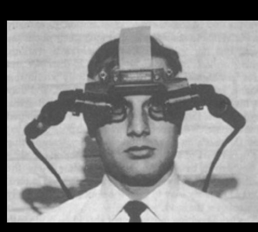
Over 40 Years of AR Research….

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





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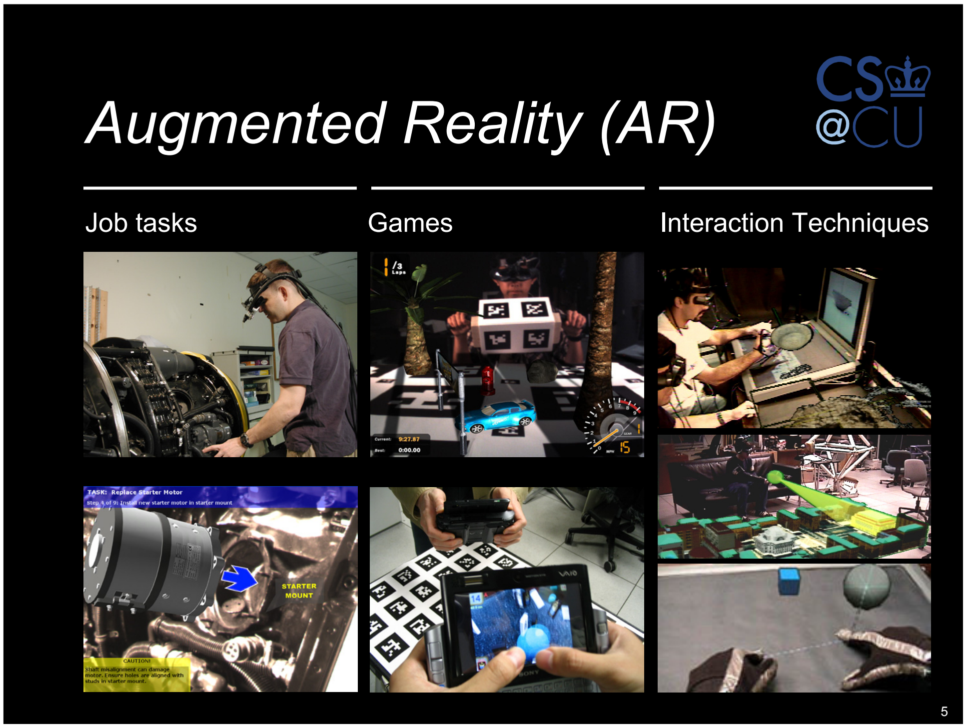
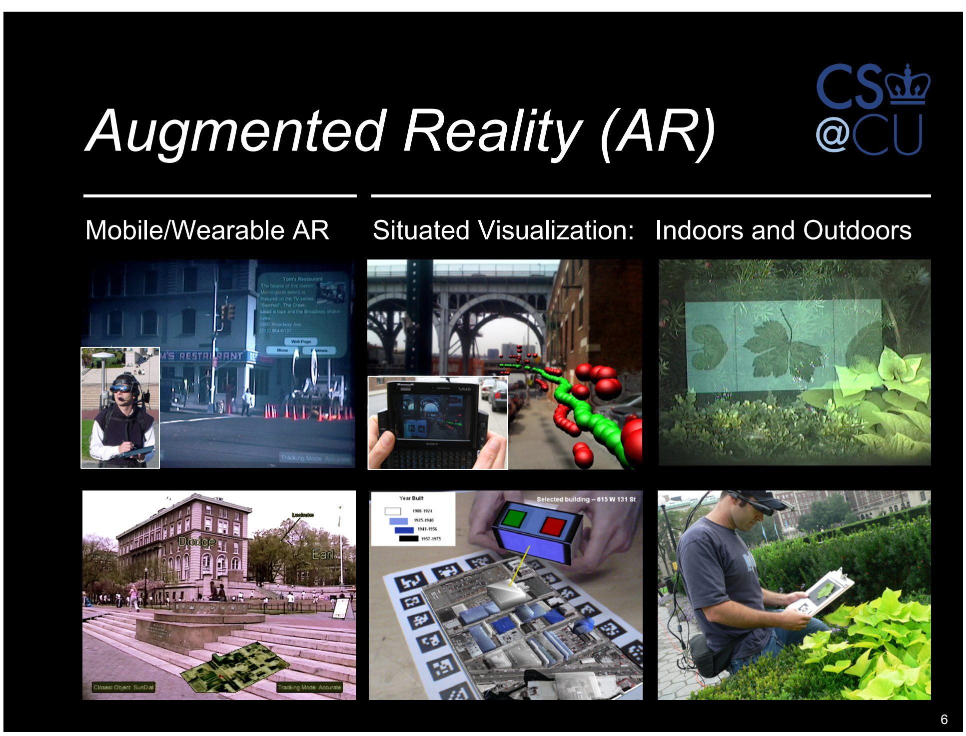

Augmented Reality (AR)
CS@CU
Job tasks
Games
Interaction Techniques
TASK: Replace Starter Motor
STARTER MOUNT
CAUTION!
5


Augmented Reality (AR)
CS@CU
Mobile/Wearable AR
Situated Visualization:
Indoors and Outdoors
Year Built
Selected building – 615 W 131 St
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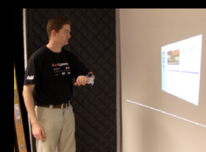
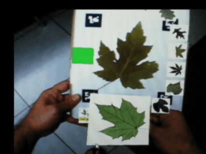
Three Roles for AR in UI Design

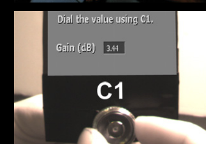
1. Simulate new UI technologies



2. Serve as a UI in its own right



3. Transform domain objects into UI

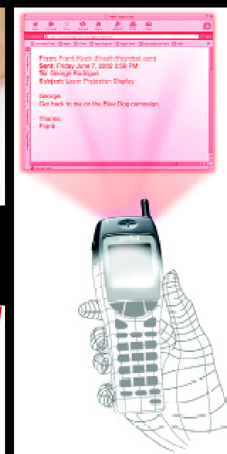


1. Simulate new UI technologies

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,…



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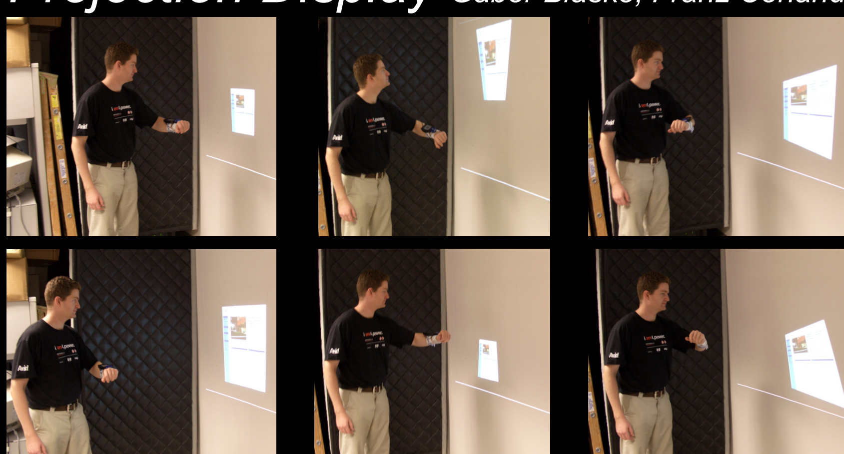
Interacting with a Wrist-Worn Projection Display *Gábor Blaskó, Franz Coriand*



- High-res, full color, bright,… with integrated UI

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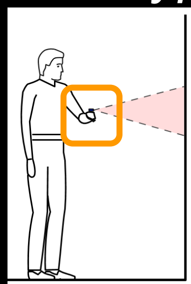
Projected Augmented Reality Prototype *Gábor Blaskó, Franz Coriand*



Wrist-mounted Touch Sensor

Orientation Tracker

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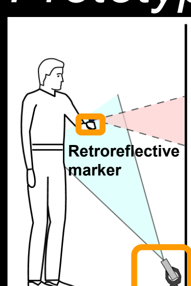
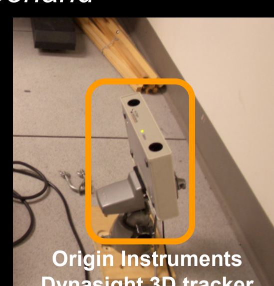
Projected Augmented Reality Prototype *Gábor Blaskó, Franz Coriand*





Wrist-mounted Touch Sensor

Orientation Tracker

Position Tracker

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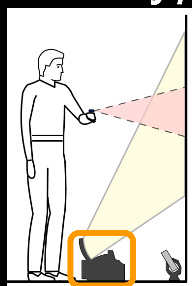
Projected Augmented Reality Prototype *Gábor Blaskó, Franz Coriand*



Wrist-mounted Touch Sensor

Orientation Tracker

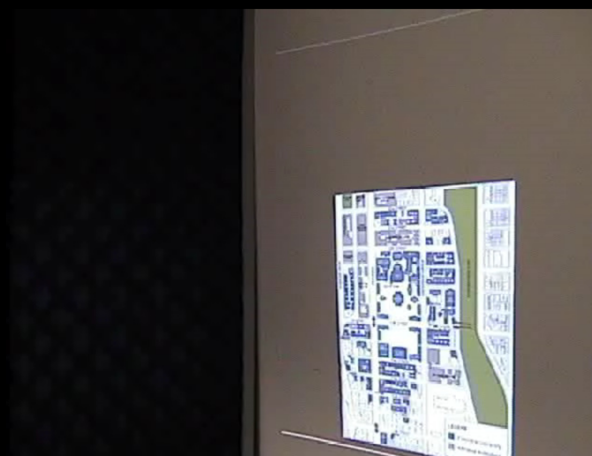
Position Tracker

Generation of texture mapping coordinates (projected textures)

Real-time rendering of simulated projection on wall

Basic Simulation

Position-based Interaction



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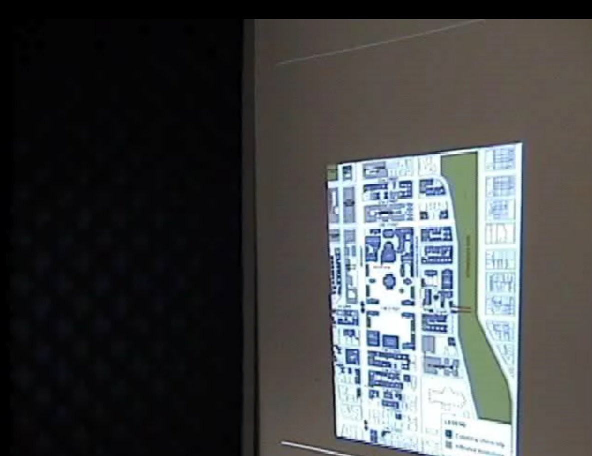
Orientation-based Interaction



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2. A UI in its own right

Electronic Field Guide herbarium.cs.columbia.edu

Columbia University, University of Maryland, Smithsonian Institution

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

P. Belhumeur
S. Feiner
R. Ramamoorthi

D. Jacobs

W.J. Kress

N. Dixit
D. Mahajan
C. Macanka
D. Marino
K. Sunkavalli
S. White

G. Agarwal
H. Ling
S. Shirdonkar

N. Bourg
I. Lopez
R. Russell

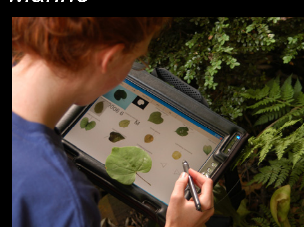
Electronic Field Guide herbarium.cs.columbia.edu

Columbia University, University of Maryland, Smithsonian Institution

- Physical type specimen collections

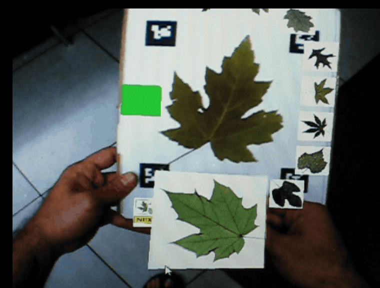
Electronic Field Guide Hand-Held Prototypes *S. White, D. Marino*

- Tablet PC
  - WiFi / Bluetooth camera



- UMPC
  - Built-in camera

Electronic Field Guide AR Prototypes *S. White, J. Kopylec*



- Inspect
- Compare

Tangible AR

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

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3. Transform domain objects into UI

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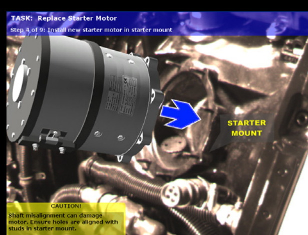
AR for Maintenance and Repair

S. Henderson and S. Feiner

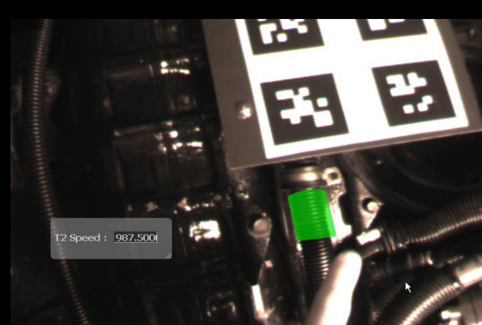


- Overlay instructions to guide maintainer
- How can we interact with the task domain?

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



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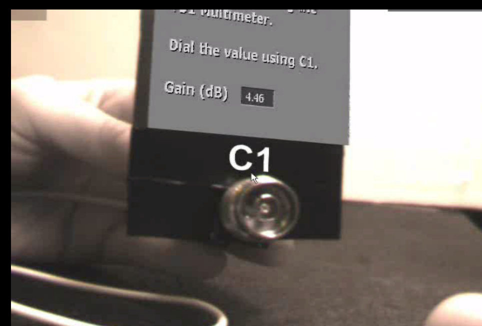
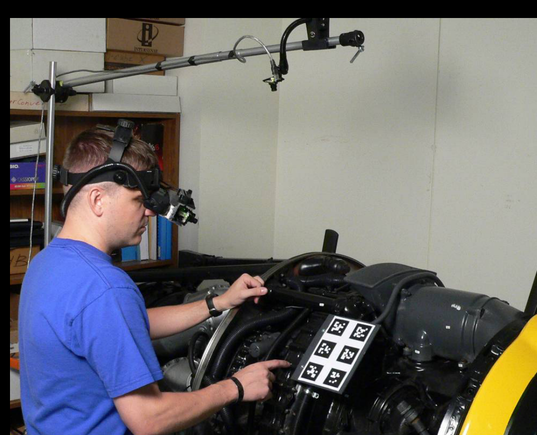


Opportunistic Controls Prototype

- 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

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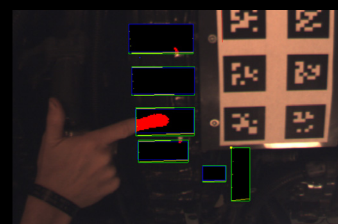
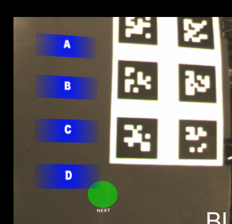
Close up of affordances

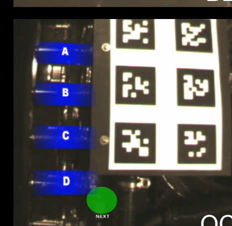


Segmentation from overhead camera

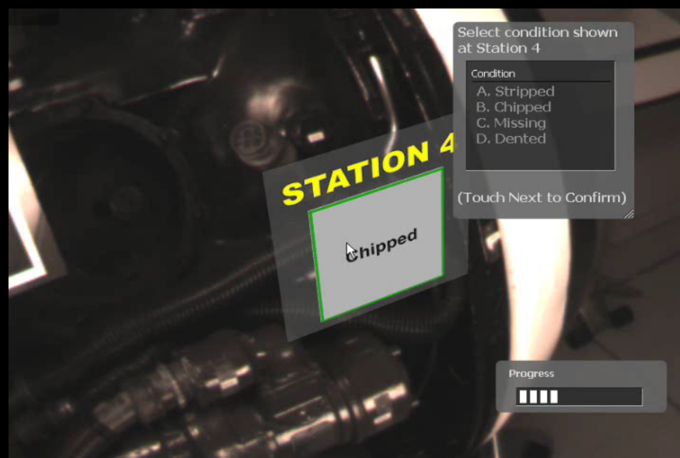
Opportunistic Controls User Study

- 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



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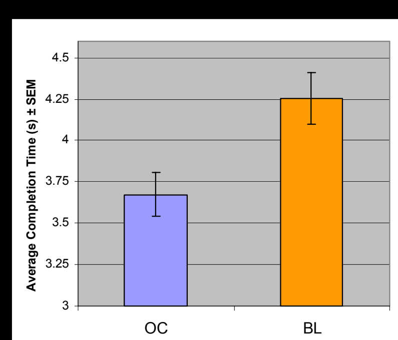
Opportunistic Controls User Study

- Results
  - OC 16% faster than BL
  - 73% of users preferred OC over BL
  - Users liked ability to do “eyes-free” interactions



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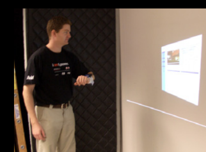
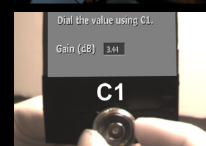
Three Roles for AR in UI Design

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

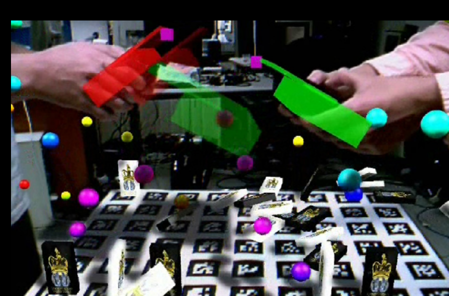




One More Role…

O. Oda

- Debugging



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  - U. Maryland
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  - Smithsonian
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- Peter Allen, Alejandro Troccoli, Ben Smith (scanning and modeling)
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