

Recent Advances in Augmented Reality

By R. Azuma, Y. Bailot, R. Behringer, S. Feiner, S. Julier, and B. MacIntyre

Presented by Eric Lam and Kathy Tang

What is Augmented Reality?

A system which...

- Combines real & virtual objects in real environment
- Runs interactively in real time
- Registers (aligns) real and virtual objects with each other



Milgram's reality-virtuality continuum



a completely physical space which has no virtual elements

an Augmented Reality space is a physical space where virtual elements have been integrated

an Augmented Virtuality space is a virtual space where physical elements have been integrated

a completely virtual space which has no physical elements

Overview

- **Enabling technologies**
- Interfaces and visualization
- Visualization problems
- New applications
- Future work

Enabling Technologies

- **Displays**
 - Head-worn displays (HWD)
 - Handheld displays
 - Projection displays
 - Problem areas
- New tracking sensors and approaches

Enabling Technologies

Displays – head worn displays

Types of HWD:

- Optical see-through
- Video see-through
- Retinal Display



Enabling Technologies

Displays – head worn displays

Characteristics:

- No larger than pair of sunglasses
- Lightweight



Minolta eyeglass display

Enabling Technologies

Displays – handheld displays



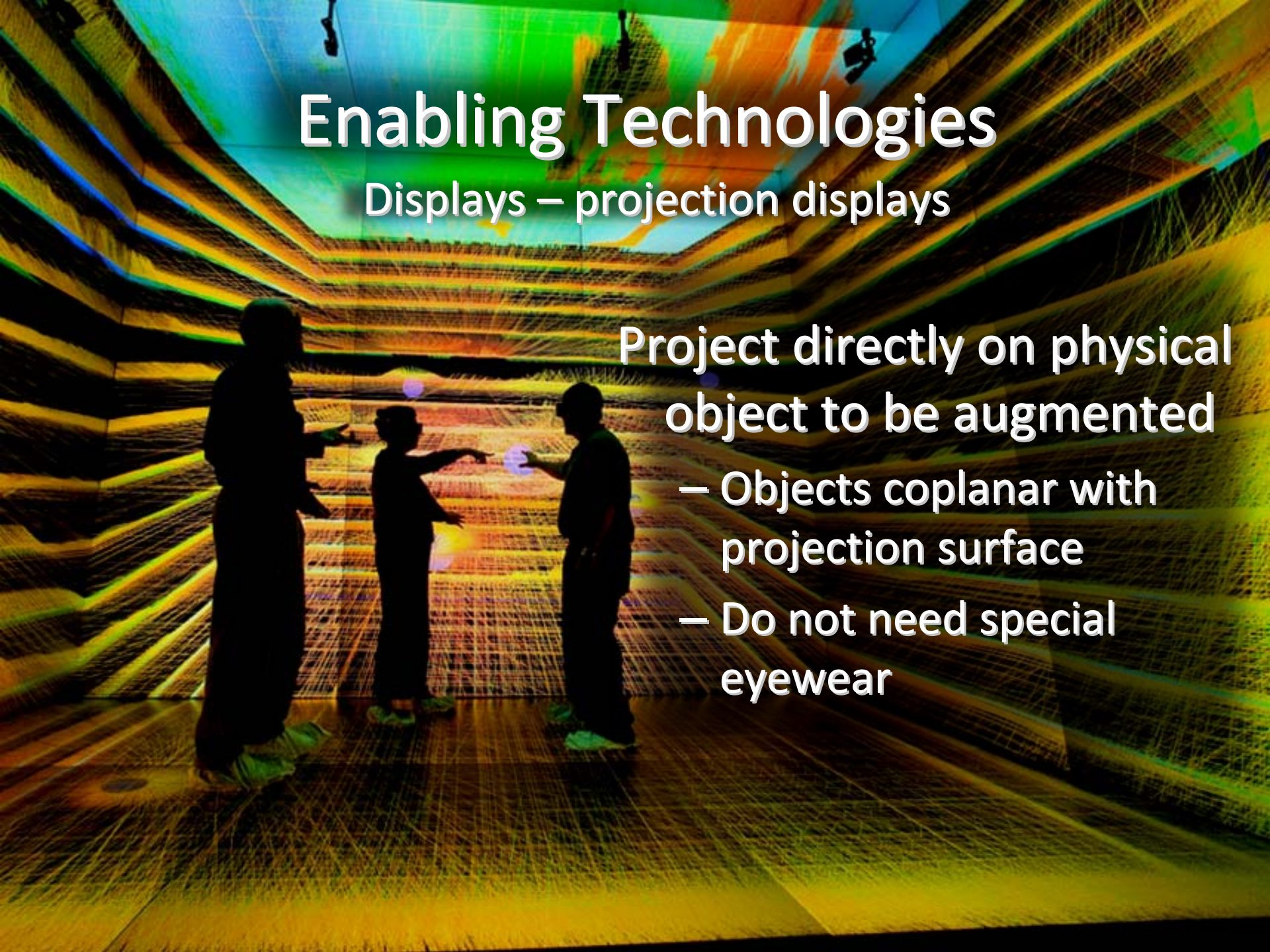
- Handheld, flat panel LCD Displays
- Camera provides video see-through

Enabling Technologies

Displays – projection displays

Project directly on physical object to be augmented

- Objects coplanar with projection surface
- Do not need special eyewear



Enabling Technologies

Displays – projection displays

Headworn projection displays

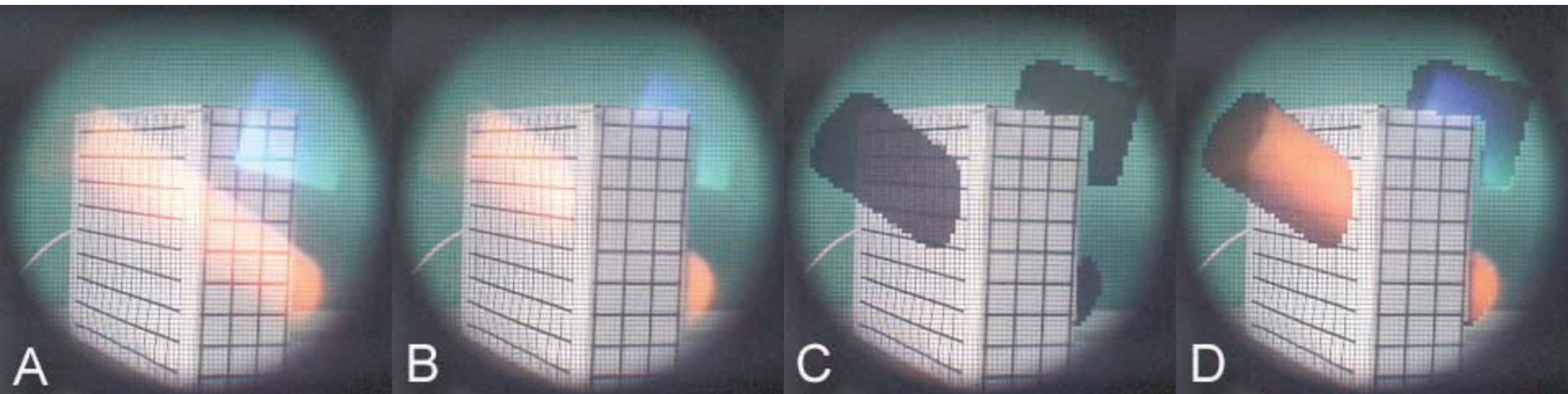
- Images projected at user's line of sight
- Retroreflective material
 - Coat target object
 - Reflects light back at angle of incidence
- Different users see different projected images



Enabling Technologies

Displays – problems

- Insufficient brightness, resolution, field of view (see-through displays)
- Virtual objects can't completely occlude real ones
- Display system alignment for eye



a) Transparent overlay, b) Transparent overlay w/ real world depth, c) LCD panel blocks areas to be occluded, d) opaque overlay blocking selected pixels

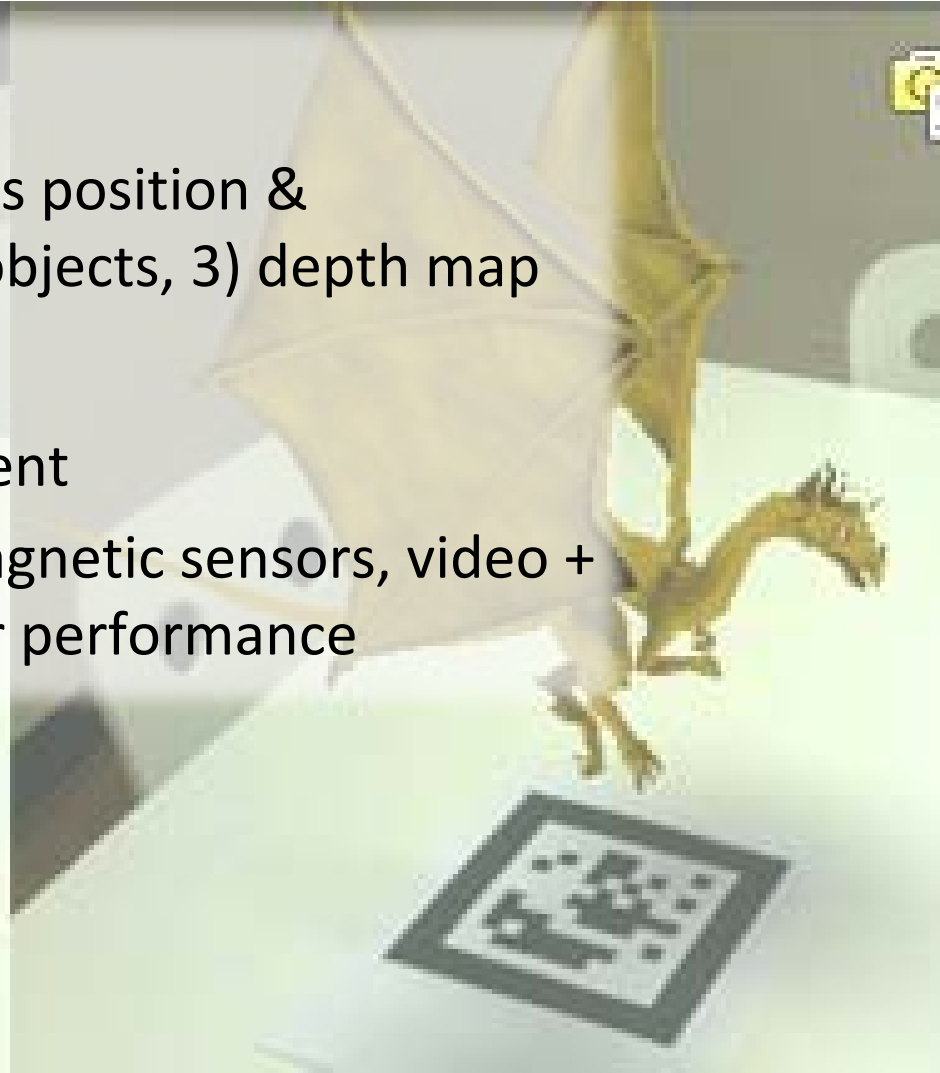
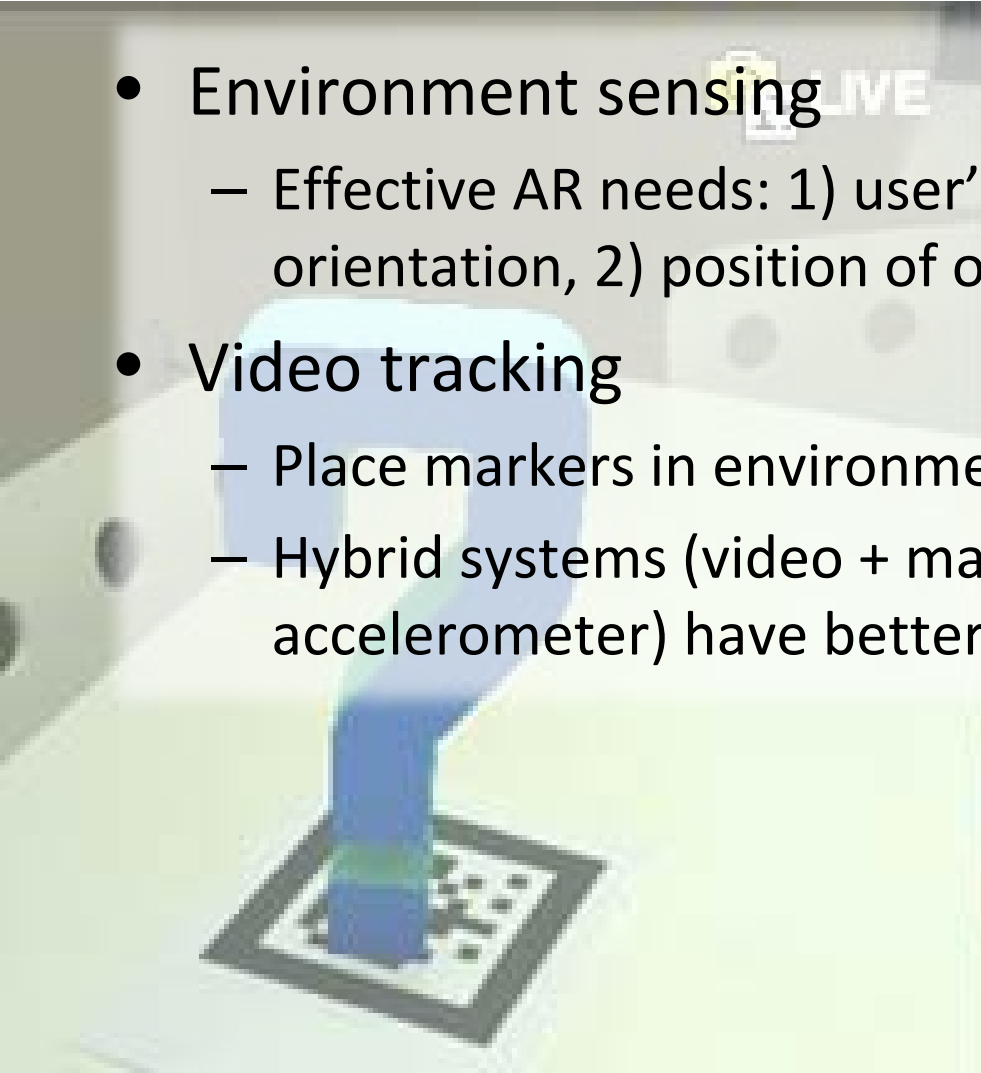
Enabling Technologies

- Displays
- **New tracking sensors and approaches**
 - Environment sensing
 - Outdoor, unprepared environments

Enabling Technologies

New tracking sensors and approaches

- Environment sensing
 - Effective AR needs: 1) user's position & orientation, 2) position of objects, 3) depth map
- Video tracking
 - Place markers in environment
 - Hybrid systems (video + magnetic sensors, video + accelerometer) have better performance



Enabling Technologies

New tracking sensors and approaches

- Outdoor, unprepared environments
 - Outdoor & mobile AR apps
 - Not practical to cover environment with markers
 - Compass/gyroscope tracker (orientation)
 - GPS (position)
 - Unprepared environments
 - Rely on tracking visible natural features
 - Track horizon silhouette (given database of environment)



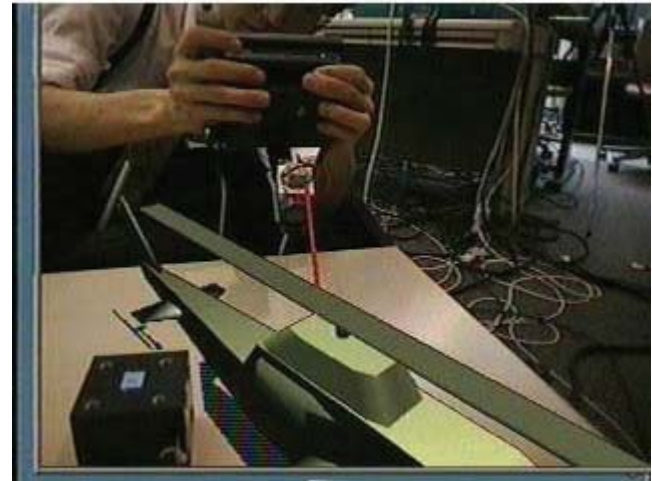
Overview

- Enabling technologies
- **Interfaces and visualization**
- Visualization problems
- New applications
- Future work

Interfaces and Visualization

Utilizing Heterogeneous devices

- Leverage advantage of different displays
- Multiple interaction techniques



Interfaces and Visualization



Integrate virtual & physical through tangible interfaces

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Visualization Problems

Errors and data density

- Measured location may not be accurate
- May cause visible registration error
- Environment may be cluttered with information and become unreadable
 - Use filtering technique to remove clutter



13 Data filtering to reduce density problems. Unfiltered view (top) and filtered view (bottom), from Julier et al.⁵⁵

Visualization Problems

Advanced rendering

- Mediated reality
 - Adding and removing objects
- Photorealistic rendering
 - Real time rendering
 - Capture environmentally illumination and reflectance



Courtesy INRIA

Visualization Problems



Perceptual and human factors

- Latency
- Depth perception
- Adaptation
- Fatigue and eye strain

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New Applications

- Mobile
 - Navigation
 - Situational awareness
 - Geolocated information
- Collaborative
- Commercial

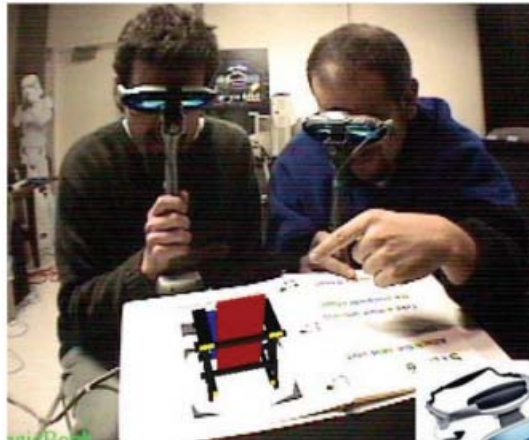
New Applications - Mobile

- Touring Machine – Columbia University
 - Compass, GPS, inclinometer
- Battlefield Augmented Reality System
- ARQuake



New Applications - Collaborative

- Goals
 - Seamless integration with existing tools and practices
 - Enhance practice by supporting remote and collocated activities that would otherwise be impossible



New Applications - Commercial



- Football
- Hockey
 - FoxTrax system
- NASCAR
- Advertisement

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- **Future work**

Future Work

- Few projects have gone past lab-based prototypes
- Three obstacles
 - Technological
 - User interface
 - Social acceptance

Future Work – Technological

Technology needs to be...

- Lighter
- Cheaper
- Less power consuming
- Computationally powerful
- Accurate
- Easy to use
- Portable



Future Work – User Interface

How do we...

- Identify what data to provide
- Present data in the most effective manner
- Make user queries and reports effective



Future Work – Social Acceptance

How do we persuade a user to wear an AR system?

- Issues include but not limited to...
 - Fashion
 - Privacy concerns



Q&A