Augmented Reality

- Goals
- Taxonomy
- Technology

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What is Augmented Reality?

- A combination of a real scene viewed by a user and a virtual scene generated by a computer that augments the scene with additional information.
What is the Goal of AR?

- To enhance a person’s performance and perception of the world

- But, what is the ultimate goal????
The Ultimate Goal of AR

- Create a system such that no user CANNOT tell the difference between the real world and the virtual augmentation of it.
## Augmented Reality vs. Virtual Reality

<table>
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<tr>
<th>Augmented Reality</th>
<th>Virtual Reality:</th>
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<td>- System augments the real world scene</td>
<td>- Totally immersive environment</td>
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<td>- User maintains a sense of presence in real world</td>
<td>- Visual senses are under control of system (sometimes aural and proprioceptive</td>
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<td>- Needs a mechanism to combine virtual and real worlds</td>
<td>senses too)</td>
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Miligram coined the term “Augmented Virtuality” to identify systems which are mostly synthetic with some real world imagery added such as texture mapping video onto virtual objects.
Miligram’s Taxonomy for Mixed Reality Displays

- Reproduction Fidelity – quality of computer generated imagery
- Extent of Presence Metaphor – level of immersion of the user within the displayed scene
- Extent of World Knowledge – knowledge of relationship between frames of reference for the real world, the camera viewing it, and the user
Combining the Real and Virtual Worlds

We need:

- Precise models
- Locations and optical properties of the viewer (or camera) and the display
- Calibration of all devices
- To combine all local coordinate systems centered on the devices and the objects in the scene in a global coordinate system
Combining the Real and Virtual Worlds (cont)

- Register models of all 3D objects of interest with their counterparts in the scene
- Track the objects over time when the user moves and interacts with the scene
Components of an Augmented Reality System
Research Activities

- Develop methods to register the two distinct sets of images and keep them registered in real-time
  - New work in this area has started to use computer vision techniques
- Develop new display technologies for merging the two images
Performance Issues

Augmented Reality systems are expected:
- To run in real-time so that the user can move around freely in the environment
- Show a properly rendered augmented image

Therefore, two performance criteria are placed on the system:
- Update rate for generating the augmenting image
- Accuracy of the registration of the real and virtual image
Limitations for Updating the Generated Images

- Must be at 10 times/second
- More photorealistic graphics rendering
- Current technology does not support fully lit, shaded and ray-traced images of complex scenes
Failures in Registration

Failures in registration due to:

- **Noise**
  - Position and pose of camera with respect to the real scene
  - Fluctuations of values while the system is running

- **Time delays**
  - In calculating the camera position
  - In calculating the correct alignment of the graphics camera
Display Technologies

- Monitor Based
- Head Mounted Displays:
  - Video see-through
  - Optical see-through
Monitor Based Augmented Reality

- Simplest available
- Little feeling of being immersed in environment
Optical see-through HMD

- Scene generator
- Head locations
- Head Tracker
- Monitors
- Optical combiners
- Graphic images
- Real world
Video see-through HMD
Advantages of Video see-through HMD

- Flexibility in composition strategies
- Wide field of view
- Real and virtual view delays can be matched
Advantages of Optical see-through HMD

- Simplicity
- Resolution
- No eye offset
Applications

- Medical
- Entertainment
- Military Training
- Engineering Design
- Robotics and Telerobotics

- Manufacturing, Maintenance, and Repair
- Consumer Design
- Hazard Detection
- Audio
PLANNED MOTION OF A ROBOT ARM
THANK YOU