Lecture 9

Introduction to Virtual Reality Technology

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Goals of this lecture

- To provide an overview of VR technology
- To give an appreciation of the potential of Virtual Reality (VR) for human computer interaction.
- To show some potential projects using VR technology
Outline

- Introduction to VR
- Why VR?
- Types of VR
- Technology Requirements
- Some Applications & Potential Research Areas
- Creating Virtual Worlds
Pre-Virtual Reality

- 1956
  - Stereo Film
  - Vibration
  - Smell
  - Sound
  - Wind
  - Graphics
  - (not interactive)
Virtual Reality…

Definition

- "Virtual Reality: A computer system used to create an artificial world in which the user has the impression of being in that world and with the ability to navigate through the world and manipulate objects in the world." - C. Manetta and R. Blade in "Glossary of Virtual Reality Terminology" in the International Journal of Virtual Reality, Vol.1 Nr.2 1995.


Commonly associated words:

- Virtual/Synthetic Environments
- Tele-presence
- Presence
- Cyberspace
Why VR?

- **New Human-Computer Interaction Concept**
  - Human as a part of simulation (sense of immersiveness)
- **Improves human understanding of complex data or situation**
- **Cost saving** – reducing the need for physical prototyping or experiment
Types of VR

- **Desktop**
  3D virtual environment graphically displayed on a desktop computer monitor.

- **Projected**
  3D environment projected onto a screen. Enables a single user to demonstrate concepts to a group of people. A CAVE™, where several screens are used to surround the user with images, is the most advanced form of projected VR in use today.
**Types of VR (cont’d)**

- **Semi-immersive**
  Most advanced flight, ship and vehicle simulators are semi-immersive. The cockpit, bridge, or driving seat is a physical model, whereas the view of the world outside is computer-generated (typically projected).

- **Immersive**
  3D environment seen through a head-mounted display (HMD). In a completely immersive system the user feels part of the environment (experiences a feeling of 'presence'). The user has no visual contact with the physical world.
Technology requirements

- **Hardware** capable of rendering real-time 3D graphics and high-quality stereo sound.

- **Input** devices to sense user interaction and motion.

- **Output** devices to replace user's sensory input from the physical world with computer-generated input.

- **Software** that handles real-time input/output processing, rendering, simulation, and access to the world database in which the environment is defined.
VR Hardware

- PC, Macintosh, Amiga, Silicon Graphics

Cheap but not so fast
- Desktop VR
- Low budget
- Personal VR
- Mobile VR
- Small Companies
- PCs or small SGI

Expensive, many displays, fast
- Fully Immersive VR
- Research Institutes
- Fixed position, larges SGI machines
- (air conditioned rooms)
- Large Companies

Dr MKAJ @ FKM’s Colloquium, 24th August 2005
Input Devices

- DataGlove and Bodysuit
- Mouse, Joystick, Keyboard, 3D Mouse
- Movement Trackers (e.g. Polhemus)
- Gesture Recognition (with DataGlove)
- Speech Recognition
Output Devices

- **Visual**
  - Computer Screen, Head Mounted Display, Active Stereo, Passive Stereo (Imax), Immersive Workbench, CAVE, Spherical Projection, Big Screen Technology, Reality Centre.

- **Audio (Stereo)**
  - Speakers, Earphones, Speech, Music

- **Tactile/ Haptic**
  - PHANToM, Tactile Gloves

- **Motion**
  - Simulators with motion base
(Some) Applications of VR & Potential Research Areas
Virtual People/ Human

- People can be represented in VEs by Virtual Humans, Mannikins, Avatars, etc.
- These are sometimes even computer controlled in CVEs, the person you are talking to may not even exist...
- **Ergonomic Testing** – reach envelopes, view, dynamics, loading, etc.
Training/ Education

- **Civilian and military training simulators**
  - Driving simulators
  - Flight simulators
  - Ship simulators
  - Tank simulators

- **Train for hazardous or difficult operations**
  - Nuclear plant maintenance Practice locating and fixing faults in equipment
  - Surgical Operations, can practice on virtual patients first, or have the patient scanned and made into a virtual model - complete with force feedback on the surgical instruments.
VR has been found to be a very effective tool in treating fear of:

- Small space
- Flying
- Spider
- Height
- Panic disorder
Architecture, heritage, design and prototyping

- **Architecture**
  - Walkthroughs to evaluate design decisions and/or present designs to customers
  - Demonstrate how a planned construction fits into the environment in which it is intended to be built

- **Design and prototyping**
  - Use to create rapid prototypes rather than make clay models or full-scale mock-ups
  - Simulate assembly lines. For example, to evaluate the risk of interference or collision between robots, cars, and car parts

- **Heritage**
  - Preservation of Cultural Heritages
  - Ancient Site Reconstruction
  - Efficient Education/Research Tool
Visualisation

Complex data sets can be modelled and given characteristics such as colour, sound, pattern, texture etc to aid in differentiation

- CFD, FEA
- Oil & Gas/Geology
- Weather Data
- Molecular/DNA
Process Control/ Virtual Manufacturing

- VR connected to a factory process
- Can see, either in HMD, screen or big-screen, a VR model of the process with extra information to indicate process characteristics, e.g. Temperature = Colour, Pressure = Pipe size
- The state of the process can be ascertained at one glance - Dangerous situations apparent by colour, alarms or movement - attention grabbing.
- Can zoom into problem areas.
Telepresence system enables a human operator to perceive and manipulate a remote environment

- Underwater vehicle
- Telesurgery
- Telerobotic
Creating Virtual Worlds

- **Models Construction** – can use conventional modelers (e.g. CAD/CAE)

- **Virtual Environment**
  - **Commercial** VR toolkits – WorldToolKit (WTK), WorldUp, World2World, Vega, etc
  - **Opensource** – OpenGL, OpenInventor, CAVE Library, VRJuggler, VRML
Books and Articles:

- **The Handbook of Virtual Environments** (2002), Kay Stanney (ed), Lawrence Erlbaum.
- Search the Web for “Virtual Reality” and be astounded.