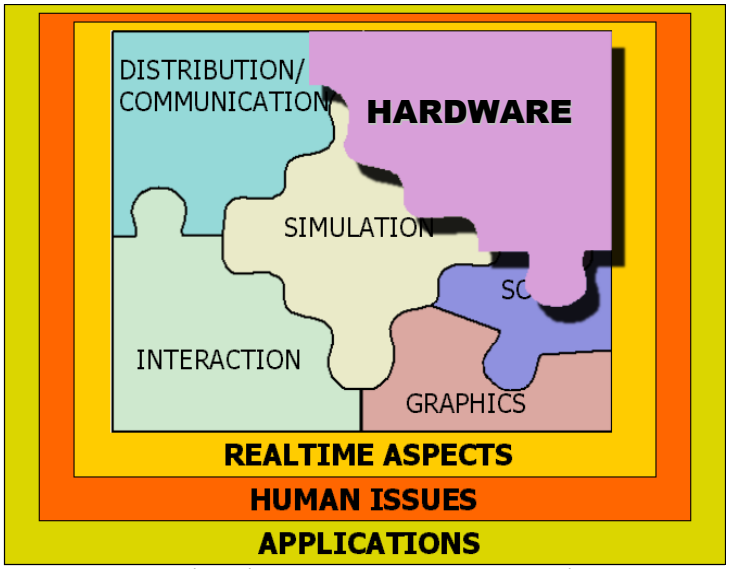
VR - Hardware

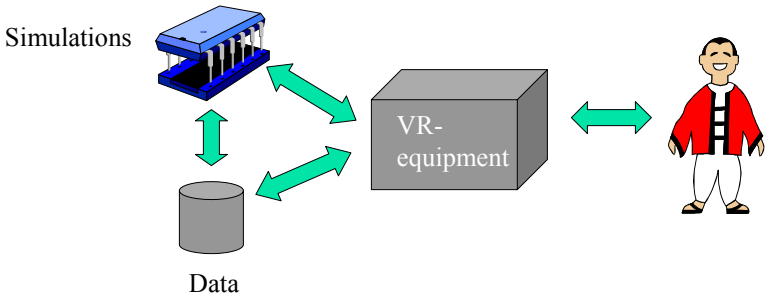


Hardware

- Vision
- Tracking
- Interaction
- Sound
- Other

Hardware

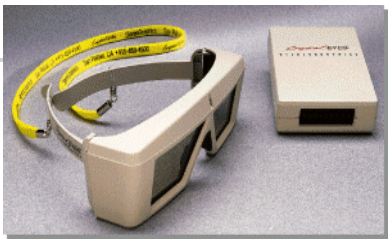
- Why hardware in VR?
  - VR supposed to support all modalities: Sound, vision, touch, smell, …
  - Connect us (humans) to the computer in a "natural way"
  - The computer interface is via hardware



Hardware

- Degree of immersion often connected to which hardware we are using.
  - Low resolution - bad displays
  - low colors - dito
  - low framerate - bad computers
  - …
- Hardware in VR is expensive and bad!
  - Not mature
  - To low market yet
  - Will change with game business though.

Hardware - Vision



Crystal Eyes, Stereographics.

- Stereo Glasses
  - Red Green glasses (anaglyph)
    - Only grayscale
  - Polarized glasses
    - Passive, no electronics, battery!
  - Stereo with ordinary screen without any glasses under development
  - Shutter glasses - Crystal Eyes de facto standard
    - Computer generates a picture for left eye while right eye is closed and vice versa. This is done in > 96Hz which avoids flicker.
    - Uses an ordinary display
    - Not completely closed during switching leaves ghost images of left/right.
    - Expensive for large crowd
    - Runs on battery.

Hardware - Vision

V8, Virtual Research

- Head Mounted Display (HMD)
  - Fully Immersive display
  - Characteristics:
    - Contrast ratio
      - Ratio of the peak luminance to the background luminance (100:1 typical)
    - luminance
      - Screen's brightness (> 1000 cd/m^2)
    - field of view (FOV)
      - Measure of horizontal and vertical visual range of the optical system, should ideally approach that of the human visual system. (around 60° vertical)
    - exit pupil
      - The distance the eye can deviate from the optical center if the display before the image disappears. (1.2 cm)

Hardware - Vision

- eye relief
  - Distance between the HMD's optical system and the users face (in the order of 2cm).
- overlap
  - Overlapping between right and left eye to get stereo.

Hardware - Vision

Ericsson Saab Avionics AddVisor™ 100	
LCD size	
Resolution	1280x1024 (SXGA)
Contrast ratio	50:1
Field-of-View	40°-53° diagonal
Interoccular range	52-78 mm (adjustable)
Eye relief	
Stereo/mono image sources	Automatic
Audio	
Weight	< 650 g
Power consumption	
Cable length	

Hardware - Vision

- HMD Advantages:
  - Gives user stereoscopic vision that moves relative to the user
  - Parallax
  - Provides an immersive experience by blocking out the real world
  - Can achieve good stereo quality
  - Fairly easy to setup
- Disadvantages
  - Average quality HMDs have poor resolution and FOV
  - Does not take advantage of peripheral vision
  - Isolation and fear of real world events
  - Usually cumbersome to wear (weight, size, cables, …)

Hardware - Vision

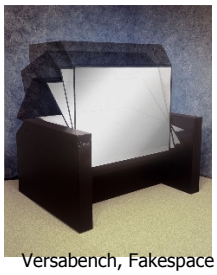
- Virtual Retinal Display (VRD)
  - Laser projects the image on the back of eye
  - + High Resolution
  - + High Contrast
  - + Immersion?
  - - Price

Hardware Vision

- Push/Boom display
  - "head-referenced"
  - less cumbersome
  - often better res./FOV
  - hands not free for tasks
  - can't turn completely around

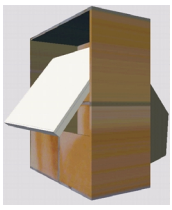
Hardware - Vision

- Virtual tables/walls
  - Semi Immersive displays
    - Immersive Workbench
    - Immersadesk
    - Versabench
    - Workbench
  - Backprojected screens with tracked users wearing stereoglasses



Versabench, Fakespace

Immersive Workbench, Fakespace



Hardware - Vision

- Desktop systems
  - Hand-eye coordination

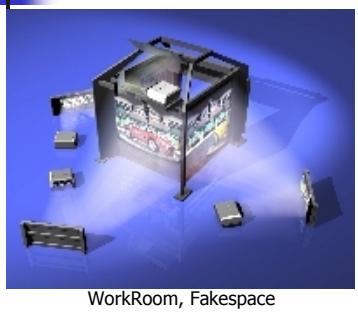
ReachIn Display, Reach In Tech.

Virtual Workbench, KRDL

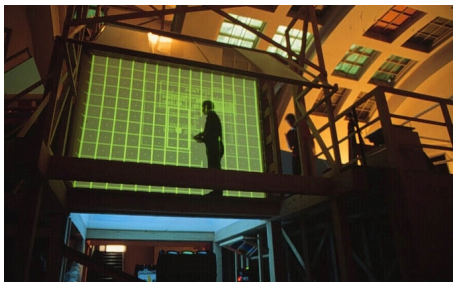
Hardware - Vision

- Surround Screen VE
  - Fully Immersed systems
    - CAVE
    - CUBE
    - WorkRoom

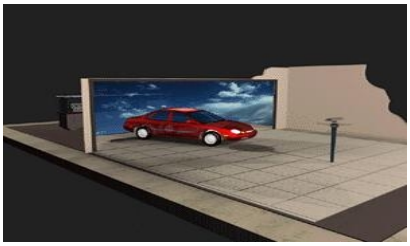
Hardware - Vision



WorkRoom, Fakespace

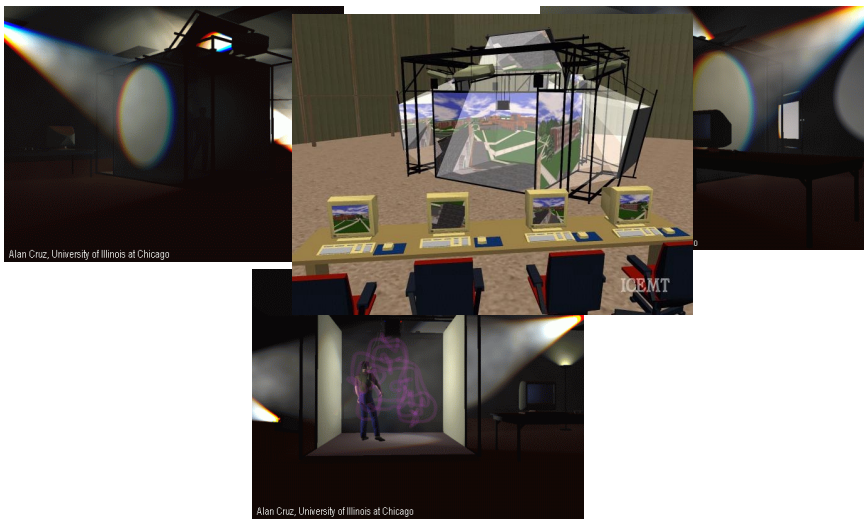


CUBE, TAN



Immersive Workwall, Fakespace

Hardware - Vision



Hardware - Vision

- SSVR - Advantages
  - Provides high resolution and large FOV
  - User uses only shutterglasses to get stereo
  - Real and virtual objects can be mixed in the environment
  - A group of people can inhabit the the room at once
- Disadvantages
  - Price
  - Requires large amount of physical space
  - Projector calibration
  - Sound problems due to the screens

Which visual display to use?

- No one knows!
- Hypotheses:
  - "360º tasks" - HMD
  - 3rd-person tasks - tabletop
  - requiring peripheral vision - CAVE

Hardware - Tracking

- To sense a users position and orientation, trackers are used
- Different types of tracker-systems:
  - Optical
  - Magnetic
  - Ultrasound
  - Inertial

Hardware - Tracking

- Magnetic
  - Currently most used and most stable
  - Builds up a magnetic field in which sens
  - -Sensitive to iron and other magnetic fie
  - 1-20 sensors
  - +Good for real-time capture
  - -No line of sight issues
  - Polhemus Fastrak
  - Polhemus Insidetrak
  - Ascention Flock Of Birds
  - Ascention MotionStar

MotionStar, Ascention

Hardware - Tracking

- Optical
  - Videosystems Vicon V8, Oxford Metrics
  - Multiple cameras
  - +High rate > 250 Hz
  - Some real-time systems exists.
  - Mostly off-line capturing
  - -Occlusion, uneven light, cause problems
  - +Can capture a large volume

Vicom, V370, Oxford Metrics

Hardware - Tracking

- Mechanical
  - Analogus Gypsy 2
    - 120 Hz
    - Captures head, clevical, upper and lower arms, hands, spine, hips, upper and lower legs, feet (heel and ball)
    - Multi input system compatibility
    - +Indoor and outdoor
    - +Easily transported (full system with cables below 22lbs)
    - +Wireless/rangeless (mobile capture) option available
    - +Totally magnetic-field-distortion free Instant feedback with drivers using Analogus skeleton

Gypsy 2, Vicon biomedics

Hardware - Trackers

- Hybrid systems
  - Intersence, IS systems
  - Ultrasound/Inertial
    - Ultrasound for position
      - -Line of sight issues
      - + Cheap
    - Inertial for orientation
      - -Subject to error accumulation

IS-600 Mark 2, InterSence

Intertrax, InterSence

Hardware - Interaction

- To interact with an environment we need tools with which we can pick up objects, move them, etc…
  - Spaceball, 6 DOF with 8 buttons
  - Wand, a pointing device for CAVE interaction.

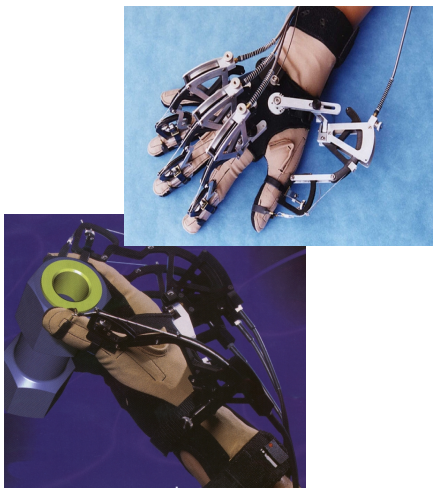
Spaceball, SpaceTech

Wand, EVL Chicago

Hardware - Interaction

- Gloves
  - Discrete
  - Continous

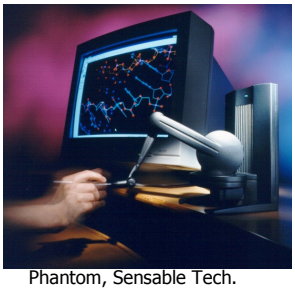
PinchGloves, Fakespace



CyberGrasp, Virtual Technologies Inc.

Hardware - Interaction

- Haptics
  - Simulates force feedback
  - User can "feel" physical objects

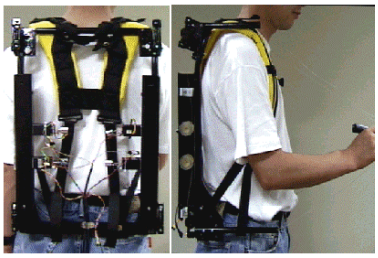


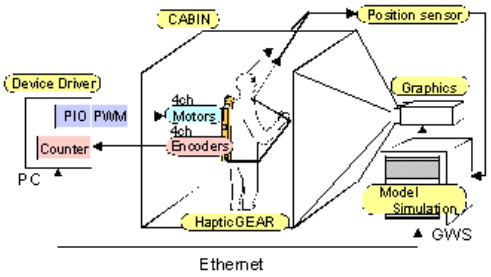
Phantom, Sensable Tech.

Phantom, Sensable Tech.

Hardware - Interaction

- HapticGEAR - Development of Wearable Force Display Display for Immersive Projection Displays





Hardware - Sound

- Spatial sound (mentioned at a later lecture)
  - Requires DSP to analyze sound and create spatial sound effects
  - A lot done in software:
    - VSS - Vanilla sound server
  - Hardware
    - Lake Huron Soundsystem
    - Aureal Vortex 2

Lake Huron, Lake DSP

Hardware - Other

- Smell
  - Inferno Firefighter simulator

OSS, Fragrance Technology

Hardware - Other

- Torus Treadmill
  - Locomotion using infinite surface