Virtual Reality

What is it actually…?

Virtual….

- Merriam-Webster: Being in essence or effect, not in fact
- Something that does not exist in the real physical world
  - **Could be a simulation of something real**
- Illusion, existing only in mind (in imagination)
- In computer science: things simulated by the computer

  -(e.g., virtual memory)
- Often related to networking, web

  -Virtual university, library, education, etc.
- A cool word, which may mean almost anything and thus nothing

…..Reality

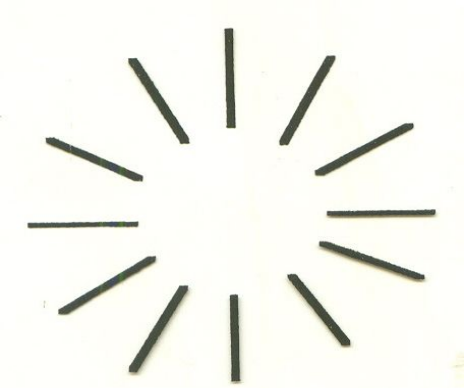
- Place
  - Where are you?
- Time
  - When it happens?
- Situation
  - What is going on there?

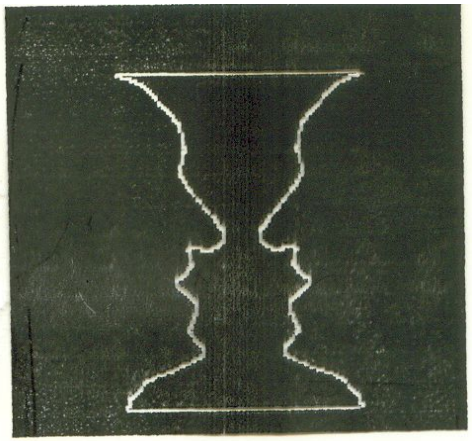
- Reality can be:
  - Technology mediated, e.g., VR
  - Chemically mediated, e.g., alcohol
  - Psychologically mediated, e.g., manipulation, lies, statistics

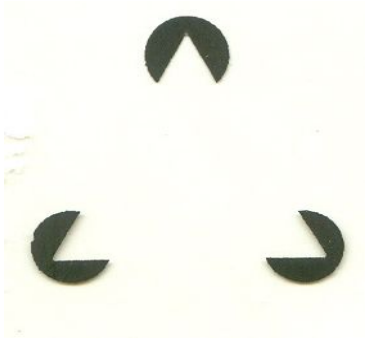
Virtual Reality ….

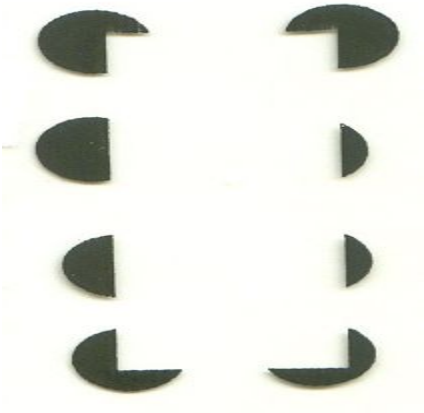
- A believable computer-generated experience
  - A perfect (?) illusion
  - Artificial sensations
- Virtual Reality (VR) is an environment that is simulated by a computer, trying to imitate the real thing
- Most virtual reality environments are primarily visual experiences
  - displayed either on a computer screen, through special stereoscopic displays or other displays
  - sound through speakers or headphones
- Some simulations include additional sensory Information
  - Tactile feedback

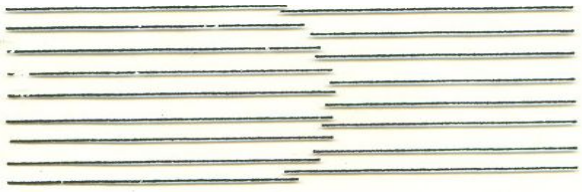
ILLUSORY BORDERS









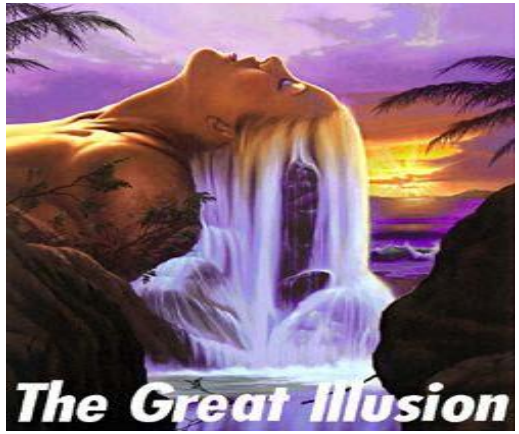


ILLUSIONS

Old Woman...Or Young Girl?
hint: the old woman's nose is the young girl's nose and chin

Woman In Vanity... Or Skull?
hint: moves farther a bit from the screen and blink to see the skull or the woman (looking at the mirror)

A Face Of A Native American... Or An Eskimo?



Virtual Reality

Virtual Reality (textbook definition)

a medium composed of interactive computer simulations that sense the participant's position and actions and replace or augment the feedback to one or more senses, giving the feeling of being mentally immersed or present in the simulation (a virtual world).

The Ultimate Display –

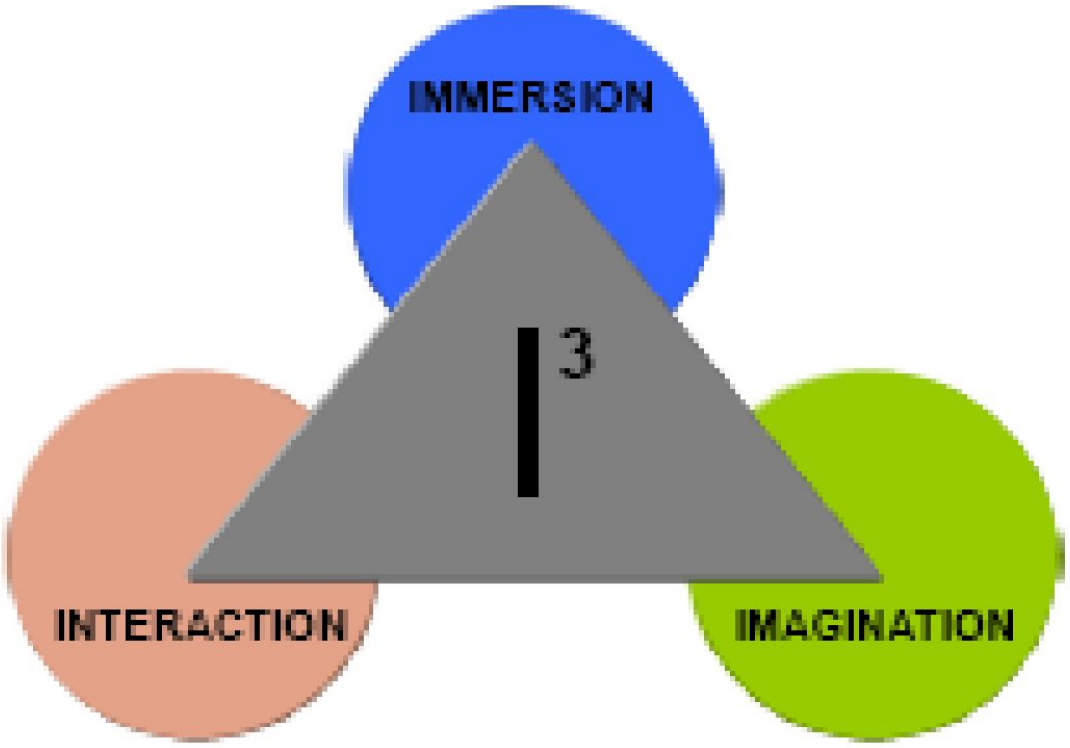
The ultimate display would be a room within which the computer can control the existence of matter.

Ivan E. Sutherland [1965]

Virtual Reality

- A simulation in which computer graphics is used to create a realistic-looking world
- Can be a completely synthetic environment **without any real counterpart**
- Virtual Reality is a high-end **user - computer interface** that involves real time simulation and interaction through multiple sensory channels.
- Sensory information may include visual, auditory, haptic, tactile, smell, taste…
- Visual is dominating

Virtual Reality Triangle



The Three I's of Virtual Reality

- **Immersion**
  - The feeling of presence, being there
  - The amount and quality of stimuli and sensations
  - Real time: very little latency accepted
    - around 50 ms is a threshold of noticability, but varies for all senses
- **Interaction**
  - Not just passive watching but Active Participation
  - Moving in the virtual world
- **Imagination (user 'buying' into the experience)**
  - The applications
  - The ideas
  - The virtual worlds

Properties of VR

- Synthetically generated environment
  - Computers, 3D, real time
- Sensory feedback
  - I/O devices
- Interaction ,moving
  - In time
  - In space
  - In scale
- Immersion
  - Being there

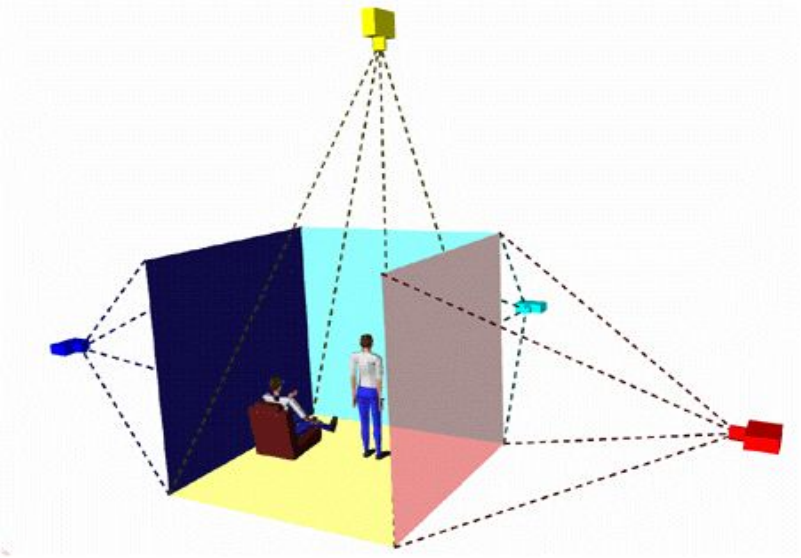
Morton Heilig
«**Sensorama**»
1962

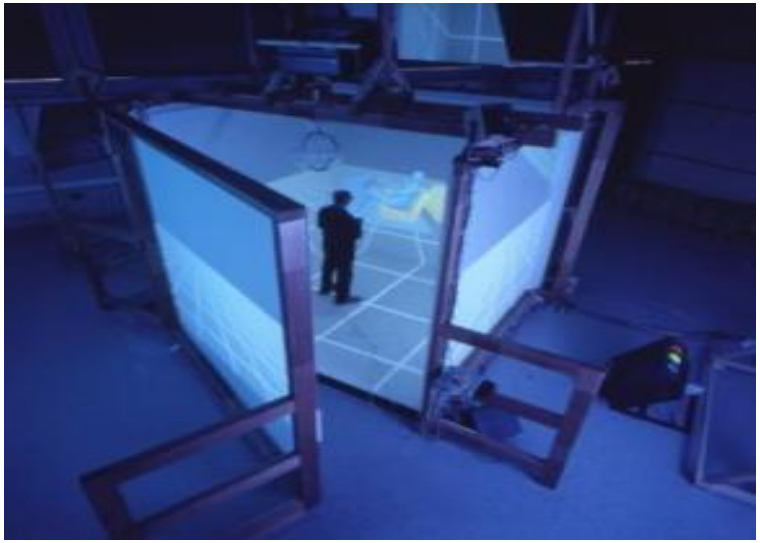
Ivan Sutherland's The Ultimate Display

"Don't think of that thing as a screen, think of it as a window, a window through which one looks into a virtual world. The challenge to computer graphics is to make that virtual world look real, sound real, move and respond to interaction in real time, and even feel real."

Cave Automatic Virtual Environment (CAVE)

- A room with projections on all walls, floor and ceiling
- The users wear shutter glasses to get a 3D view of the world.
- The users are able to move and control the environment with some kind of input mechanism
  - Camera
  - Device in hand





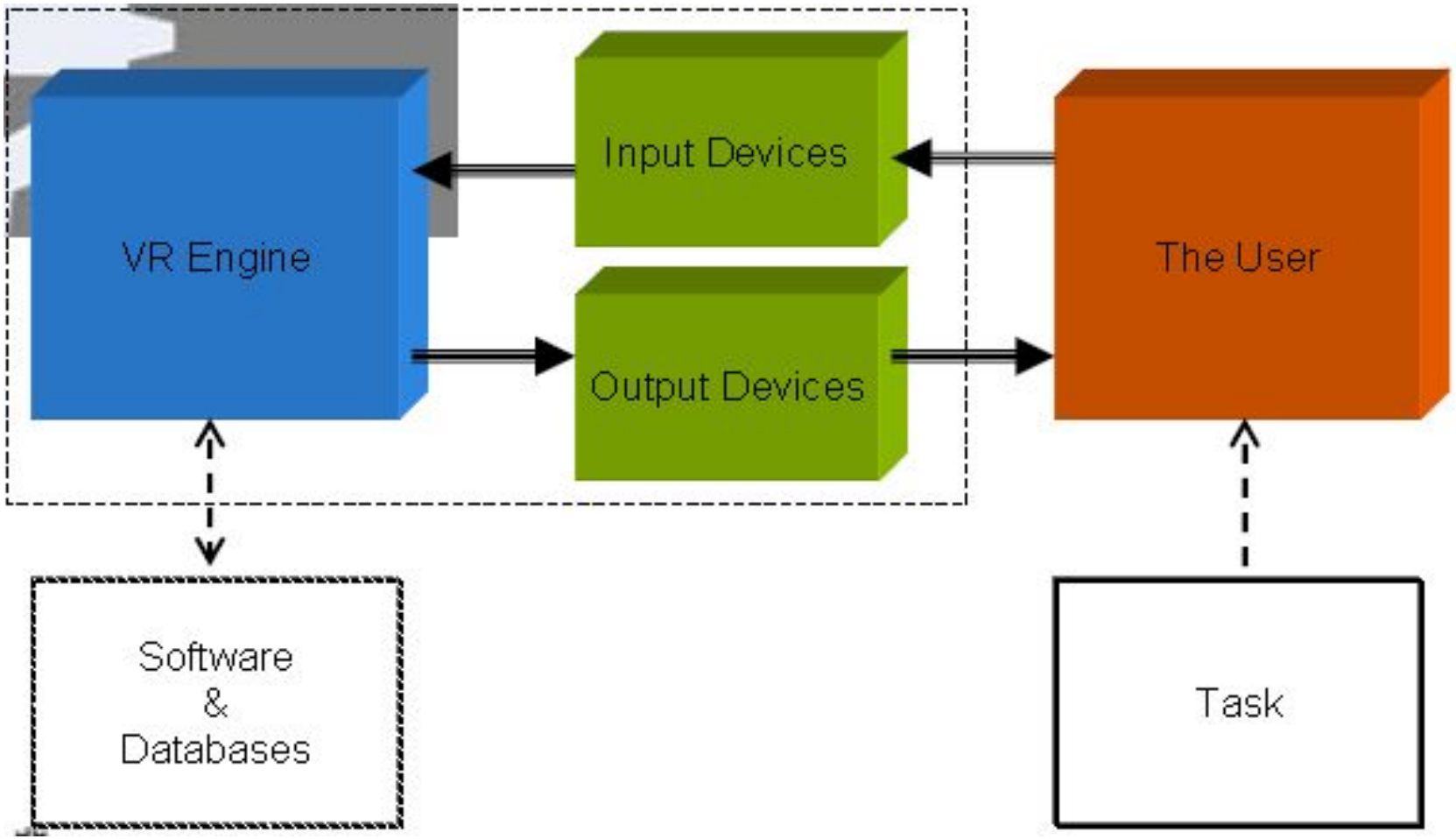
Technologies of VR--Hardware

- Data Glove
  - Outfitted with sensors on the fingers as well as an overall position/orientation tracking equipment.
  - Enables natural interaction with virtual objects by hand gesture recognition.

Technologies of VR--Software

- Toolkits
  - Programming libraries.
  - Provide function libraries (C & C++).
- Authoring systems
  - Complete programs with graphical interfaces for creating worlds without resorting to detailed programming.

The VR System Architecture



Requirements for the System

- Real time, >25 frames/s
  - So the environment is smooth
- Latency < 50 ms
  - Processing power
  - Input devices
- Big data size– Enough memory & hard disk space
- 3D speed, as much polygon/s as possible
  - PC: new and powerful graphics cards
  - If not enough power in GPU, fps drops or details drop
- CPU processing power for other calculations & simulations

VR Input Devices

The ways to transfer information from the user to the computer

- Mouse, keyboard
- Trackball, joystick, mouse, ...
- Position tracking
- Orientation tracking
- Data gloves
- Exoskeleton (external hardware on hands etc.)
- Motion capture (tracking of body)
- Eye tracking
- Video analysis
- Brainwaves (EEG), EMG

VR Output Devices

Transferring data from the computer to the senses of the user

- Displays
  - Monitors, projectors, HMDs, etc.
- Localized audio
  - Loudspeakers, headphones
- Tactile & haptic
  - Force feedback
- Smell, balance, etc.

Types of VR Systems

- Non - Immersive
- Immersive
- Telepresence
- Augmented Reality
- Distributed VR

Non – Immersive Systems

- Using the desktop system, the virtual environment is viewed through a portal or window by utilizing a standard high resolution monitor.
- These systems do not rely on any specialized input or output devices.
- User can interact with that environment, but is not immersed in it.
- Eg modern computer games
- Window-on-World (WoW) / Desktop

Types of Non-immersive VR

- **Text-based VR:** when a reader of a certain text form a mental model of this virtual world in their head from the description of people, places and things.
- **Augmented VR:** the idea of taking what is real and adding to it in some way so that user obtains more information from their environment.

Augmented Reality

- Augmented VR

Immersive VR

- A type of VR in which the user becomes immersed (deeply involved) in a virtual world. it is also a form of VR that uses computer related components.

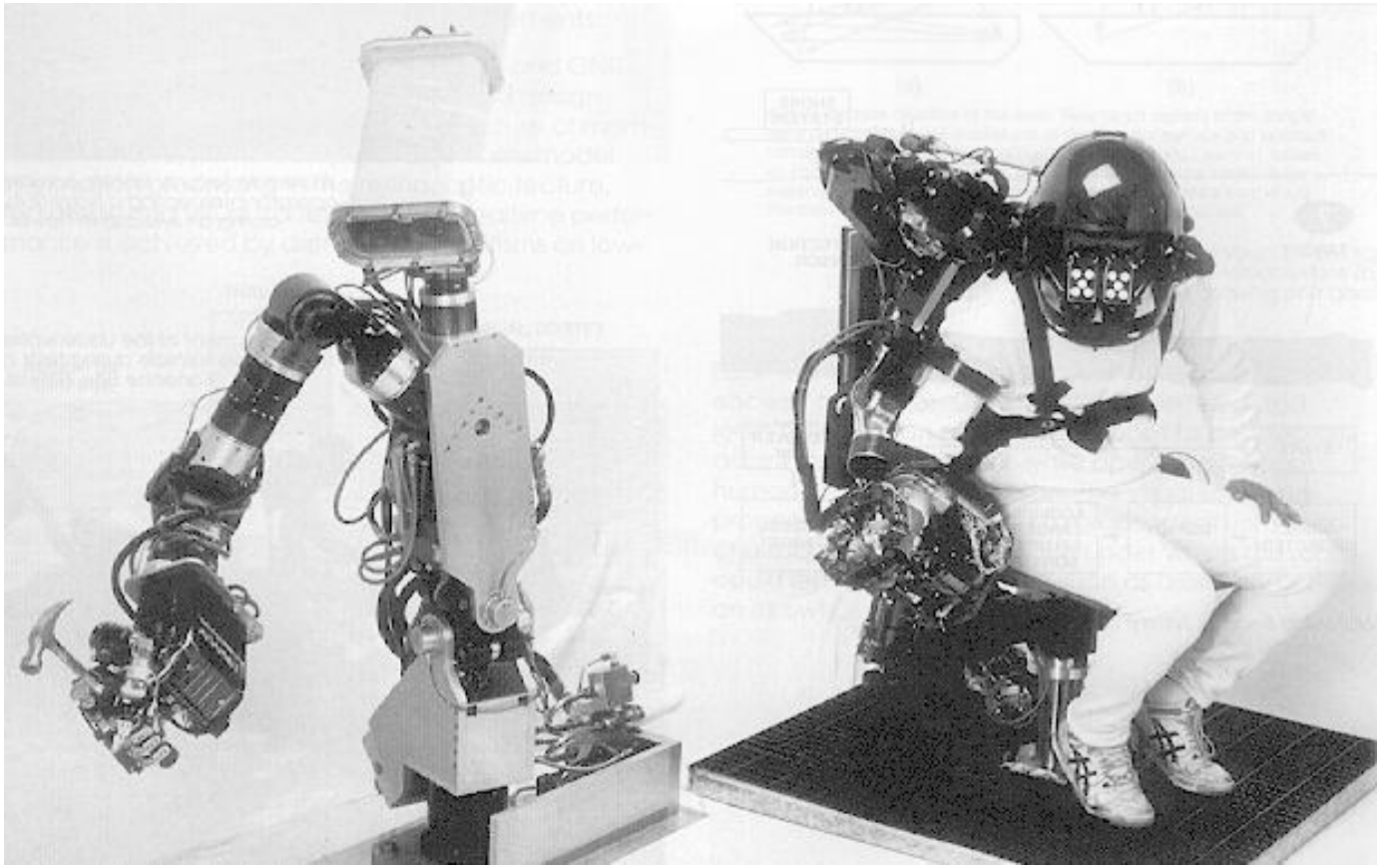
- Immersive VR
  - Completely immerse the user's personal viewpoint inside the virtual 3D world.
  - The user has no visual contact with the physical word.
  - Often equipped with a Head Mounted Display (HMD).

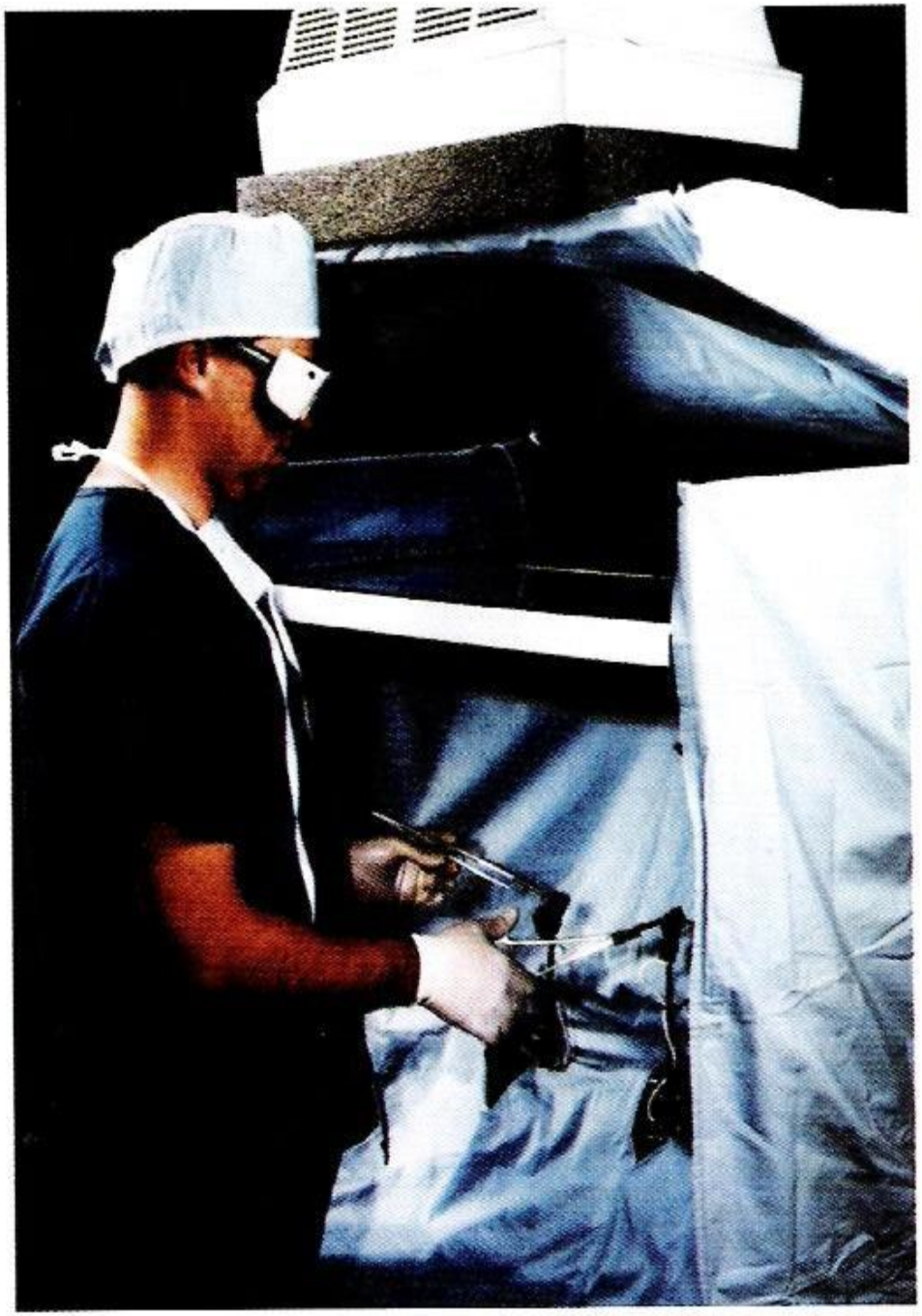
Telepresence

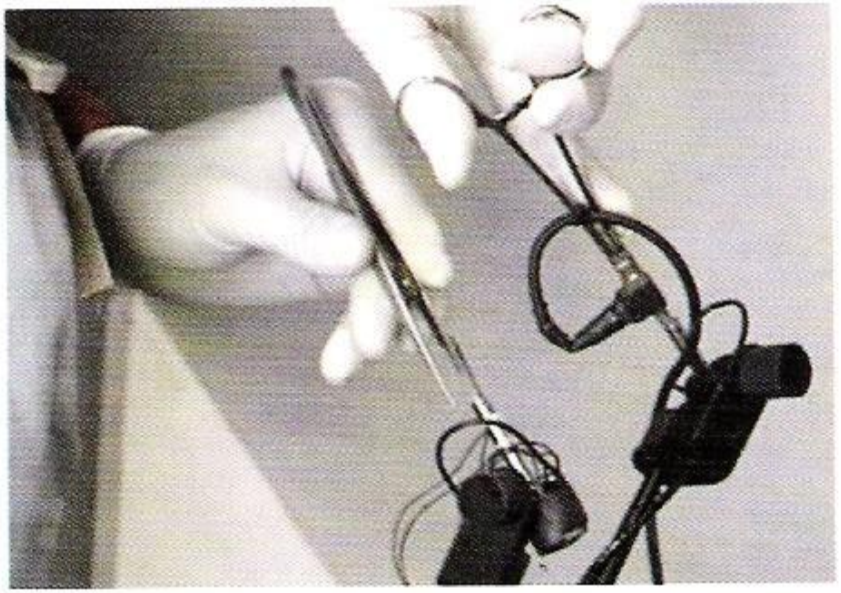
- Is a technology that links remote sensors in the real world with the senses of a human operator
- Telepresence
  - A variation of visualizing complete computer generated worlds.
  - The remote sensors might be located on a robot. Useful for performing operations in dangerous environments.

Telepresence Examples

- Telepresence VR





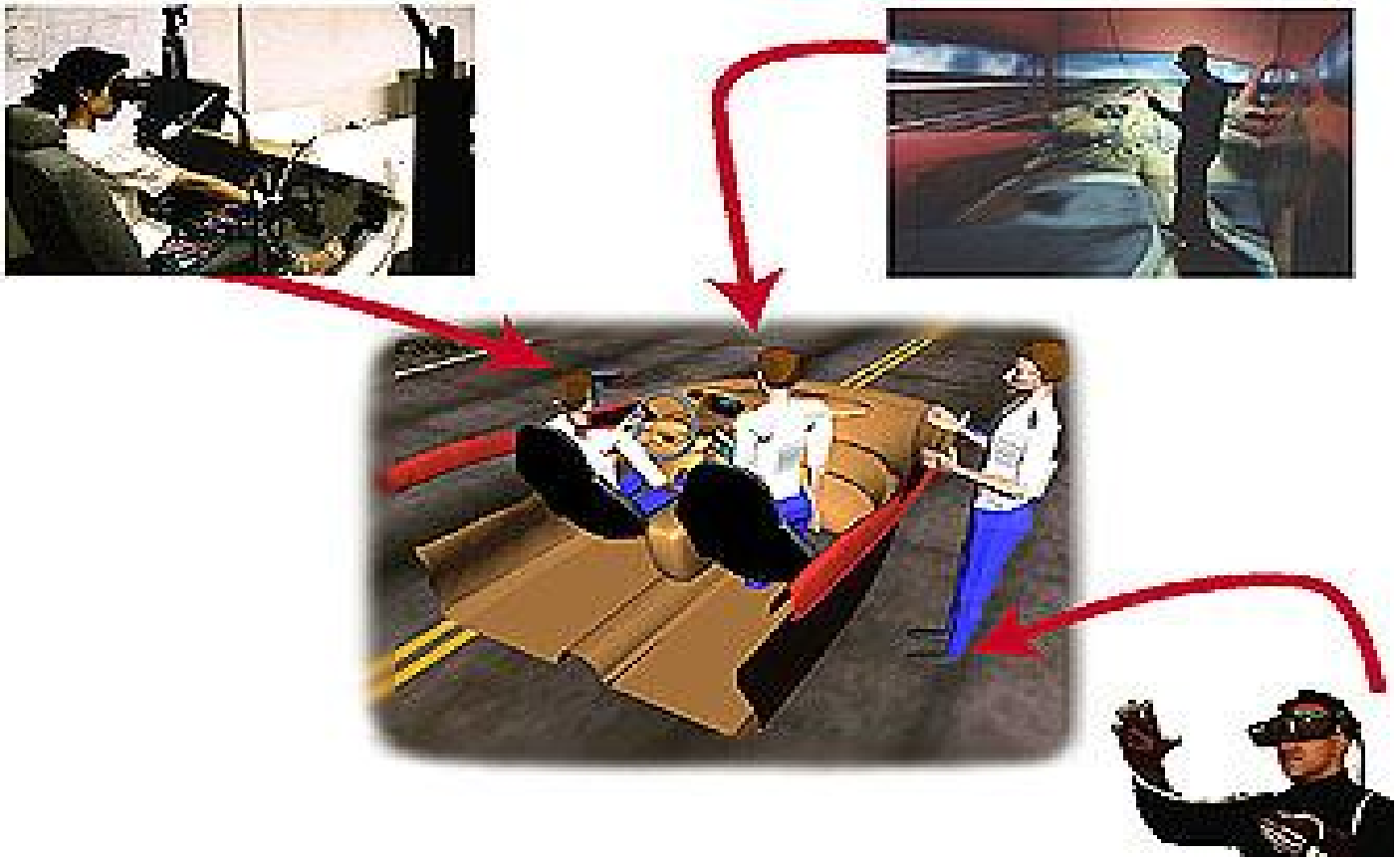


Distributed VR

- Distributed VR
  - A simulated world runs on several computers which are connected over network and the people are able to interact in real time, sharing the same virtual world.

Distributed VR

- Distributed VR

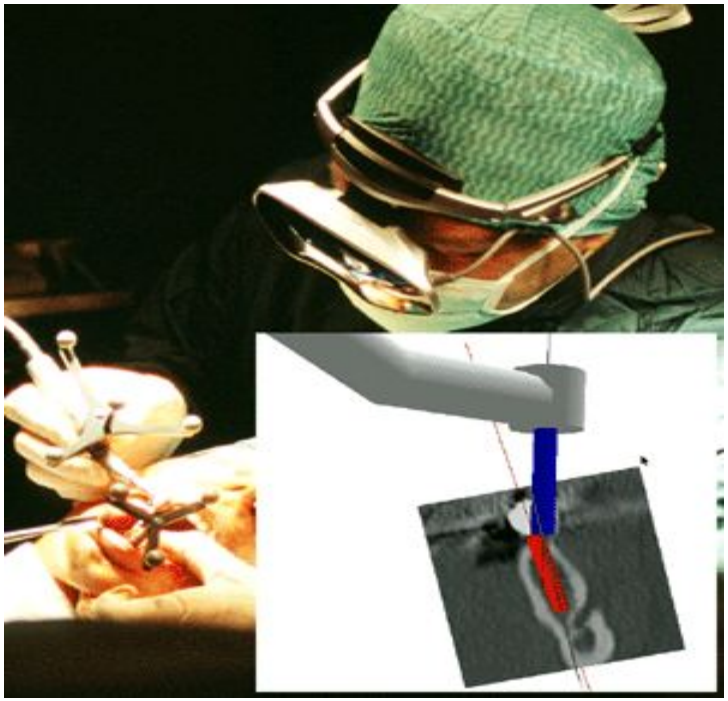


Applications

- **Entertainment**
  - More vivid
  - Move exciting
  - More attractive

Applications (Cont'd)

- **Medicine**
  - Practice performing surgery.
  - Perform surgery on a remote patient.
  - Teach new skills in a safe, controlled environment.



Applications (Cont'd)

- Manufacturing
  - Easy to modify
  - Low cost
  - High efficient

Applications (Cont'd)

- Education & Training
  - Driving simulators.
  - Flight simulators.
  - Ship simulators.
  - Tank simulators.