Animação e Ambientes Virtuais 2018/2019

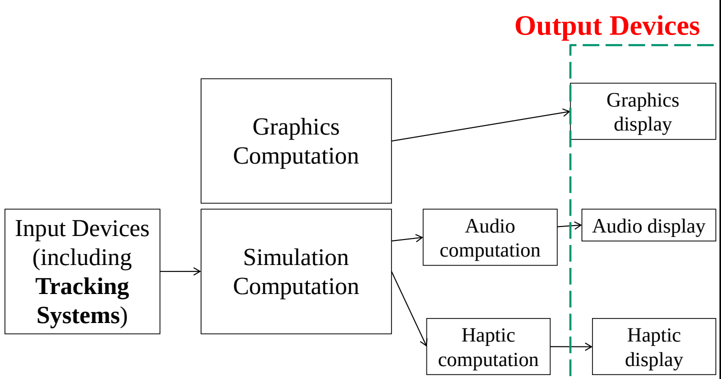
Mestrado em Engenharia Informática
Mestrado em Informática
e Pós-graduação

Virtual Reality

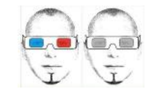
Part II

Ana Paula Cláudio

Typical VR System



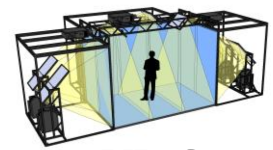
Head-Mounted Displays (HMD)



Anaglyphic glasses **Polarized glasses**

Passive glasses

Graphics displays



VR Cave

Shutter glasses

Active Glasses

VR –Output Devices- **graphics displays**

Desk-supported displays

Example:
Autostereoscopic display

Autostereoscopic display- a screen that presents floating three-dimensional images **without requiring vieweres to wear glasses** or sit directly in front of the display.

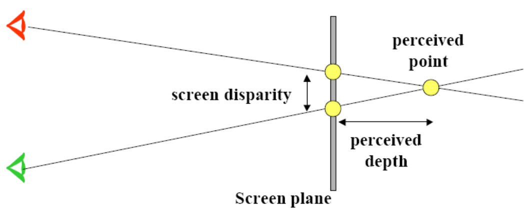
VR –Output Devices- **graphics displays**

Some autostereoscopic systems work by directing **one beam of light toward the viewer's left eye** and a **second beam toward the right**, making 3-D glasses unnecessary.

<u>If the viewer moves to the side, a camera at the top of the display registers the movement and adjusts the lens</u>. The screen is mounted <u>on a table that has cameras and infrared sensors hidden below the surface, which pick up on gestures, allowing the viewer to skip through images or rotate a three-dimensional object by pointing and moving the hand</u>.

VR –Output Devices- **graphics displays**

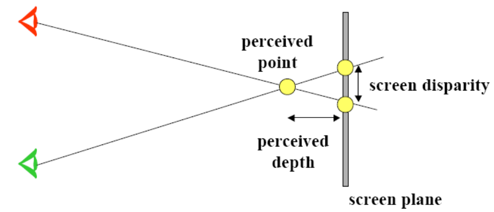
Depth Perception



The difference between the left and right images of a point on the retina is interpreted by the brain as depth information.

VR –Output Devices- **graphics displays**

Depth Perception



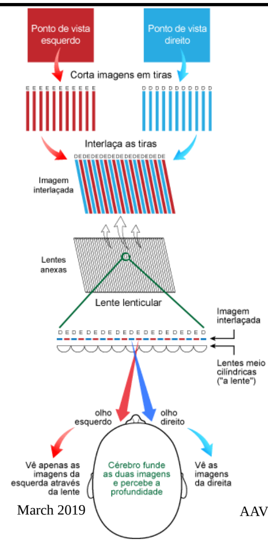
The eyes must focus (accommodate) on the screen plane and verge in front or behind the screen plane.

VR –Output Devices- **graphics displays**

Autostereoscopic display- a screen that presents floating three-dimensional images **without requiring vieweres to wear glasses** or sit directly in front of the display.

Such displays have a special "column-interlaced" **image format, which alternates individual columns assigned to the left-eye and the right-eye view**.

Special optics or illumination mechanism need to be used in order to assure that each eye sees only its corresponding image columns, which results in the perception of two images, and through parallax, **a single stereo image** floating in front of the autostereoscopic display.

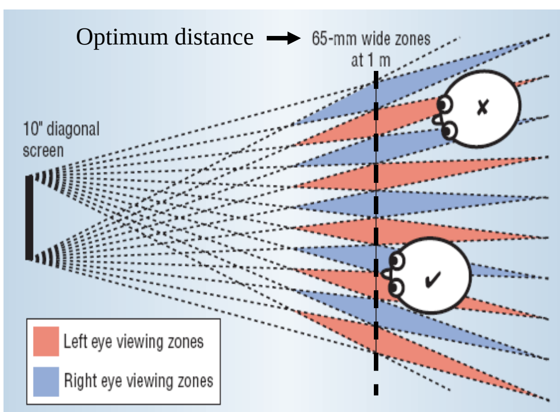


This technology requires content providers to create special images for the effect to work. **They must interlace the two sets of images together**. If you were to try and view the video feed on a normal screen, you would see a blurry double image.

http://eletronicos.hsw.uol.com.br/tv-3d5.htm

http://electronics.howstuffworks.com/3d-tv5.htm

Autostereoscopic display



Autostereoscopic display

Watch, for instance these two interesting videos

http://www.youtube.com/watch?v=-tq2LObfdr4

https://www.youtube.com/watch?v=MmsFl8TIWWc

VR –Output Devices- **haptic feedback**

(The Greek term *haptai* means touch)

Haptic feedback is a crucial sensorial modality in virtual reality interactions.

Haptics means both
- **force feedback** (simulating object hardness, weight, and inertia) and
- **tactile or touch feedback** (simulating surface contact geometry, smoothness, slippage, and temperature).

Providing such sensorial data requires desktop or portable special-purpose hardware called **haptic interfaces.**

VR –Output Devices- **haptic feedback**

Haptic feedback greatly improves simulation realism.

The **hand** has the highest density of touch receptors in the body. Most VR systems provide haptic feedback only to **user's hand and wrist**.

Touch feedback conveys real-time information on contact surface geometry, virtual object surface **roughness**, **slippage**, and **temperature**.

It does not actively resist the user's contact motion and **cannot stop the user** from moving through virtual surfaces.

VR –Output Devices- **haptic feedback**

Force feedback provides real-time information on virtual object surface compliance, object weight and inertia.

It actively resists the user's contact motion and **can stop it** (for large feedback forces).

Haptic feedback devices should guarantee user's safety and confort.

They **should not harm the user** and be **fail-safe** (users should not be subject to accidents in case of computer failure).

If the interfaces are too heavy and bulky, the **user will get tired** easily

VR –Output Devices- **haptic feedback**

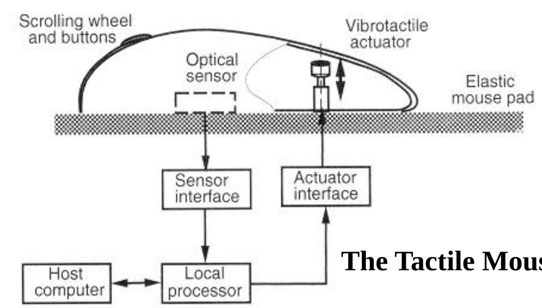
Some examples:

Tactile feedback interfaces:

- The tactile mouse
- The Temperature Feedback Glove
- The CyberTouch Glove

Force Feeback Interfaces

- Force Feedback Joysticks
- The PHANToM Arm
- The Haptic Master Harm
- The CyberGrasp Glove
- The CyberForce

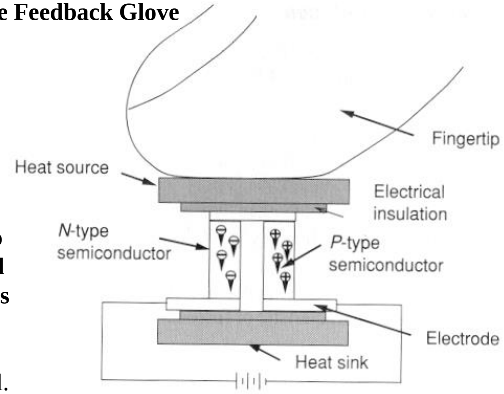


The Tactile Mouse

The outside appearance of this mouse is similar to the standard computer mouse. The difference is the addition of an electric actuator that can vibrate the mouse outer shell. Therefore, it provides vibrotactile feedback to the user.

VR –Output Devices- **haptic feedback**

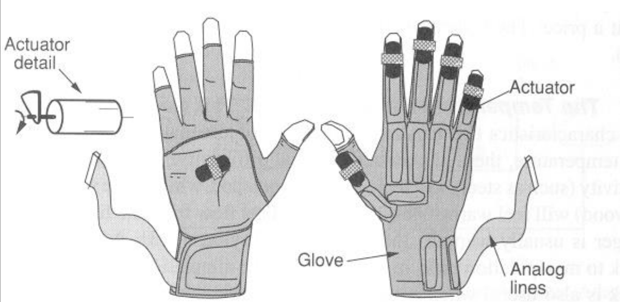
The Temperature Feedback Glove



This glove allows users to detect **thermal characteristics** that can help identify an object material.

VR –Output Devices- **haptic feedback**

The CyberTouch Glove



This haptic interface also provides <u>vibrotactile</u> <u>feedback</u> to the user.

VR –Output Devices- **haptic feedback**

CyberTouch

The CyberTouch is a tactile feedback option that features small vibrotactile sensors on the inside of the fingertips

https://www.virtalis.com/blogs/products/cyberglove-systems/

http://www.cyberglovesystems.com/

VR –Output Devices- **haptic feedback**

Force feedback interfaces are devices that differ in several aspects from the tactile feedback interfaces.

First, the requirement to **provide substantial forces to stop user's motion** implies larger actuactors, heavier structures (to assure mechanical stiffness), larger complexity and greater cost.

Furthermore, force **feedback interfaces need to be grounded** (rigidly attached) on some supportive structures to prevent slippage and potential accidents.

VR –Output Devices- **haptic feedback**

Force Feedback Joysticks

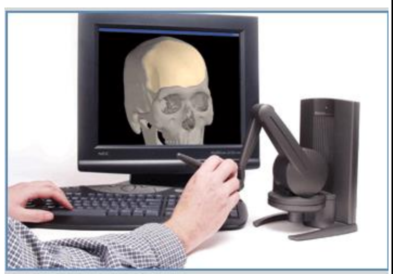
They are not portable, they are grounded on the desk. These are some of the simplest, least expensive and most widespread force feedback interfaces today.

https://flipboard.com/@topreviews/top-10-best-gaming-pro-flightstick-joystick-controllers-for-pc-2016-2017-no3r86qez

VR –Output Devices- **haptic feedback**

The PANTHoM Arm

The interface main component is a serial **feedback arm** that ends with a stylus. It is mainly used in industrial environments.



Three small motors give **force feedback to the user by exerting pressure on the stylus.** So, a user can feel the **elasticity of a virtual balloon** or the **solidity of a brick wall**.

http://www.geomagic.com/en/products/phantom-desktop/overview

The PHANTOM® interface from SensAble Technologies was one of the first haptic systems to be sold commercially. Its success lies in its simplicity. Instead of trying to display information from many different points, this haptic device simulates touching at a single point of contact. It achieves this through a stylus which is connected to a lamp-like arm. Three small motors give force feedback to the user by exerting pressure on the stylus. So, a user can feel the elasticity of a virtual balloon or the solidity of a brick wall. He or she can also feel texture, temperature and weight. The stylus can be customized so that it closely resembles just about any object. For example, it can be fitted with a syringe attachment to simulate what it feels like to pierce skin and muscle when giving a shot.

http://electronics.howstuffworks.com/everyday-tech/haptic-technology3.htm

Watch a video here:
https://www.youtube.com/watch?v=REA97hRX0WQ

VR –Output Devices- **haptic feedback**

The CyberGrasp Glove

http://www.cyberglovesystems.com/

This interface is <u>used for tasks requiring more dexterity</u> it may be necessary to control <u>simulated forces on independent fingers</u> rather than at the wrist as joysticks and master arms do.

"users are able to feel the size and shape of virtual objects that only exist in a computer-generated world. "

The CyberGrasp

• **This device fits over the user's entire hand like an exoskeleton and adds resistive force feedback to each finger.**

• **Five actuators** produce the forces, which are transmitted along tendons that connect the fingertips to the exoskeleton. With the CyberGrasp system, **users are able to feel the size and shape of virtual objects that only exist in a computer-generated world**. To make sure a user's fingers don't penetrate or crush a virtual solid object, the actuators can be individually programmed to match the object's physical properties.

http://electronics.howstuffworks.com/everyday-tech/haptic-technology3.htm

VR –Output Devices- **haptic feedback**

The CyberForce

This device is an addition to the CyberGrasp in order to allow the simulation of the object <u>weight</u> and <u>inertia</u>. It consists of a mechanical arm attached to the desk and to the user's wrist at the CyberGrasp exoskeleton.

http://www.cyberglovesystems.com/

VR –Output Devices- **haptic feedback**

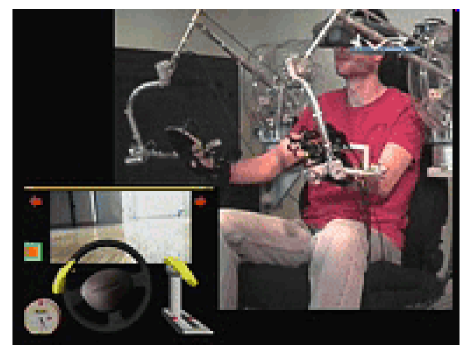
Haptic Workstation

The Haptic Workstation is a fully integrated simulation system providing right and left whole-hand haptic feedback, immersive 3D viewing, and easy-to-use CAD model manipulation and interaction software

http://www.cyberglovesystems.com/

https://www.youtube.com/watch?v=4aMCJDOEi0k

VR –Output Devices- **haptic feedback**



http://vrlab.epfl.ch/Movies/Movies_index.html

VR –Output Devices- **haptic feedback**

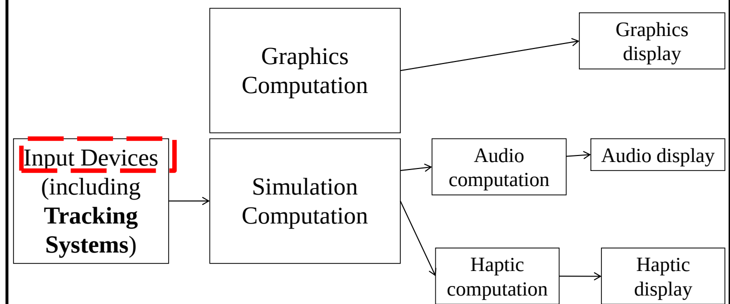
http://www.ohsu.edu/ohsuedu/newspub/releases/062005virtual.cfm

VR –Output Devices- **haptic feedback**

“The instruments give you force feedback in your hands that mimics how tissue and blood vessels feel and behave in real life. That's a great advance in simulators and a tremendous advantage for training our surgeons," said Hunter, co-director of the OHSU Digestive Health Center and a pioneer in laparoscopic surgery.”

http://www.ohsu.edu/ohsuedu/newspub/

Typical VR System



VR–Input Devices

Input devices: are used to mediate the user’s input into the VR simulation.

We can differentiate between **two types of input**:

- ***passive input:*** events triggered by the system monitoring the participant
- ***active input:*** events specifically triggered by the user

VR–Input Devices

Passive input

- trackers

Position trackers are key input components for VR systems

Active input

- navigation and manipulation interfaces
- gesture interfaces

VR–Input Devices–Navigation and Manipulation Interfaces

Trackball

An input device used for **pointing**, designed as an alternative to the mouse. It is almost an upside-down mouse; it is stationary and contains a movable ball that you rotate using your fingers to move the mouse cursor on the screen.

VR–Input Devices
Navigation and Manipulation Interfaces

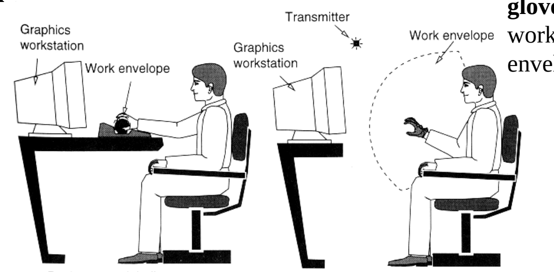
A **navigation/manipulation interface** is a device that allows the interactive change of the view to the virtual environment and exploration through the **selection and manipulation of a virtual object of interest**.

VR–Input Devices- Gesture Interfaces

Gesture interfaces are devices that measure the real-time position of the user's fingers (and sometimes wrists) in order to allow natural, gesture-recognition- based interaction with the virtual environment.

Trackball work envelope

Sensing glove work envelope



VR–Input Devices- Gesture Interfaces

The **drawbacks** that **most sensing gloves** have are need for **user-specific calibration**, complexity and high-cost.

Each person has a different hand size, with women generally having smaller hand size than men. In order to reduce inaccuracies, most **sensing gloves need to be calibrated to the particular user wearing them**.

VR–Input Devices- Gesture Interfaces

How the Nintendo-Wii Remote control Works

http://electronics.howstuffworks.com/wii1.htm

VR–Input Devices- Gesture Interfaces

How the Nintendo-Wii Remote control Works

- The Wii Remote uses a combination of built-in **accelerometers,** and **infrared detection** to sense its position in 3D space **when pointed at the LEDs in the Sensor Bar**.
- This design allows users to control the game with physical gestures as well as button-presses. The controller connects to the console using Bluethoot with an approximate 9.1 m range.

VR–Input Devices- Gesture Interfaces

How the Nintendo-Wii Remote control Works

The controller contains solid-state **accelerometers** and **gyroscopes** that let it sense:
Tilting and rotation up and down
Tilting and rotation left and right
Rotation along the main axis (as with a screwdriver)
Acceleration up and down
Acceleration left and right
Acceleration toward the screen and away.

http://electronics.howstuffworks.com/wii1.htm

VR–Input Devices- Gesture Interfaces

How the Nintendo-Wii Remote control Works

The Wii Remote also features an optical sensor, allowing it to determine where the Wii Remote is pointing.

This image shows Sensor Bar highlighting IR LEDs taken with a camera sensitive to infra-red. (Note: The lights coming from the edges of the bar are **not** visible to the human eye, just Wii Remotes and any other equipment that can sense IR light sources, including most digital cameras).

http://en.wikipedia.org/wiki/Sensor_Bar#Sensing

VR–Input Devices–Gesture Interfaces

The Kinect for Windows SDK (1)
[Webb12]

The Kinect for Windows SDK is the set of libraries that allows us to program applications on a variety of Microsoft development platforms using the Kinect sensor as input.

The glossy black case for the Kinect components includes a head as well as a base. The head is 12 inches (30,5 cm) by 2.5 inches (5,2 cm) by 1.5 inches (3,81 cm).

VR–Input Devices–Gesture Interfaces

The Kinect for Windows SDK (1)
[Webb12]

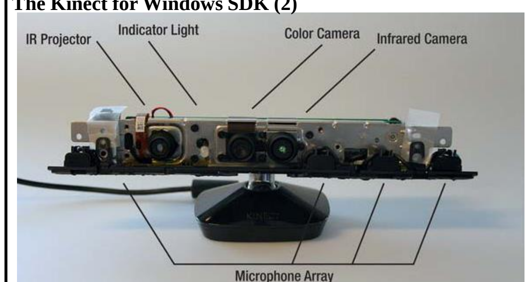
The Kinect for Windows SDK is the set of libraries that allows us to program applications on a variety of Microsoft development platforms using the Kinect sensor as input. With it, we can program:

- WPF applications,
- WinForms applications,
- XNA applications and, with a little work, even
- browser-based applications running on the Windows operating

The glossy black case for the Kinect components includes a head as well as a base. The head is 12 inches (30,5 cm) by 2.5 inches (5,2 cm) by 1.5 inches (3,81 cm). The attachment between the base and the head is motorized.

VR–Input Devices–Gesture Interfaces

The Kinect for Windows SDK (2)



The case hides an infrared projector, two cameras, four microphones, and a fan.

The base Kinect hardware **performs depth recognition between 0.8 and 4 meters**.

When facing the Kinect, to the far left is the **infrared light source**. Next to this is the LED ready indicator. Next is the **color camera used to collect RGB data**, and finally, on the right, is the **infrared camera used to capture depth data**.

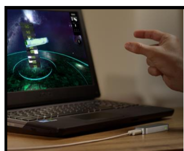
VR–Input Devices–Gesture Interfaces

Leap-motion

computer hardware sensor device that supports hand and finger motions as input, analogous to a mouse, but. **requiring no hand contact or touching**

“The **Leap Motion Controller** senses how you naturally move your hands and lets you use your computer in a whole new way. Point, wave, reach, grab. Pick something up and move it.”

https://www.leapmotion.com/product

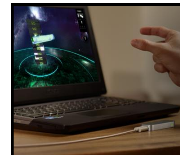


Leap-motion controller

http://en.wikipedia.org/wiki/Leap_Motion

Using **two monochromatic IR cameras** and **three infrared LEDs,** the device observes a roughly hemispherical area, to a distance of about 1 meter (3.28084 feet).

The LEDs generate a 3D pattern of dots of IR light and the cameras generate almost 300 frames per second of reflected data, which is then sent through a USB cable to the host computer, where it is analyzed by the Leap Motion controller software using "complex maths" in a way that has not been disclosed by the company, **in some way synthesizing 3D position data by comparing the 2D frames generated by the two cameras**.



Leap-motion controller

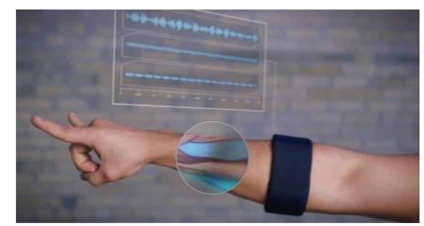
http://www.engadget.com/2013/07/22/leap-motion-controller-review/

the Leap is different from a Kinect sensor bar in more than just its size and appearance.
Leap works using **infrared optics and cameras instead** of depth sensors, and does not cover as large an area as Microsoft's gestured controller.

VR–Input Devices–Gesture Interfaces

Myo lets you use **the electrical activity in your muscles to wirelessly control your computer**, phone, and other favorite digital technologies.

With a wave of your hand, Myo will transform how you interact with your digital world.



https://www.thalmic.com/en/myo/

https://www.youtube.com/watch?v=oV0PbKZyqg8&feature=youtu.be

VR–Input Devices

Passive input

- trackers

Position trackers are key input components for VR systems

Active input

- navigation and manipulation interfaces
- gesture interfaces

VR–Input Devices

Trackers

Sensory feedback is an ingredient essential to virtual reality.
The VR system provides direct sensory feedback to the participants based on their **physical position**.

In order to base the sensory output of the VR system on the position of the participant, the system must **track their movement**.

A typical VR system will track the head of the participant and at least one hand or an object held by the hand. Advanced systems may track many of the major body joints.

VR–Input Devices

Trackers

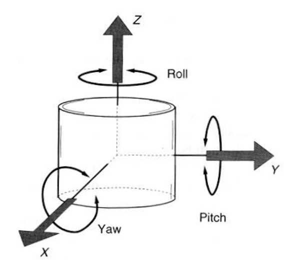
A good definition of ***position tracking*** is the computerized sensing of the position (location and/or orientation) of an object in the physical world-usually at least *part* of the participant's body.

Continuous tracking of the user's movements is what allows the system to render and display the virtual world from a user-centric perspective providing the effect of **physical immersion**.

VR–Input Devices

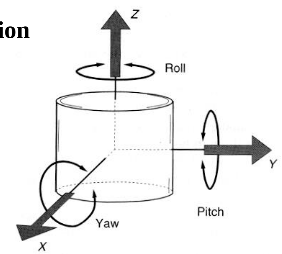
Trackers

A moving object in 3D space has **six degrees of freedom (6-DOF)**, three for **translations** and three for **rotations**.These movements define a dataset of **six** numbers **that need to be measured sufficiently rapidly**, as the object may be moving at high speed.



Trackers VR–Input Devices

- 3 rotational DOF: define **orientation**
- 3 translational DOF: define **location**

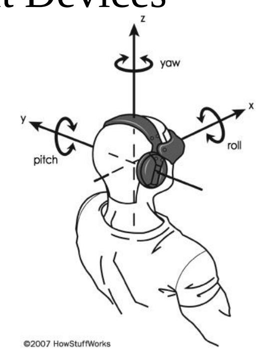


Not all position-tracking devices are capable of determining the complete 6-DOF position and thus report only one set or the other.

VR–Input Devices

Trackers

The trackers on the HMD tell the CPU what you are looking at, and the CPU sends the corresponding images to your HMD's screens.



http://electronics.howstuffworks.com/gadgets/other-gadgets/VR-gear6.htm

VR–Input Devices–Trackers

All 3D tracker, regardless of the technology they use, share a number of very important **performance parameters**:

- **Accuracy**
- **Jitter**
- **Drift**
- **Latency**
- **Update rate**

VR–Input Devices–Trackers
Performance Parameters

Tracker accuracy represents the <u>difference between the object's actual 3D position and that reported by tracker measurements</u>. The <u>more accurate a tracker</u>, the smaller this difference is and the <u>better the simulation follows</u> the user's real actions.

Accuracy is given separately for tracking translation (fraction of milimeter) and rotation (fraction of degree).

VR–Input Devices–Trackers
Performance Parameters

Tracker **jitter** represents the change in the tracker output when the tracked object is stationary.

Tracker **drift** is the degradation of accuracy over time.

A tracker with no jitter (and no drift) would report a constant value if the tracked object is stationary in time.

VR–Input Devices–Trackers
Performance Parameters

Tracker **latency** is the time delay between action and result. In the case of the 3D tracker, latency is the time between the change in object position/orientation and the time the sensor detects that change.

Low latency tracking is particularly important to increase immersion and reduce the likelihood of **simulator sickness**.

VR–Input Devices–Trackers
Performance Parameters

The tracker **update rate** represents the number of measurements (datasets) that the tracker reports every second. The larger the tracker update rate, the better is the dynamic response of the simulation.

It is necessary to look at tracker performance parameters in order to match their measurements capabilities to different sensorial channel requirements and available budgets.

VR–Input Devices–Trackers
Methodologies

Tracking methodologies:

- Mechanical
- Electromagnetic
- Ultrasonic
- Optical
- Inertial
- Neural position-sensing devices
- Hybrid

Each methodology has its own benefits and limitations.

VR–Input Devices–Trackers
Methodologies

Position sensors impose limitations on the system. Of course, limitations vary with the type of sensor employed, but in general, **limitations arise from the technology used to determine the relationship from some fixed origin and the sensor**.

Some trackers require an **uninterrupted line of sight** between a transmitter and a sensor. When the line of sight is interrupted (i.e., something comes between the transmitter and the sensor), the tracking system cannot function properly.

VR–Input Devices–Trackers
Methodologies

In position-sensing systems, three things play against one another (besides cost):

(1) accuracy/precision and speed of the reported sensor position,
(2) interfering media (e.g., metals, opaque objects), and
(3) encumbrance (wires, mechanical linkages).

No available technology, at any cost, **provides optimal conditions in all three areas**.

VR–Input Devices–Trackers
Methodologies

The system designer must consider how the VR system will be used and make the optimal tradeoffs.
One consideration is simply the ability of the system to produce an acceptable experience. **Noise** and **low accuracy** in the position sensor reports and lag time decrease the realism or immersiveness of the experience and can lead to **nausea** in some participants.

VR–Input Devices–Mechanical Trackers

A **mecanical tracker** consists of a series or **parallel kinematic structure composed of links interconnected using sensorized joints**.

VR–Input Devices–Mechanical Trackers

Example:

A mechanical tracker: the Gypsy Motion capture system is a **sensorized exoskeleton worn on a lycra suit**. The user's 15 joint positions are measured by 42 single-turn conductive plastic precision **potentiometers**. **Wires** from each sensor are routed through hollow alluminium housings at the shoulders and hips. **The wires are then connected to three cables that go to the host computer**.

VR–Input Devices–Mechanical Trackers

robotic exoskeleton to amplify the strength of the wearer's arms.

VR–Input Devices–Mechanical Trackers

Example:

A BOOM Display used by NASA to emulate space
PHOTO COURTESY OF NASA

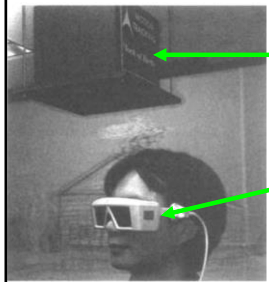
http://electronics.howstuffworks.com/gadgets/other-gadgets/virtual-reality9.htm

VR–Input Devices–Mechanical Trackers

Compared to others, mechanical trackers are simpler and easier to use. They are fast and their accuracy is fairly constant.

The primary **disadvantage** of this type of system is that the physical linkages restrict the user to a fixed location in the world.

VR–Input Devices–Electromagnetic Trackers



A **magnetic tracker** is a noncontact position measurement device that uses a **magnetic field** produced by a **stationary transmitter** to determine the real-time position of a moving receiver element.

smaller *receiver* unit worn by the user. The signal in the receiver is measured to determine its position relative to the transmitter.

VR–Input Devices–Electromagnetic Trackers

This method uses a ***transmitter*** to generate a low-level magnetic field from three orthogonal coils within the unit.
In turn, **these fields generate current in another set of coils in the smaller *receiver* unit worn by the user**. The signal in each coil in the receiver is measured to determine its position relative to the transmitter.
The **transmitter unit is fixed at a known location** and orientation so that the absolute position of the **receiving unit** can be calculated. Multiple receiving units are generally placed on the user (typically on the head and one hand) and sometimes on a handheld device.

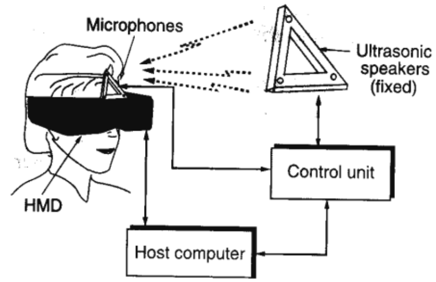
VR–Input Devices–Electromagnetic Trackers

The main benefit of this system is that **it does not require line of sight between the transmitter and the receiver** so occlusion is not a problem.

Electromagnetic trackers **are not immune to interference** from metallic structures or magnetic fields that may exist in their vicinity.

VR–Input Devices–Ultrasonic Trackers

An **ultrasound tracker** is a noncontact position measurement device that uses an ultrasonic signal produced by a stationary transmitter to determine the real-time position of a moving receiver element.



VR–Input Devices–Ultrasonic Trackers

The **transmitter is a set of three ultrasonic speakers** mounted about 30 cm from each other on a rigid and fixed triangular frame.

Similarly, the **receiver is a set of three microphones** mounted on a smaller rigid triangular frame which is placed at the top of the head-mounted display.

- Tracking performance can be degraded when operated in a **noisy environment**.

VR–Input Devices–Ultrasonic Trackers

Properties of sound do limit this method of tracking:

- Tracking performance can be degraded when operated in a **noisy environment**.
- The sounds must have an **unobstructed line** between the speakers and the microphones to accurately determine the time (and therefore distance) that sound travels between the two.
- Trackers built around this technology generally have a **range of only a few feet** and are encumbered by wires attached to both the transmitter and receiver.

VR–Input Devices–Ultrasonic Trackers

- This method of tracking relies on such common technology as speakers, microphones, and a small computer so, it provides a **fairly inexpensive** means of position tracking.

VR–Input Devices–Optical Trackers

Optical tracking systems make use of visual information to track the user.

The most common is to make use of a video camera that acts as an electronic eye to "watch" the tracked object or person.

The video camera is normally in a fixed location. **Computer vision** techniques are then used to determine the object's position based on what the camera "sees."

- In some cases, **light-sensing devices** other than video cameras can be used.

VR–Input Devices–Optical Trackers

- When using a **single sensing device**, the position of the "watched" point can be reported in only **two dimensions**; that is, where the object is in the plane the sensor sees, but without depth information.

Example:

A single-source video-tracking method uses a small camera mounted near a desktop monitor (such as one used for desktop video teleconferencing). This camera can roughly calculate the user's position in front of the monitor by detecting the outline of the viewer's head (given that the distance of the user's head from the screen generally falls within some limited range).
This system can then be used as a crude optical tracker for a VR system based on a desktop monitor (also known as ***Fishtank VR*** because of the display's resemblance to peering into a fishtank).

VR–Input Devices– **Optical Trackers**

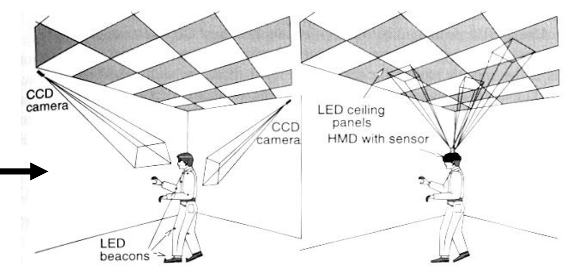
- Watching multiple points or using multiple sensors allows the system to **triangulate** the location and/or orientation of the tracked entity, thereby providing **three-dimensional** position information.
- A **limitation** of optical tracking is that the **line of sight** between the tracked person or object and the camera must always be clear. Keeping the tracked object within the sight of the camera also **limits the participant's range of movement**.

VR–Input Devices–Optical Trackers

- Similar to ultrasonic trackers, **optical trackers** work through triangulation, require direct line of sight, and are immune to metal interference.
- **Optical trackers, however, offer significant advantages over their ultrasonic counterparts**. Their **update rates are much higher** and their **latency smaller** than those of ultrasonic trackers because **light (whether visible or infrared) travels much faster than sound**.
- They are capable of **much higher envelopes**, which is increasingly important in modern VR technology.

VR–Input Devices–Optical Trackers

Mainly used for motion capture

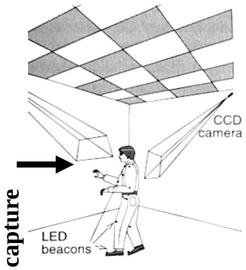


Outside-looking-in: some light beacons are placed on the user (LED= light-emitting diode)

Inside-looking-out: cameras are attached to the tracked object

VR–Input Devices–Optical Trackers

Mainly used for motion capture



Outside-looking-in: some light beacons are placed on the user
(LED= light-emitting diode)

Tracking sensitivity is **degraded** when:

1- distance deacreses between the beacons on the user's body.

2- the distance increases between the user and the camera.

VR–Input Devices–Inertial Trackers

- ***Inertial tracking*** uses **electromechanical instruments** to detect the relative motion of sensors by measuring change in **gyroscopic** forces, **acceleration**, and **inclination**
  - **Accelerometers**
  - **Inclinometer**
  - **Gyroscopes**

Modern mobile/smart phones and tablets incorporate these sensors + **Global Positioning System (GPS)**

This technology has been used in highly accurate, large-scale systems as a means of maritime and flight navigation via inertial navigation systems (INS)

VR–Input Devices– Inertial Trackers

- **Accelerometers** measure acceleration. They can be used to determine the new location of an object that has moved, <u>if you know where it started</u>.
- **Inclinometers** measure inclination, or how tipped something is with respect to <u>its "level" position</u> (the tilt of a person's head, for instance). It is very much like a carpenter's level except that the electrical signal it provides as its output can be interpreted by a computer.
- **Gyroscopes** measure orientation.

VR–Input Devices–Inertial Trackers

- Because **accelerometers provide relative (rather than absolute) measurements**, errors accumulate in the system over time, leading to **inaccurate** information. Thus, in practical applications of virtual reality, these tracking systems are typically limited to orientation-only measurement.

http://archive.ncsa.illinois.edu/Cyberia/VETopLevels/VR.Overview.html#toc

VR–Input Devices–Inertial Trackers

Inertial trackers offer some significant **benefits**:

- The primary benefit is that they are self-contained units that **require no complementary components fixed to a known location**, so there is no range limitation.
- They move freely with the user through a large space.

VR–Input Devices–Inertial Trackers

Inertial trackers offer some significant **benefits**:

- The primary benefit is that they are self-contained units that **require no complementary components fixed to a known location**, so there is no range limitation.
- They move freely with the user through a large space.
- They work relatively quickly compared with many of the other tracking methods and, therefore, introduce little lag into the system. Units of reasonable quality are fairly **inexpensive** and have been incorporated directly into some inexpensive head-based displays (HBDs).

VR–Input Devices–Neural Trackers

Neural or ***muscular tracking*** is a method of sensing individual body-part movement, relative to some other part of the body. It can be used to track movement of fingers or limbs. Small sensors are attached to the fingers or limbs, with something like a Velcro strap or some type of adhesive to hold the sensor in place.

VR–Input Devices–Neural Trackers

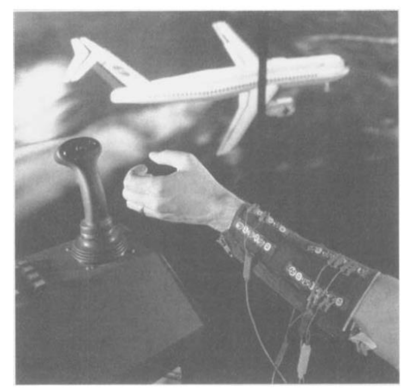


FIGURE 3-6 *NASA researchers have prototyped a device that measures muscle contractions in the arm and can determine the approximate movement of the fingers (Image courtesy of NASA).*

This type of tracking measures the electrical skin response to determine nervous and muscular activity in a certain area.

VR–Input Devices–Neural Trackers

- This type of tracking measures the electrical skin response to determine nervous and muscular activity in a certain area.
- By monitoring electrical impulses in specific areas of the skin, it is possible to determine the triggering of the muscles that control finger flexion and similar movements.
- This technology has been tested in **prosthetic devices** to control movements in the prosthesis by monitoring nerve stimulus farther up the limb.

VR–Input Devices–Hybrid Trackers

A **hybrid tracker** is a system thar utilizes two or more position measurement technologies to track objects better than any single technology would allow.

VR–Input Devices- Calibrating the Trackers

All tracking systems have to be calibrated in some way before they are useful at all.

Calibration is a comparison between measurements – one of known magnitude or correctness made or set with one device and another measurement made in as similar a way as possible with a second device.

The device with the known or assigned correctness is called the **standard**. The second device is the **unit under test**, test instrument, or any of several other names for the device being calibrated.

http://en.wikipedia.org/wiki/Calibration

VR–Input Devices- Calibrating the Trackers

Calibrating the system for operation within a specific environment can help reduce errors, such as those caused by certain metals when near a magnetic tracking system, for instance.

- **In some cases, calibration is simply a matter of telling the system where it is originally.**
- Regardless of what the tracking system inherently allows, the signals it puts out can always be altered (i.e., **corrected**) in the computer code that calculates the tracker position with respect to the VR application.

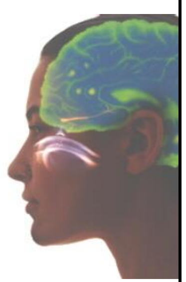
VR–Input Devices- Calibrating the Trackers

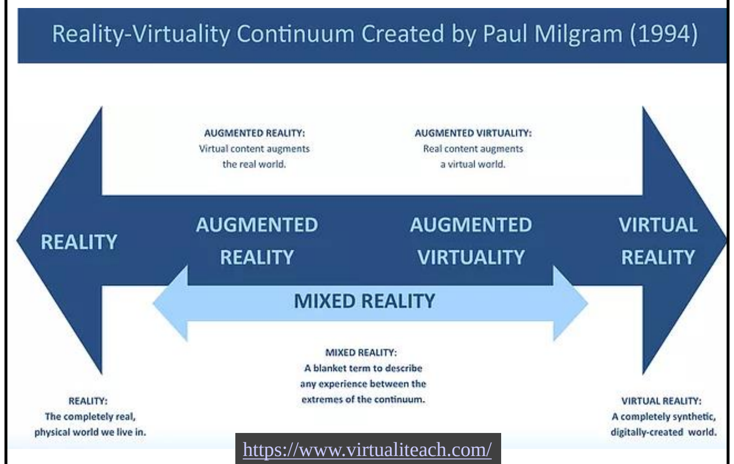
Example:

One form of calibration clone for electromagnetic systems is to create a **correction (lookup) table**. The tracking sensor is put in a very specific place. You can see if the tracking system reports that it is in that exact spot. If it does not, you *tell* the system that it is *really* in the spot you know it is in. You keep doing this by moving the tracking sensor and measuring, thereby building a lookup table that the system can use to correct the values it is reporting. In other words, once you've built the lookup table, the system can always apply those corrections to the reported values.

Augmented Reality

Augmented Reality is a special form of Virtual Reality that **superimpose** meaningful virtual images onto the user's view of the real world.





virtuality continuum

In 1994 Paul Milgram and Fumio Kishino defined a mixed reality as "…anywhere between the extrema of the virtuality continuum." (VC), where the Virtuality Continuum extends from the completely real through to the completely virtual environment with augmented reality and augmented virtuality ranging between.

https://erealityhome.wordpress.com/2008/10/18/paul-milgram-and-fumio-kishino-virtuality-continuum/

Augmented Reality (example)

http://www.youtube.com/watch?v=oiqIPXnKkKo