

## Chapter 11:

### Tracking and Input devices

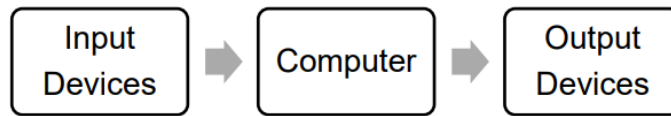
#### Overview

- 1 Input devices
- 2 Tracking



#### Input devices

Input devices are tools for the user to interact with the virtual world. Signals with information about the user's action are sent to the VR engine to aim appropriate real-time feedback or reaction of the output device.



There are different types of input devices, e.g. 3D input devices (gloves, 3D mice and bats), desktop input devices (SpaceBall), joystick, data-suit, light-pen or trackers.

#### Data Gloves

Data gloves can be used for the detection of the finger position. They are usually combined with trackers for the manipulation of objects. With the gloves, you get an intuitive interaction.



Vrrealities.com

#### Guns

Guns are motion controllers for VR experiences and can be used for shooting enemies or decorating a cake. You can differentiate between mono grip and dual grip.



Kickstarter.com

#### Treadmills and Locomotion

e.g. Virtuix Omni



Powerupgaming.co.uk

#### Data-Suits

Data-Suits enable full-body motion control in games. Inertial sensors on the head etc. are used for tracking. There are different flavours: Upper body-only solution, kicking or walking ets, and Full sensor suit. An example for a data-suit is PrioVR

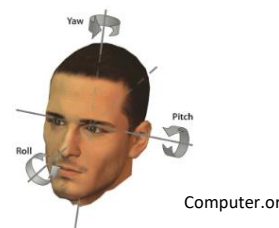


PrioVR.com

## Trackers

trackers.

Trackers are sensors that capture the orientation and/or position of a real object. The orientation and position are used for the rendering of the images. Tracking is done on different parts of the body (head, eye, hand, device, face, body). 3D objects need to have 6 degrees of freedom (DOF): the position coordinates (x,y and z offset) and the orientation (roll, pitch and yaw angles).



6 DOF

position  $x, y, z$

orientation (roll, pitch, yaw angles)

The properties of 6 DOF trackers are:

Speed →  
action transmission →  
Correctness →  
Resolution →  
Coverage →


- **Update rate:** measurements per second → The higher the smoother the tracking of movements
- **Latency:** Difference time between the physical, real action of the user and the transmission begin of the report representing the action → The lower the better the performance
- **Accuracy:** Measured error between real and reported position and orientation → the smaller the better
- **Resolution:** Smallest change in orientation and position that can be detected by the tracker → the smaller the better the performance
- **Range:** Angular coverage of tracker respectively the volume in which the tracker can measure orientation and position

There are different tracking Systems: magnetic trackers, optical trackers, acoustic trackers, mechanical trackers and inertial trackers.

### Magnetic Trackers

Magnetic trackers measure the intensity of the magnetic field in various directions. The system often consists of an emitter, a receptor, and a control unit. They are the most used trackers.

Example: Magnetic winding to detect the position across all axes.

Advantages	Disadvantages	
<ul style="list-style-type: none"> <li>• Precise</li> <li>• Multiple receptors</li> <li>• Small</li> <li>• Large tracking area</li> </ul>	<ul style="list-style-type: none"> <li>• Limited area of action</li> <li>• Sensitive to ferromagnetic surfaces</li> <li>• Sensitive to magnetic fields</li> </ul>	 Roadtovr.com

### Optical Trackers

In optical trackers, you have different types of markers that need to be found by using

image processing.

#### Advantages

- Ability to register big quantity of points
- Cheap

#### Disadvantages

- Limited workspace to FOV of cameras
- Variable latency time



Roadtovr.com

#### Acoustic Trackers

propagation time of sound

Acoustic trackers use the propagation time of acoustic signals. The system consists of emitters and receptors (fixed, mobile). An example is the InterSense IS-900 positional tracker.

#### Advantages

- Cheap

#### Disadvantages

- Easily distorted signals
- Not very precise
- Sensitive to noise



Roadtovr.com

#### Mechanical Trackers

potentiometers to joints. fixed points.

To reconstruct the position and orientation of the headset, you use the rotation angle of potentiometers attached to joints of the articulated structure. You have a fixed base point and free side point.

#### Advantages

- Fast
- Precise
- Low latency

#### Disadvantages

- Requires fixed objects
- Limits movement freedom
- Stationary



Fakespacelabs.com

#### Inertial Trackers

Accelerometers  
Gyroscopes

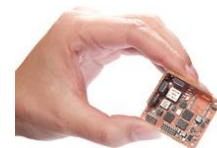
Inertial trackers are devices that measure acceleration and rotatory orientation. The system consists of accelerometers and gyroscopes

#### Advantages

- No cables result in unlimited areas of action
- Used in large indoor areas

#### Disadvantages

- Relative position
- Accumulative errors
- Sensitive to movement velocity

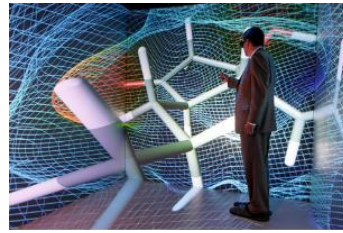


Xsens.com

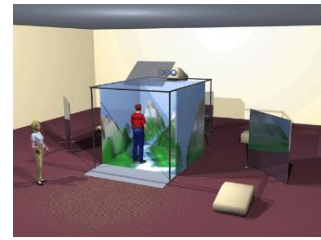
There are also possibilities of exploring the VR world without having additional headsets or headphones attached to the body. One example is the CAVE (Cave Automatic Virtual Environment system).

The standard setup consists of:

- Rear projection walls
- Down projection floors
- Tracking sensors in the walls
- Speakers at different angles
- Sound/music
- Video



Neatorama.com



Indiana.edu

A different example is VGX (Virtual Glovebox System). It is a package of virtual environment technologies. It is an immersive desktop environment registered with physical space. It is a combination of force-feedback haptics, real-time graphics and hand-tracking.



Twombly, 2006