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Department of Biomedical Engineering

Course Name: 19BMT401 – Virtual Reality in Medicine

IV Year : VII Semester

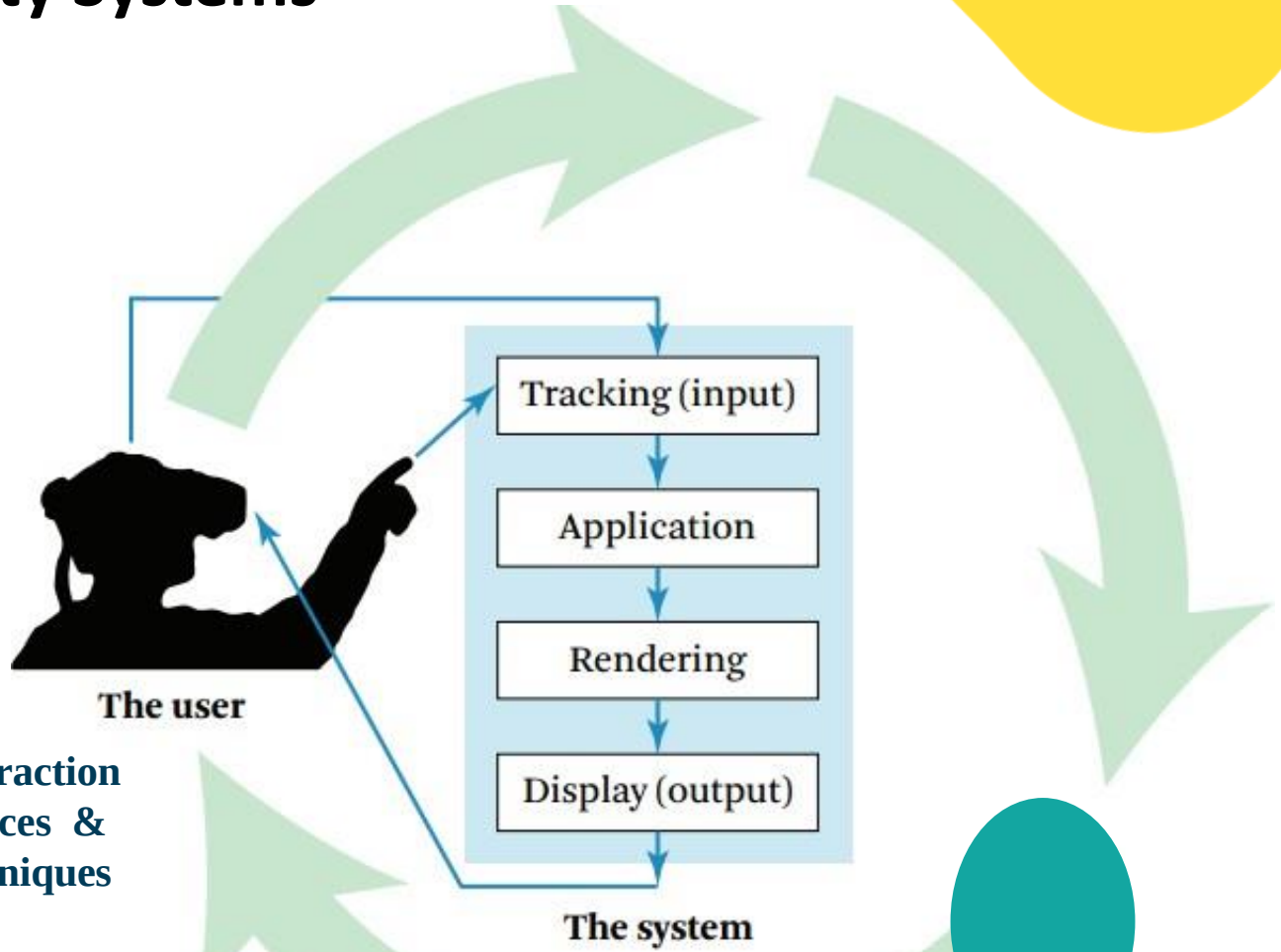
Unit I –INTRODUCTION

Topic : Input Devices :(Trackers, Navigation, and Gesture Interfaces)

What is Virtual Reality?

"A high-end user interface that involves real-time simulation and **interaction** through multiple sensorial channels." (vision, sound, touch, smell, taste) (Burdea and Coiffet., 2003)

Virtual Reality Systems



(Jerald, 2016)

Crucial technologies for VR

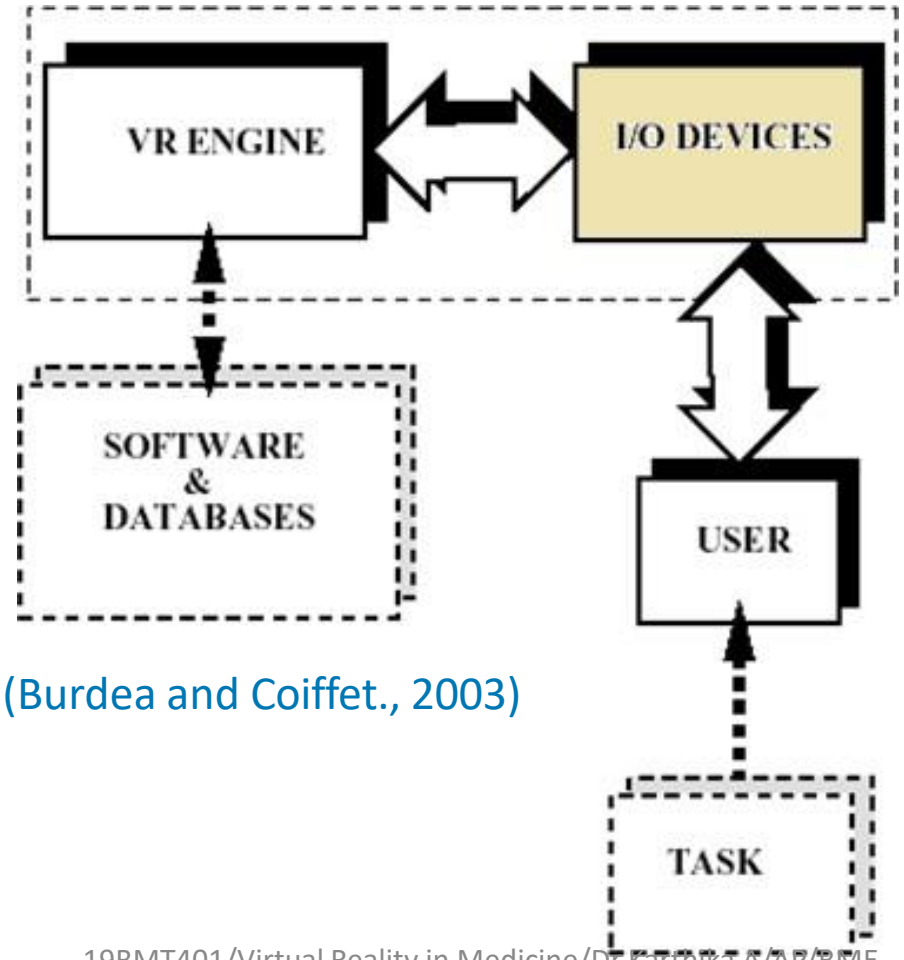
- Visual displays
- Graphics rendering system
- Tracking system
- Database system
- **Interaction devices**
- Interaction techniques
- Sound and haptic displays

(if possible…)

for AR

+ Cameras and registering

Input Devices:
Trackers, Navigation and gestures interfaces

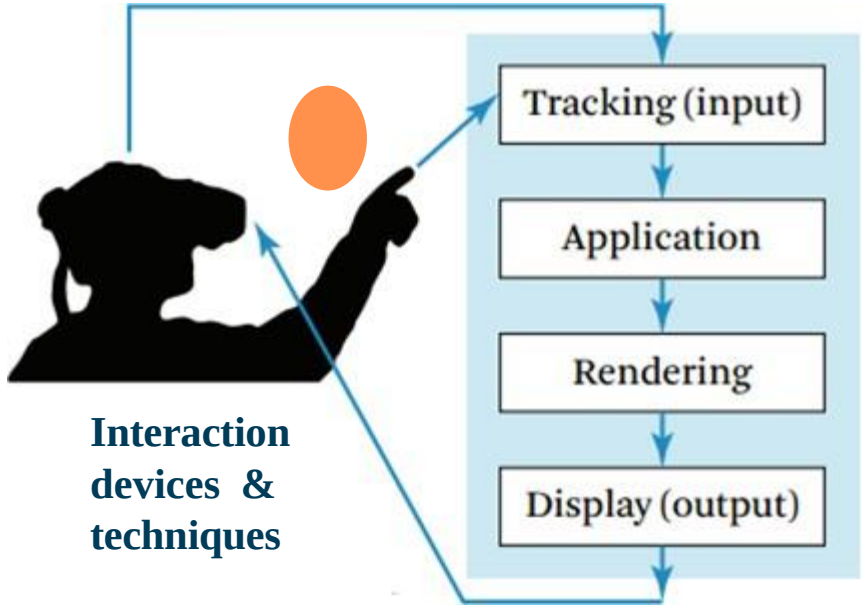


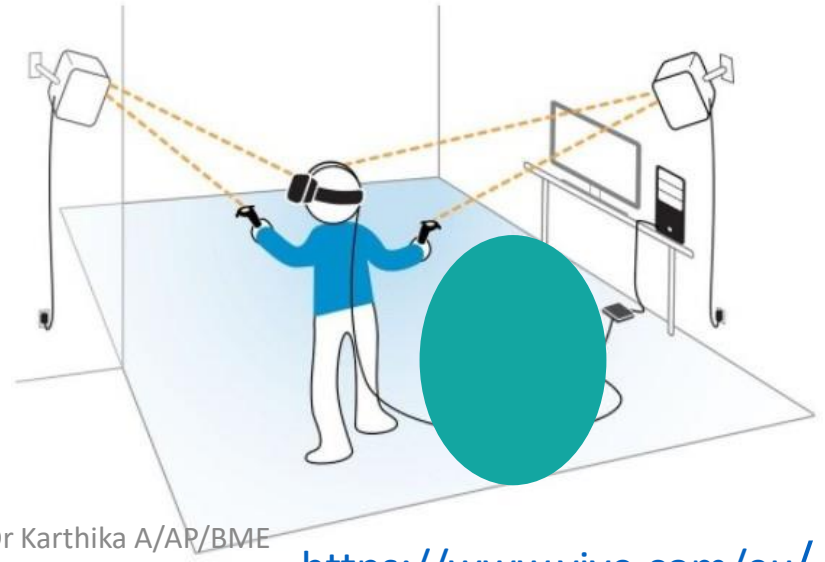
(Burdea and Coiffet., 2003)

Input devices

- Trackers:
  - Magnetic (AC, DC)
  - Optical
  - Ultrasonic
  - Inertial,
  - Mechanical
  - Hybrid …
- Navigation and manipulation interfaces:
  - Tracker-based
  - Controllers
  - 3D mice, …
- Gesture interfaces:
  - Depth cameras

  Gloves …





https://www.vive.com/eu/

Tracker is a special purpose H/W to measure the real-time change in a 3D object position and orientation

Trackers measure the motion of “objects (e.g. user head)
in a fixed system of coordinates.

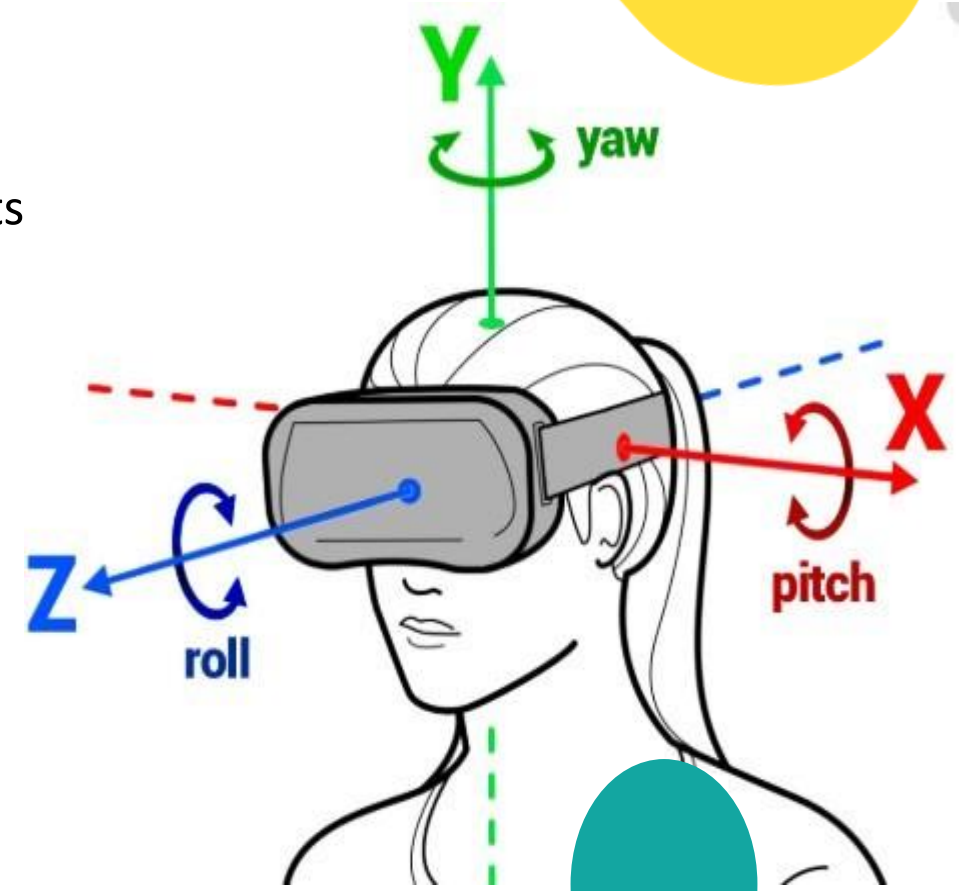
Virtual objects have **6 degrees of freedom** (D.O.Fs):

-three translations;

-three rotations.

Roll – rotation around the zz axis

Note – you may find other definitions…



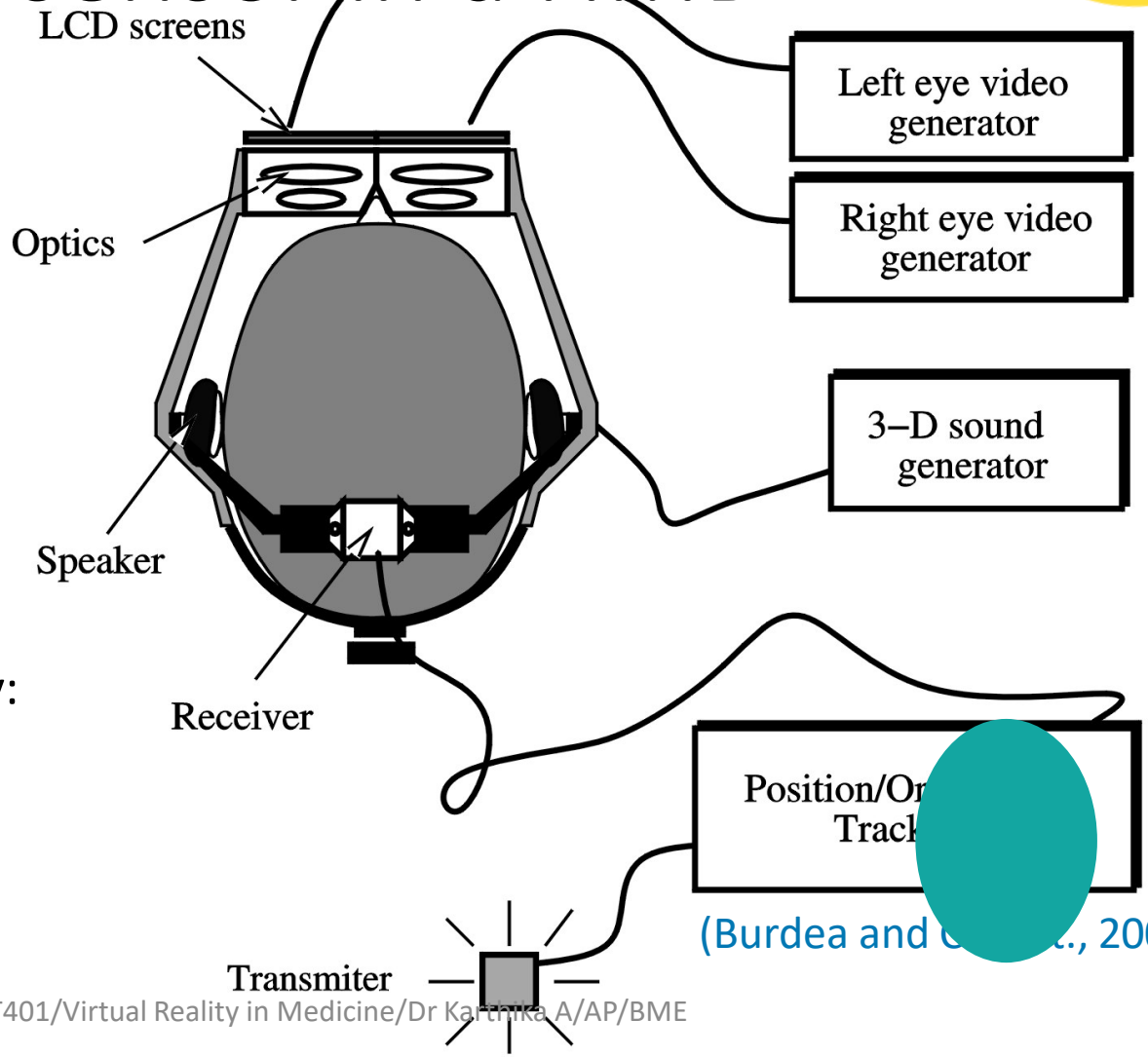
(Burdea and Co 003)

Example:
3D magnetic sensor in a HMD

Without the head tracker
- the image
- the sound

cannot change to
match the head posture

Required tracking accuracy:
Image > sound



(Burdea and [illegible]., 2003)

Tracker characteristics:

- Measurement rate – Readings/sec
- Sensing latency
- Sensor noise and drift
- Measurement accuracy
- Measurement repeatability
- Resolution
- Tethered or wireless
- Work envelope
- Sensing degradation
- …

Magnetic Trackers

- A magnetic tracker is a non-contact position measurement device t uses a magnetic field produced by a stationary **TRANSMITTER** to determine the real-time position of a moving **RECEIVER** element

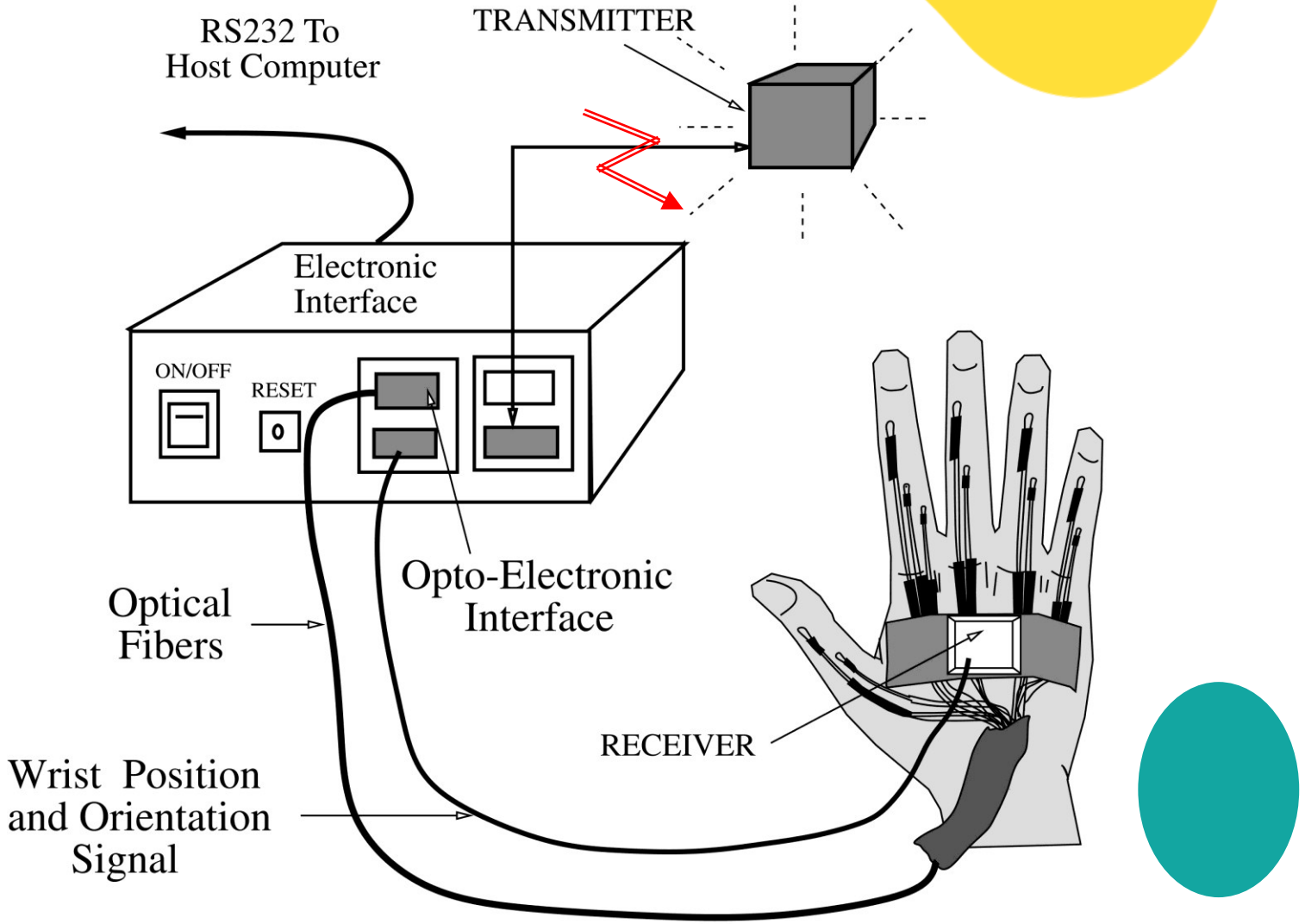
  - may be AC
    - DC

Magnetic Trackers

- Use low-frequency **magnetic fields to measure position**
- Fields are produced by a fixed source
- Size of source grows with the tracker work envelope
- The **receiver is attached to the tracked object** and has three perpendicular antennas
- Distance is inferred from the voltages induced in the antennas – **needs calibration**…

Magnetic tracker with the old Data Glove

(Burdea and Coiffet., 2003)



Ultrasonic Trackers

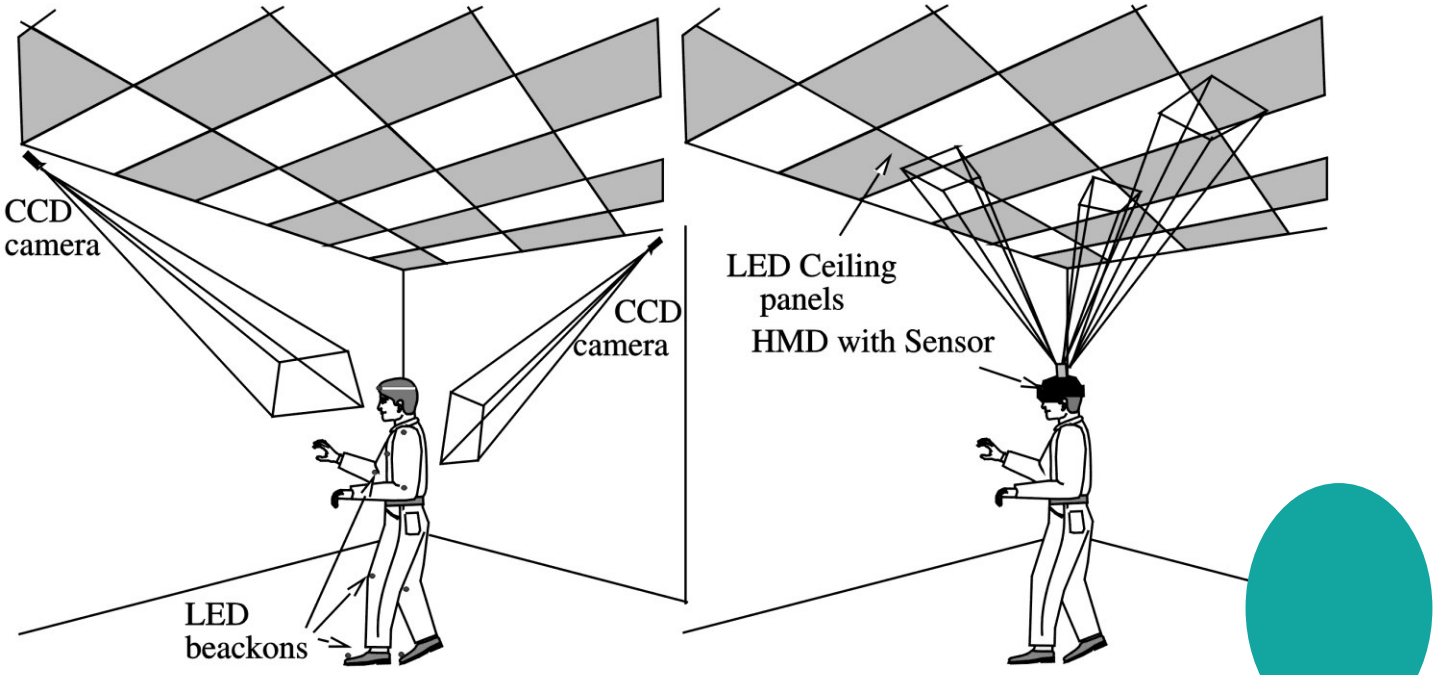
A non-contact position measurement device that uses an ultrasonic signal produced by a stationary transmitter to determine the real-time position/ orientation of a moving receiver. (Burdea and Coiffet., 2003)

Ultrasonic Trackers

- Use low-frequency ultrasound to measure position
- Number of sources grows with the tracker work envelope
- Distance is inferred from the sound time of flight
- **Sensitive to air temperature and other noise sources**
- **Requires “direct line of sight”**
- Slower than magnetic trackers (max 50 updates/sec)
- More adequate to track hands than head

Optical Trackers

A non-contact position measurement device that uses optical sensing to determine the real-time position/ orientation of an object (Burdea and Coiffet., 2003)



outside-looking-in inside-looking-out

Inertial Trackers

- No interference from metallic objec t:
- No interference from magnetic fields
- Large-volume tracking
- “Source-less” orientation tracking
- Full-room tracking
- Errors grow geometrically in time!

Xsens

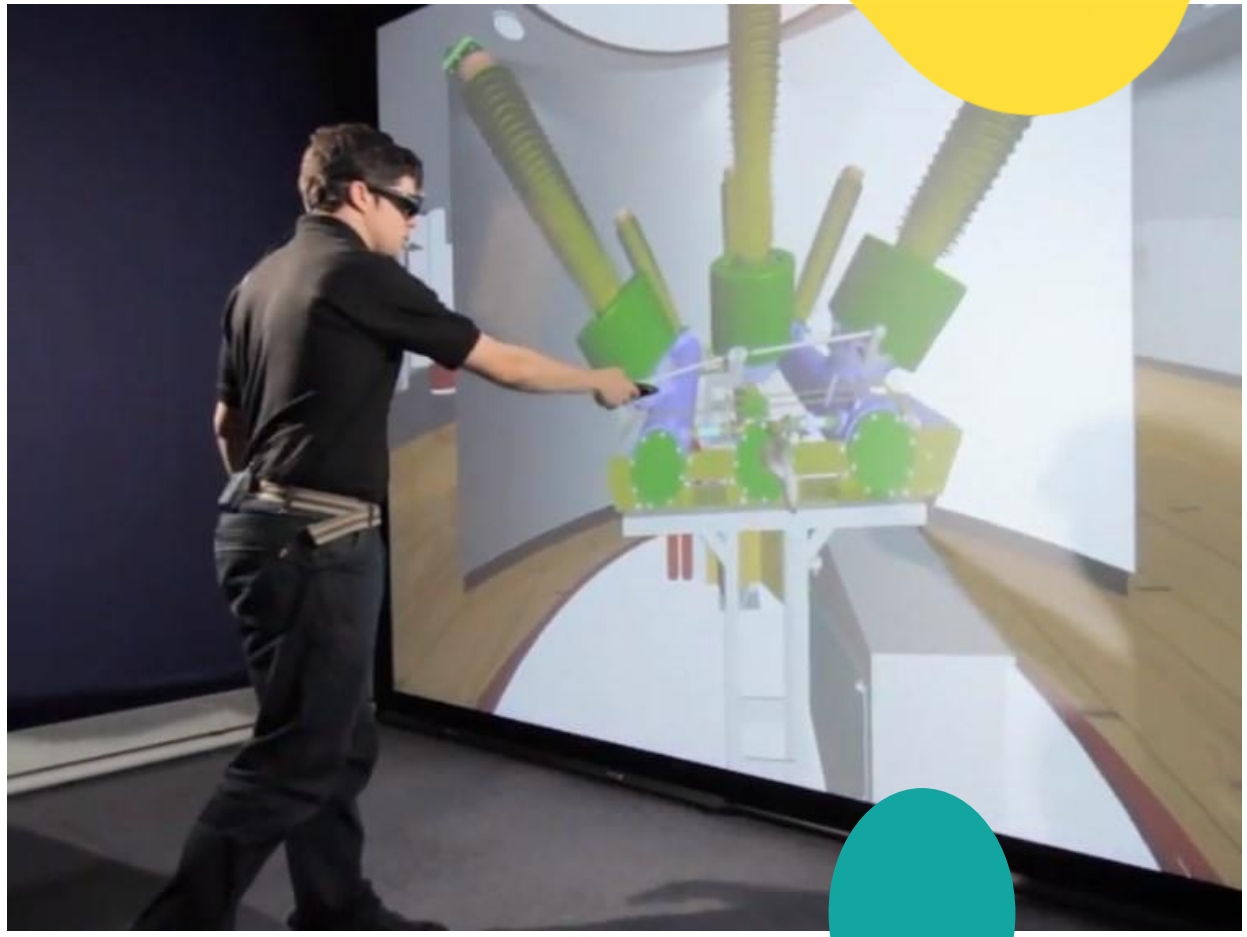
Hybrid Ultrasonic/Inertial Tracker

6 DOFs
Utrasonic – position
Inertial - orientation
Sub-millimiter accuracy

Head + hand units

Used for:

- Training
- Assembly/ disassembly and design review
- …

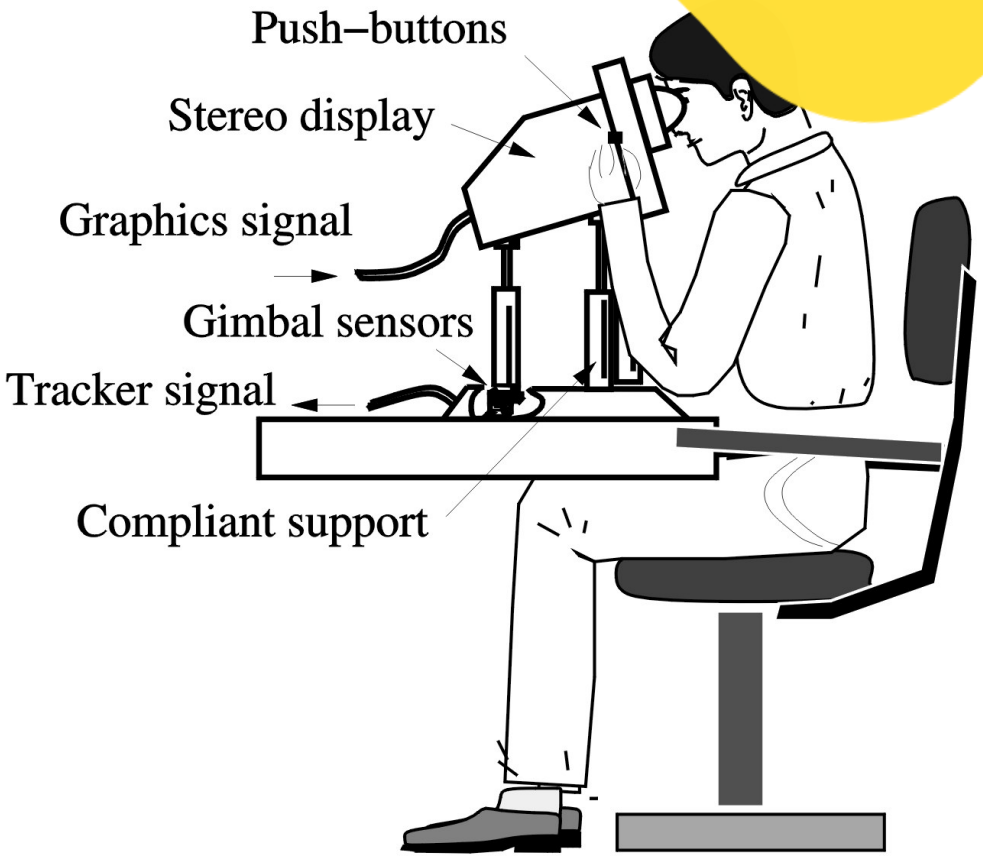


Mechanical Trackers

A mechanical tracker consists of a serial or parallel kinematic structure composed of links interconnected by sensorized joints.

(Burdea and Coiffet., 2003)

Were among the first tracking systems ever used



Mechanical tracker - Push 128[illegible]o display (Fakespace Inc)

Mechanical Trackers

Pros

- Use sensors imbedded in exoskeletons to measure position
- Have extremely low latencies
- Are immune to interference from magnetic fields and large metal objects

Cons

- Limit the user's freedom of motion
- Can be heavy if worn on the body
- Expensive

Thank You