Tracking Methods

DOM-E5161 - Introduction to Virtual Reality

Markku Reunanen

Tracking?

Making the computer aware of the location and/or orientation of an object.

A crucial feature in VR:

- Following input devices
- Detecting gestures
- Calculating graphics correctly when the user looks/moves around
- Location-based content

What to track?

Head (view calculation, general location)

Hands, fingers (interaction)

Legs (movement)

Torso, whole body (location, motion capture)

Eyes (testing, view-related calculations)

Physical props like input devices – often held in hand

General properties

Frame of reference

Degrees of Freedom

Range and accuracy – typically adverse to each other

Calibration

Wired or wireless

Availability, ergonomy, durability, cost ...

Methods: Inertia

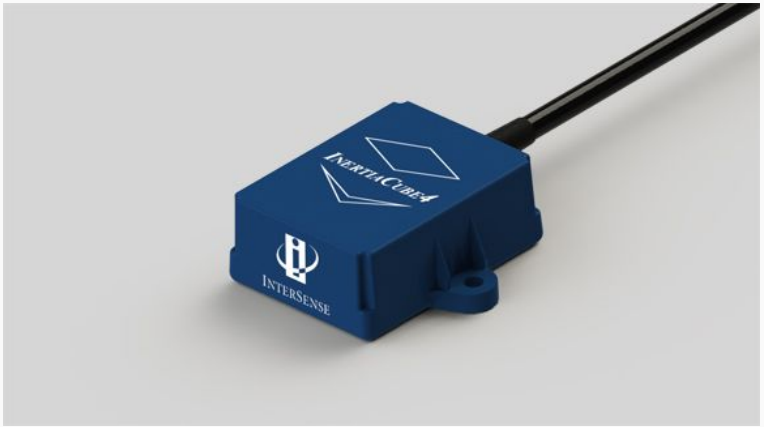
Inertia sensors

Movement or rotation

Present on today's mobiles too

No fixed frame of reference!

http://www.immersion.fr/en/inertiacube-4/



Methods: Magnetic tracking

A transmitter generating a magnetic field around itself

Sensors with orthogonal coils

Full 6DOF

Sensitive to metal

Limited range

https://polhemus.com/motion-tracking/all-trackers/patriot/

Methods: Ultrasound

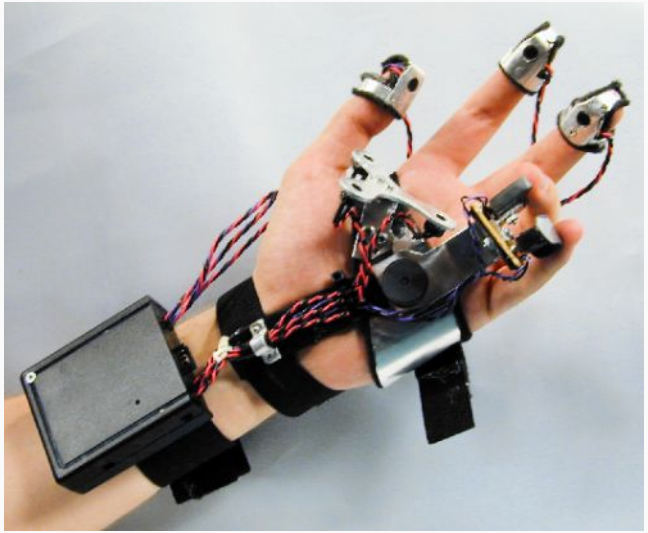
Short pulses transmitted from piezoelectric speakers

Microphones pick up the pulses

Time of flight measured

Sensitive to occlusion and echo but not lighting

Limited range



Methods: Camera-based tracking

A vast topic, some local research at Aalto as well

Normal or infrared camera(s)

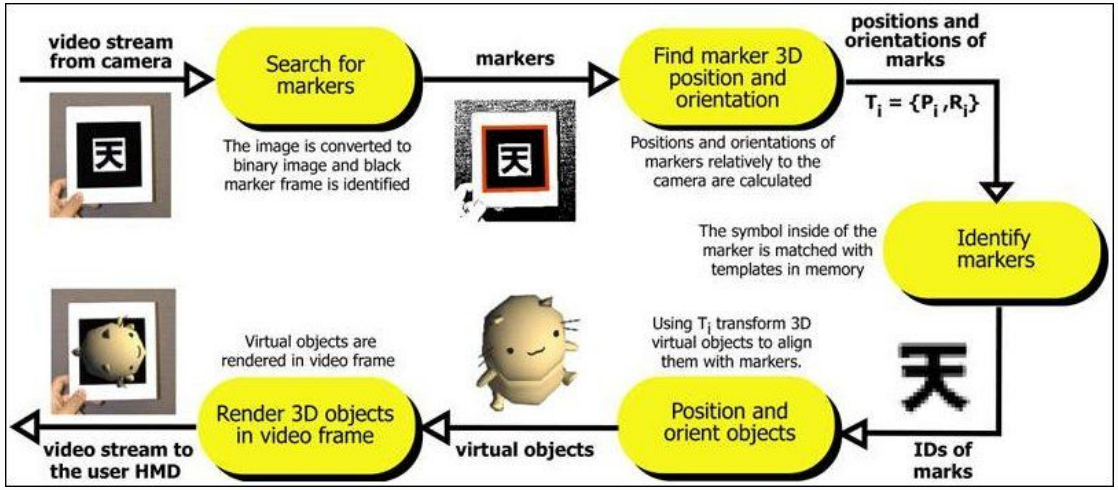
Marker-based and markerless

Sensitive to occlusion and lighting conditions

Increasingly common, mobiles can do this too

Wireless (unless user wears the camera)

Example: ARToolkit



http://www.hitl.washington.edu/artoolkit/documentation/userarwork.htm

Example: Wiimote hacking

https://www.youtube.com/watch?v=Jd3-eiid-Uw

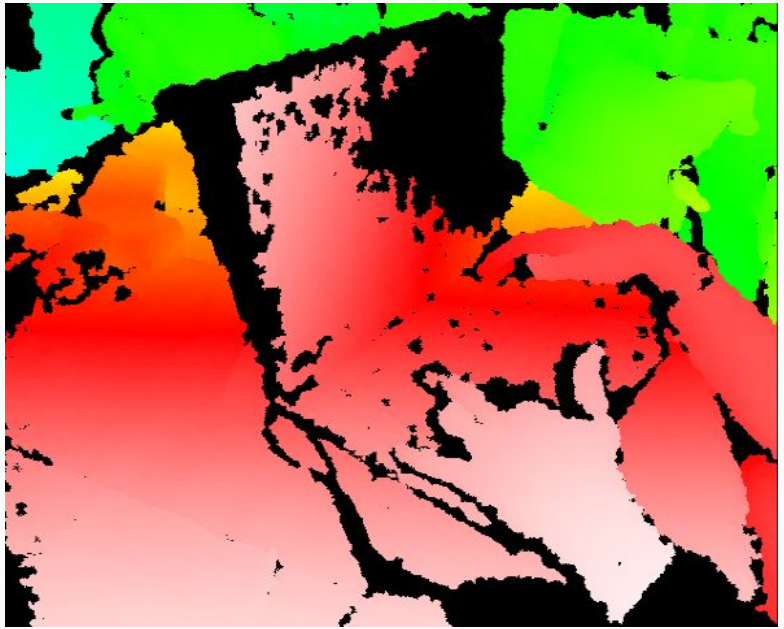
Example: Kinect

Based on an infrared point cloud

IR emitter, normal and IR camera

Provides a depth map

Software for building a skeletal model of the user



Methods: Laser scanning

An emerging technology in VR

Popularized by HTC Vive (SteamVR)

Laser "lighthouses"

Several light sensors around devices

Still prone to occlusion, not to light

https://www.youtube.com/watch?v=oqPaaMR4kY4

Methods: Wireless networks

Bluetooth, WLAN ("WiFi") and GSM

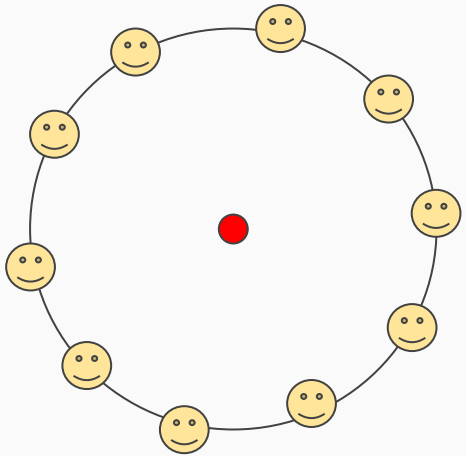
Measure signal strength from multiple base stations

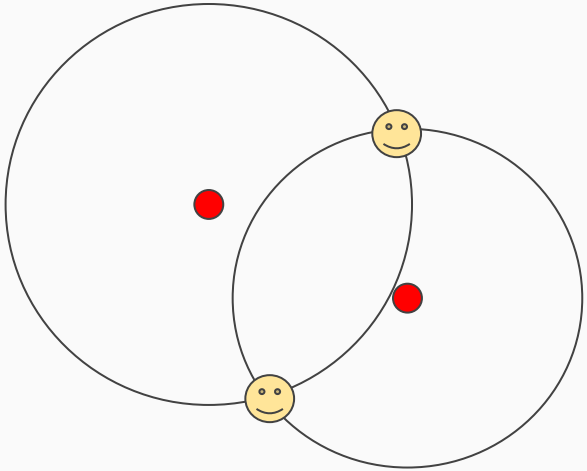
...including **your** WLAN base station :)

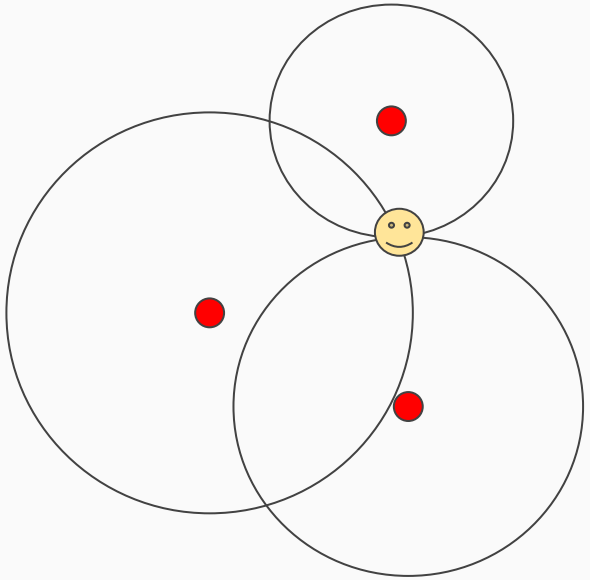
Limited accuracy, generally just position

Mobiles can be tracked without GPS

Wireless and ultrasound working principle







Methods: GPS

Satellite-based with military origins (1978), radio waves

Does not work indoors

Affected by weather

Recently up to 30 cm best accuracy,
was ~5 meters for long

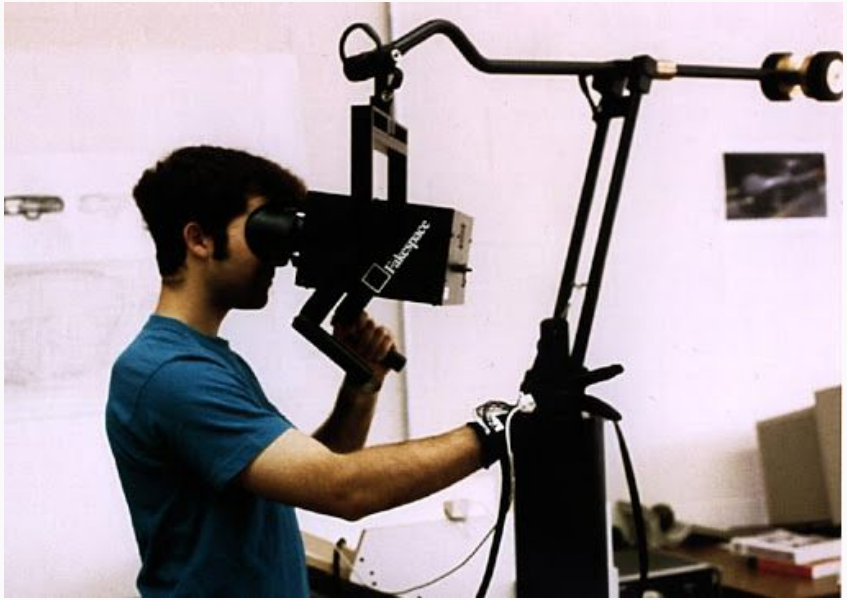
Relevant for outdoors AR(/VR) mostly

Methods: Others

Mechanical tracking

Compass (direction only)

Often *hybrid tracking*, combining multiple methods



Tracking and ethics

Mobile phones, tablets and laptops are tracked all the time

Targeted ads, location-based services, even coronavirus monitoring, but also less desirable uses

Supporting the surveillance state or just the new normal?

https://www.businessinsider.com/huawei-workers-helped-african-governments-spy-opponents-report-2019-8