CSE 190: Virtual Reality Technologies

LECTURE #12: 3D TRACKING TECHNOLOGIES PART 2

Announcements

Project 2 due this Sunday, May 10th at 11:59pm

Project 3 to be released Monday at 1pm in Discussion

Today's VR app presentations:

- Brandon Foey: Gravity Pull
- Kwok Ming Leung: VR Ducks

Overview

Position/Orientation Tracking
- Mechanical Tracking
- Electromagnetic Tracking
- Ultrasonic Tracking
- Inertial Tracking
- Optical Tracking
- Tracking with Radar

Outside-in/Inside-out Tracking

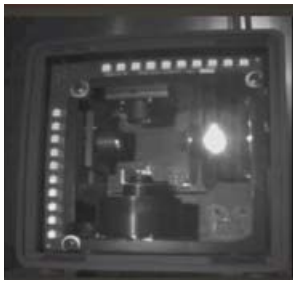
Hand/Finger Tracking

Eye Tracking

Application-specific Input Devices

Optical Tracking Continued

HTC Vive Lighthouse



- Runs at 60 Hz
    - i.e. horizontal & vertical update combined 60 Hz
    - broadband sync pulses in between each laser sweep (i.e. at 120 Hz)
- Each laser rotates at 60 Hz, but offset in time
- Usable field of view: 120 degrees
- Sync pulse emitted 120 times per second (Hz)
- Each sync pulse indicates beginning of new sweep

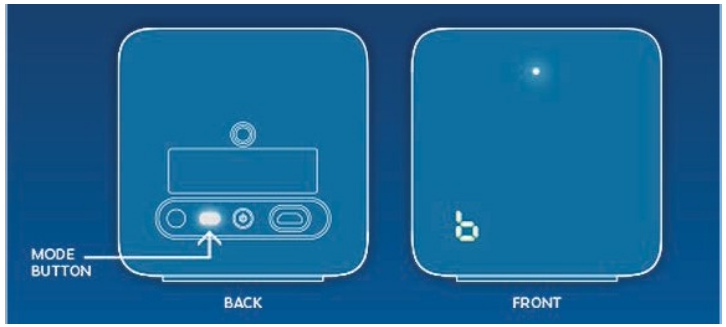
HTC Lighthouse – Base Station

- Can use multiple base stations simultaneously via *time-division multiplexing* (TDM)
- Base station modes:

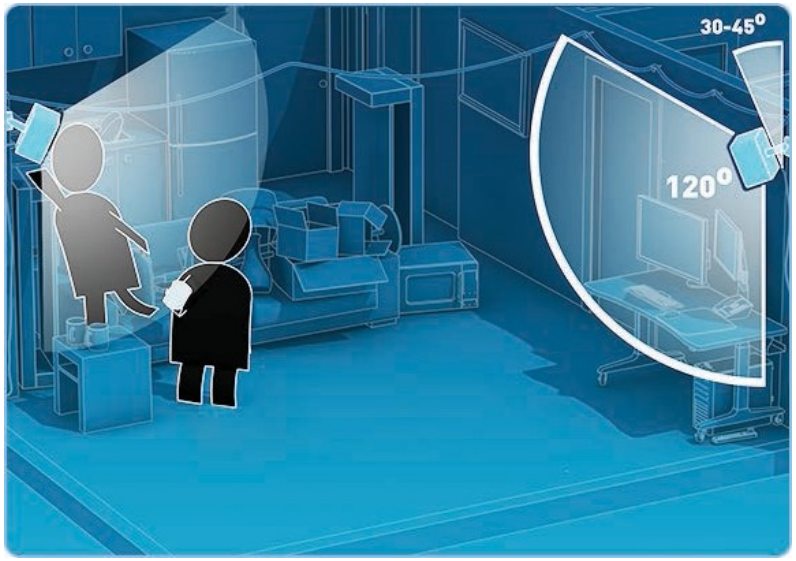
  A: TDM slave with cable sync

  B: TDM master

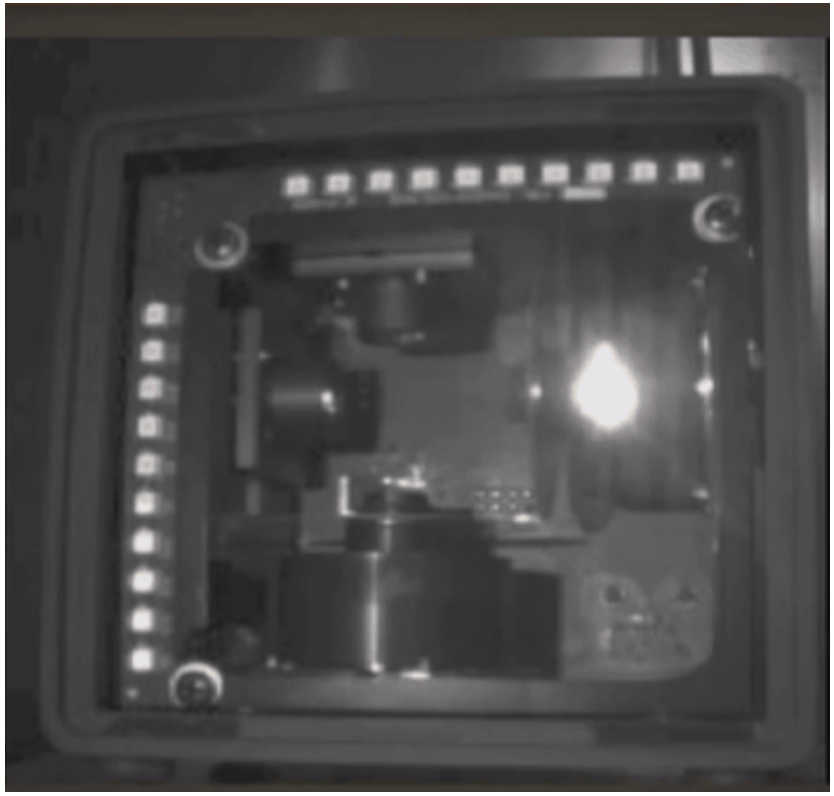
  C: TDM slave with optical sync

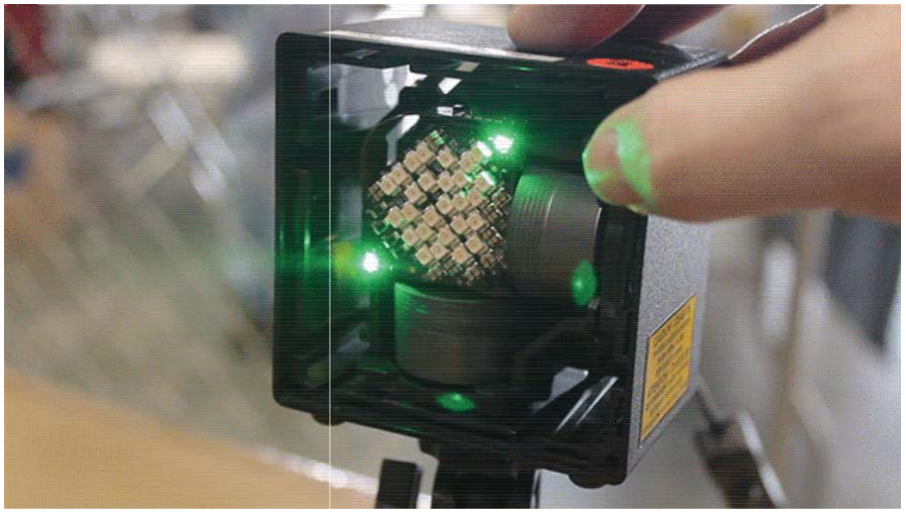


HTC



HTC Lighthouse





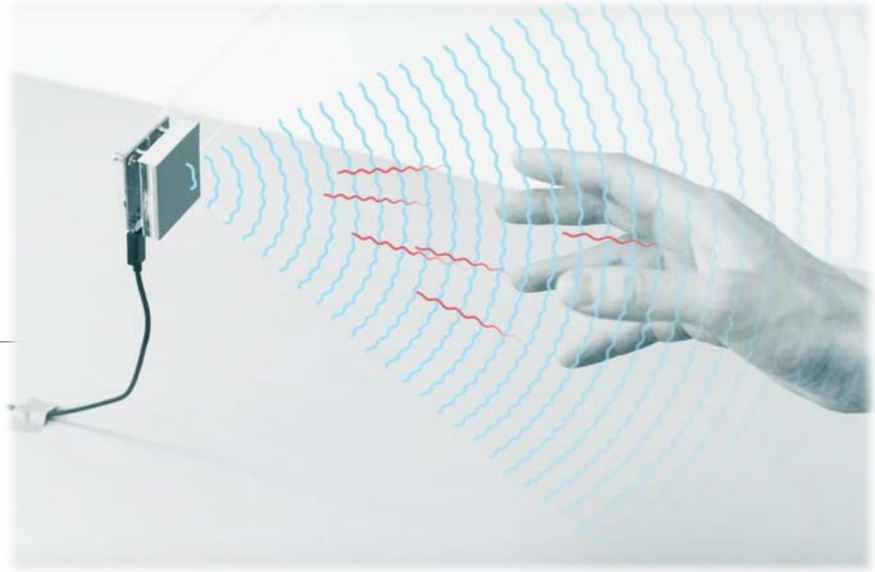
http://gizmodo.com/this-is-how-valve-s-amazing-lighthouse-tracking-technol-1705356768

HTC Lighthouse

https://www.youtube.com/watch?v=J54dotTt7k0

Tracking with Radar

Radar



Tracking with radar is early stage technology.

Most prominent example: Google's Project Soli from 2015

- https://www.youtube.com/watch?v=0QNiZfSsPc0

Soli sensor technology works by emitting electromagnetic waves in a broad beam.

Objects within the beam scatter this energy, reflecting some portion back towards the radar antenna.

Properties of the reflected signal, such as energy, time delay, and frequency shift capture information about the object's characteristics and dynamics, including size, shape, orientation, material, distance, and velocity.

Application-Specific Tracking

Application-Specific Devices

Virtual hang-gliding over Rio de Janeiro (Soares at. al., 2005)

Virtual canoe, Siggraph 2005

Miscellaneous devices:

- https://www.youtube.com/watch?v=8kjZ-nKjfgE

Cave Painting

Physical props (brush, color palette, bucket) allow intuitive painting

Created by Daniel Keefe at Brown University (now Prof. at Univ. of Minnesota) in 2001

Google Tilt Brush and Oculus Quill are modern versions for HMDs

Cave Painting Video

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

Finger Tracking

Hybrid Devices: Haptic Feedback Devices

PHANToM haptic device

Force feedback joystick

Exoskeleton-like devices

Geomagic Touch

LEXOS: Frisoli et. al., Italy

Immersion CyberForce

Pinch Gloves

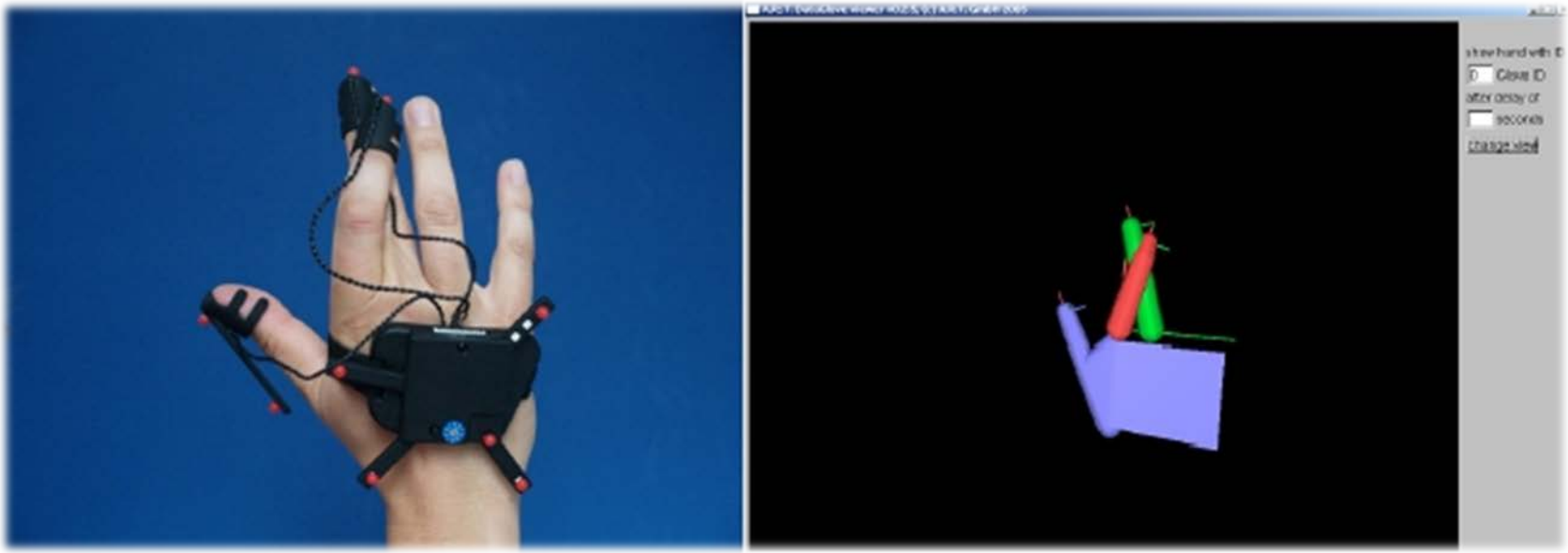
- Released 2001
- Determine if two or more fingertips are touching
- Use conductive cloth to close circuit
- Tethered to controller box
- Designed for pinching and grabbing gestures
- Recognize any gesture of 2 to 10 fingers touching, plus combinations of gestures

www.fakespacelabs.com

Optical Finger Tracking

Extension of ART Tracking system

Tracks three fingers and the hand with IR LEDs

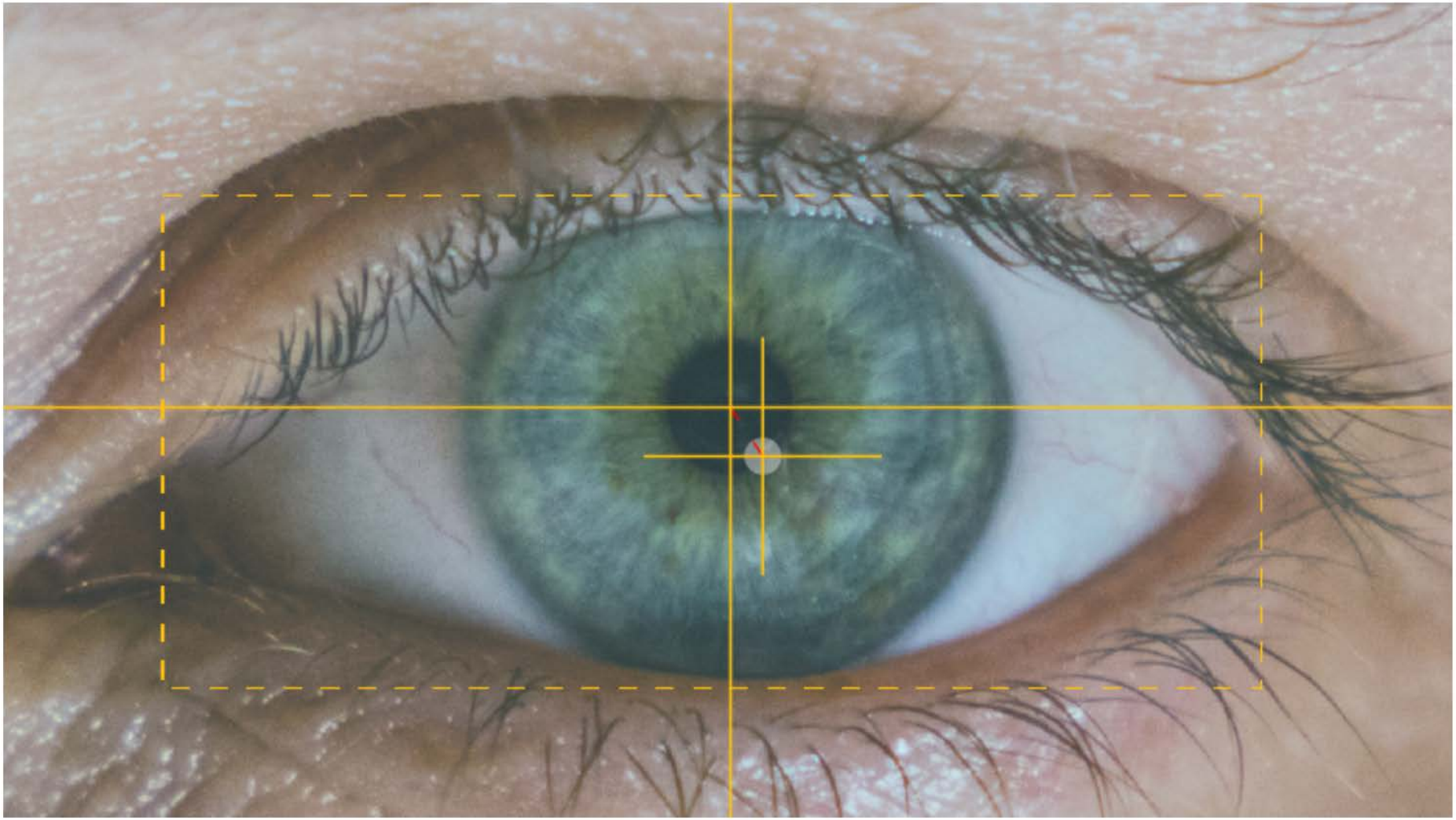


Optical Finger Tracking

Oblong Industries g-speak

- Video: http://www.youtube.com/watch?v=9OpmxbPzDM0

Eye Tracking



The center of the eye (pupil center) is tracked in relation to the position of the corneal reflection. The relative distance between the two areas allows the calculation of the direction of the gaze.

Tobii Eye Tracking

Add-on for VR headsets

Video: https://www.youtube.com/watch?v=q8GhIfsrizM

Vive Pro Eye

Vive Pro with built-in eye tracking

Separate product from regular Vive Pro

FOVE

Released Nov 2016

OLED display

2560×1440 pixels

70Hz refresh rate

90-100 degree field of view

6 DOF tracking with external camera

Eye Tracking: 120FPS infrared x2 (accuracy <1 degree)

Headphone jack (no built-in audio)

Magic Leap

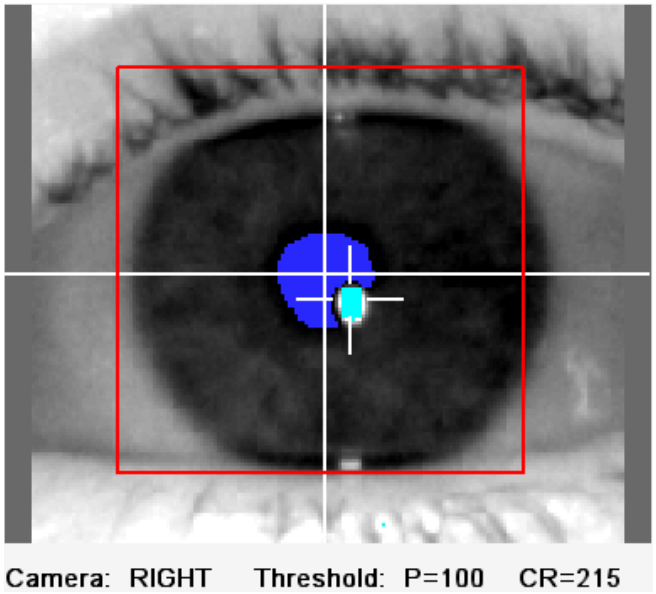
Built-in infrared eye tracking

Eye Tracking Challenges

Pupil deforms during fast eye motion, inertia effects

Eye motion can be very fast

Small angular eye motion can mean large differences for distant objects



Outside-In/Inside-Out Tracking

Outside-In Tracking

Cameras or markers are placed around the room

Examples:

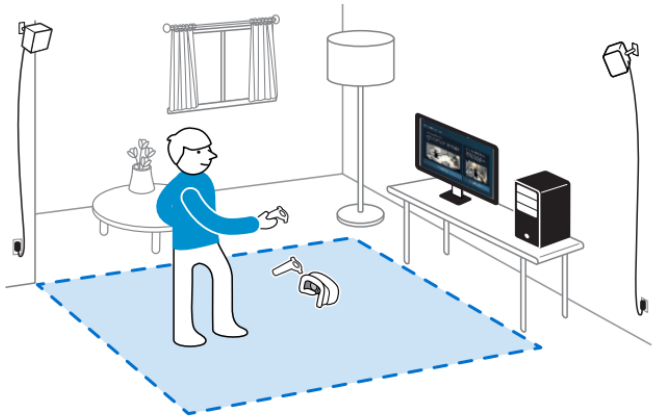
- Oculus Rift, HTC Vive

Pros:

- Higher tracking accuracy and latency than inside-out tracking
- More trackers can be placed to increase accuracy and tracking volume

Cons:

- Finite tracking volume
- Equipment needs to be placed in the environment
- Setup takes time



Inside-Out Tracking

Device tracks itself without special preparation of environment

Examples:
- Oculus Quest, Rift S
- Microsoft Mixed Reality, HoloLens
- Magic Leap One
- Smartphone with ARKit/ARCore

Typical solution:
- Simultaneous localization and mapping (SLAM)

Pros:
- Unrestricted tracking volume
- No cameras or other objects need to be placed in the environment

Cons:
- Lower accuracy and latency than many outside-in tracking solutions
- Significant computational requirements for image processing