PGR research training seminar Introduction to Virtual Reality

Szonya Durant (Director of VR lab)

Doga Gulhan (Part time technician VR lab)

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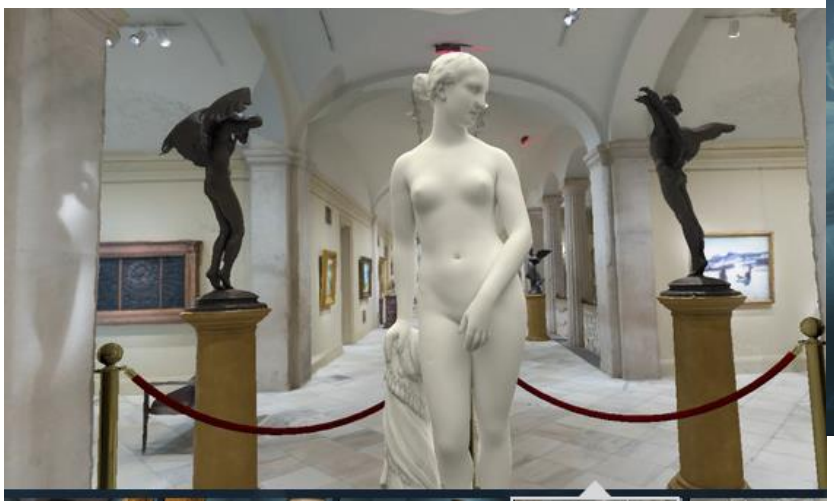
What is virtual reality?

Aims to recreate the same sensation as if viewing the 'real version' of the scene being presented in the headset

Largely relies on recreating visual sensation

Can make us of auditory also, combines with vestibular sensation caused by actual head movement

Some haptic options



https://www.evevalkyrie.com/

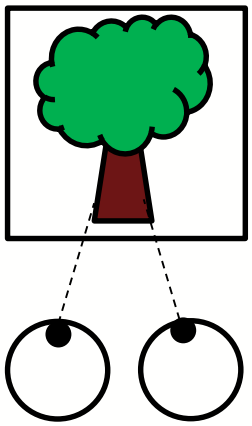
https://store.steampowered.com/app/1087320/Smithsonian_American_Art_Museum_Beyond_The_Walls/

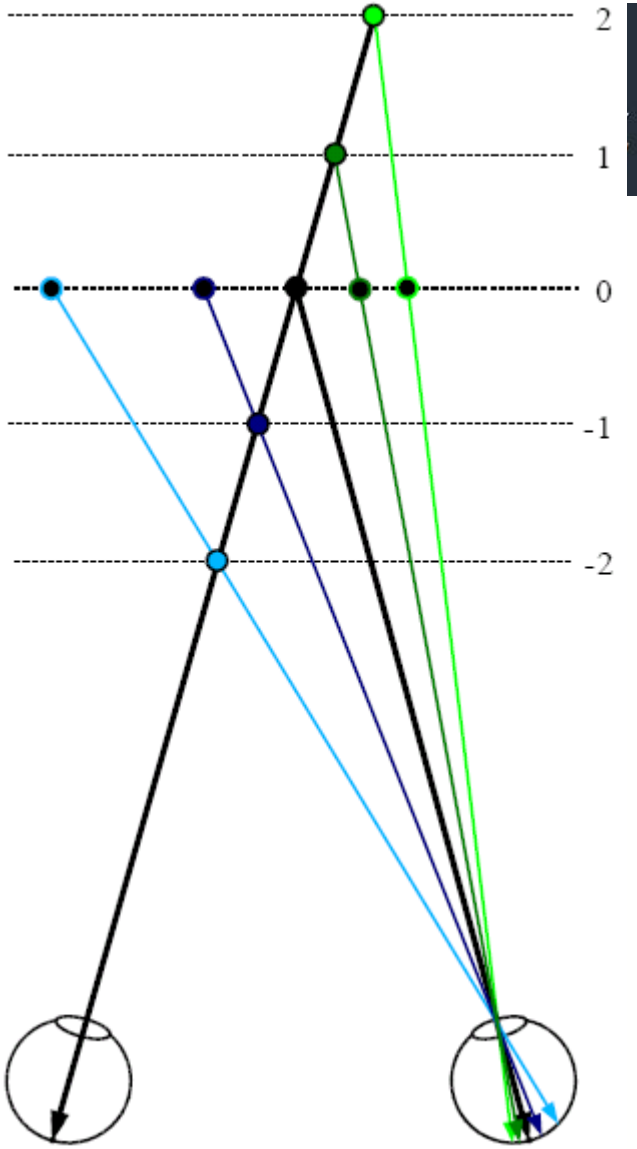
Visual recreation of reality

Different to just viewing a screen with an 2D static image or a normal movie playing in a headset – although some may consider this immersive.

Different to viewing a 3D image or video in the headset (although stereo vision is often important to VR).

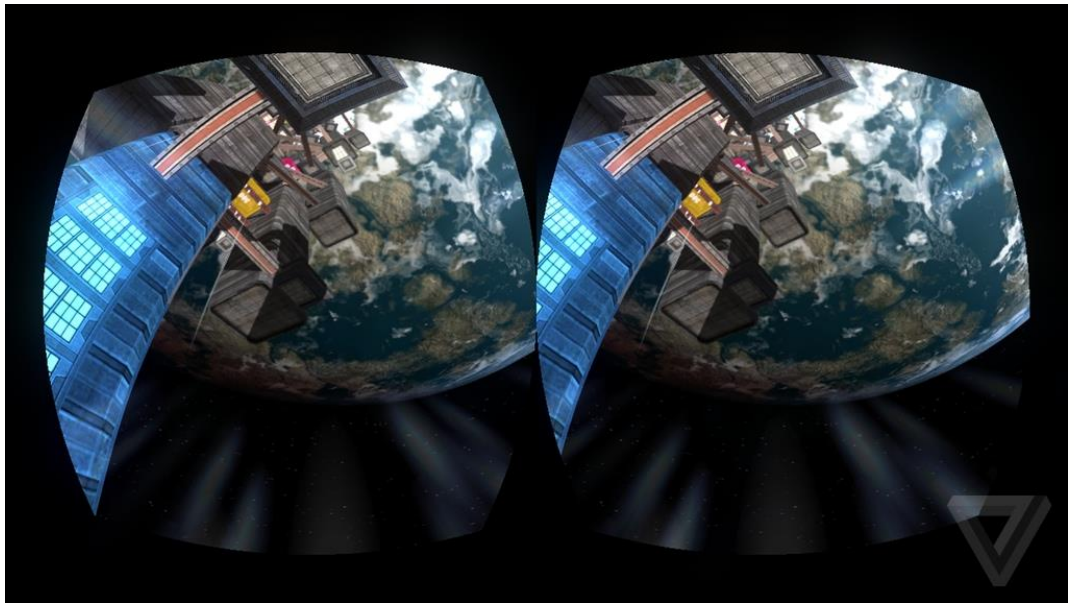
Quick reminder stereo vision (binocular disparity):





By I, Sbitzer, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=2306803

Inside the headset

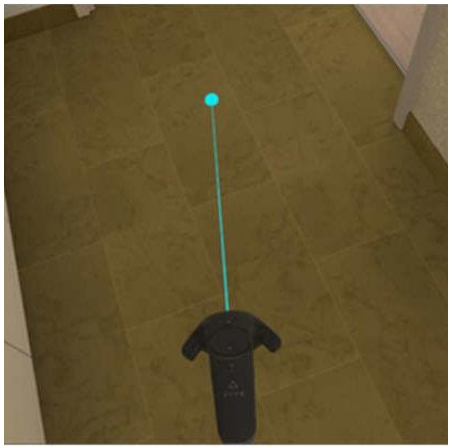


Visual recreation of reality

Relies on using head position and direction to real-time update the visual input – involves calculating lighting/geometry using standard physics models

Additionally can us manual interaction to alter visual input, either in terms of manipulating objects or changing the visual point of view

(e.g. “teleporting”)



Why use VR?

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Types of virtual reality

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360 images/video

Viewer remains static in the centre of the scene

Mapped onto a sphere around the viewer

Use 360 camera to create

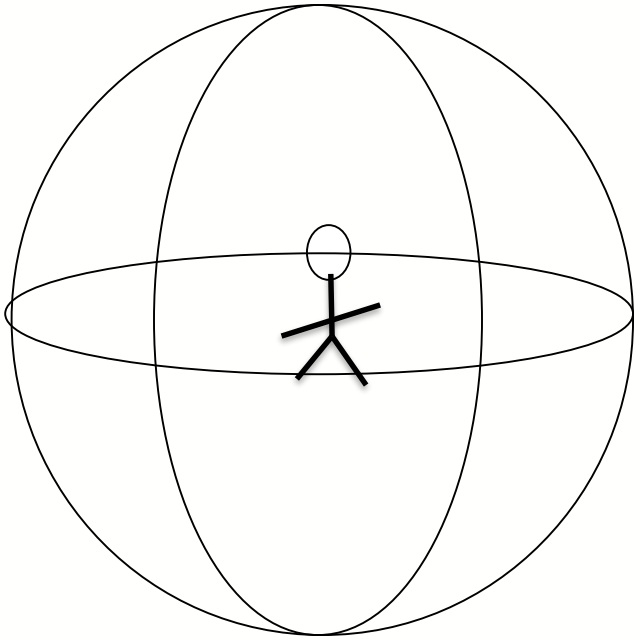
Stereo 360 camera will give stereo content

Gimbalguru.com

Types of virtual reality

In 2d looks like this in equirectangular projection

Types of virtual reality



360 images/video

Demos

Here I am using mouse to change the point of view (can use google photos to do this)

https://www.alamy.com/360-degree-panoramic-view-of-full-seamless-spherical-panorama-360-degrees-angle-view-on-bank-of-wide-river-in-front-of-bridge-in-city-center-360-panorama-in-equirectangular-proje-image243157548.html

https://www.royalholloway.ac.uk/virtual-experience/life/360-tour/#pano34/-57.7/-1.1/90.0

In virtual reality it is the change in head position that changes what part of the image/movie you see

Types of virtual reality

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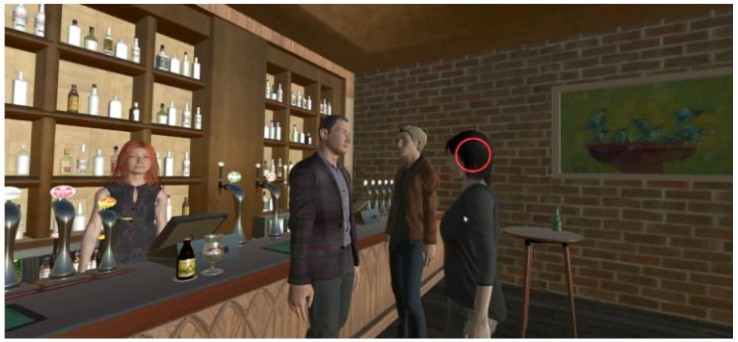
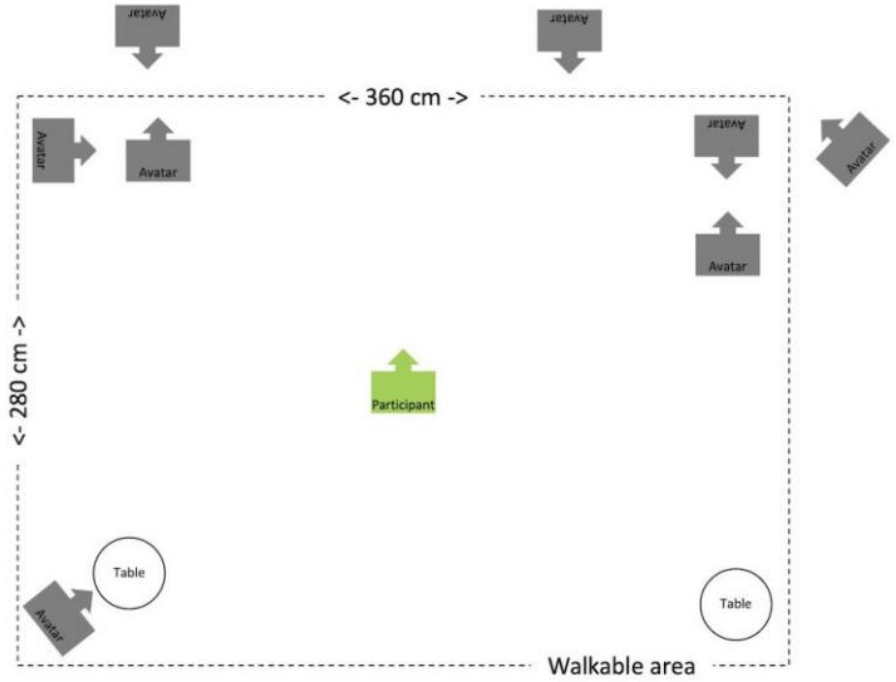
A 3D environment





Types of virtual reality

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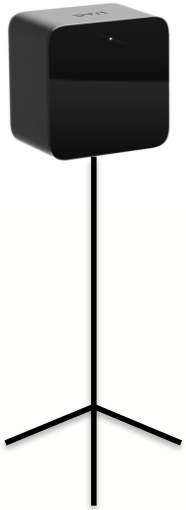
- Interactions

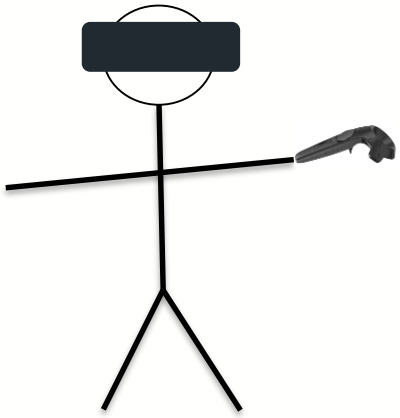
Typically you have a 'controller' that is also tracked by the VR set up and a version of it is made visible in the environment

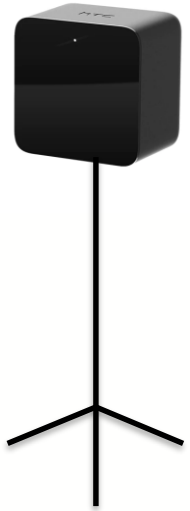
VR gloves can help reproduce hands in VR and some provide haptic feedback – to feel like touch

Credit to: Manus

Different types of headsets







Different types of headsets

Camera based tracking – forward pointing cameras on headset ap out the space and the viewers location (using SLAM)

Gyroscopes in the headset and controllers and additionally

LEDs in the controllers are tracked by the headset

Oculus Quest

https://www.youtube.com/watch?v=nrj3JE-NHMw&ab_channel=UploadVR

Computing requirements

Computers with very fast graphics cards are needed for some headsets, usually used by gamers, hence weird looking

However

Oculus Quest is

a standalone

headset – computing

done in headset

The Royal Holloway VR lab

- Housed in Psychology Dept., room W-211
- Set up jointly between Psychology, Computer Science and Electronic Engineering
- http://pc.rhul.ac.uk/sites/vrlab/

- Other VR equipment in college: StoryFutures, Electronic Engineering, Can + Veli

Hardware in the lab

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Headsets

2 HTC VIVE eye tracking headsets

1 HTC VIVE

1 Oculus Rift

Computers

Lenovo ThinkStation Desktop (VR ready in the lab)
Dell Alienware 17 Laptop
Dell Alienware 15 Laptop

Hardware in the lab

Camera
Ricoh Theta Z1 360-deg camera

Displays

Sony VPL-ES2 Projector

Physiological Data
BIOPAC MP160 (16-channel system) including AcqKnowledge data analysis software

Headset Peripherals
HTC Vive Wireless Adapter
HTC Vive Tracker & Tracker Strap (x4)
Wireless & wired gamepads
Disposable face cover masks for HMDs

https://www.youtube.com/watch?v=Dw8La6fylLQ&ab_channel=SweViver

Constructing a 3D environment

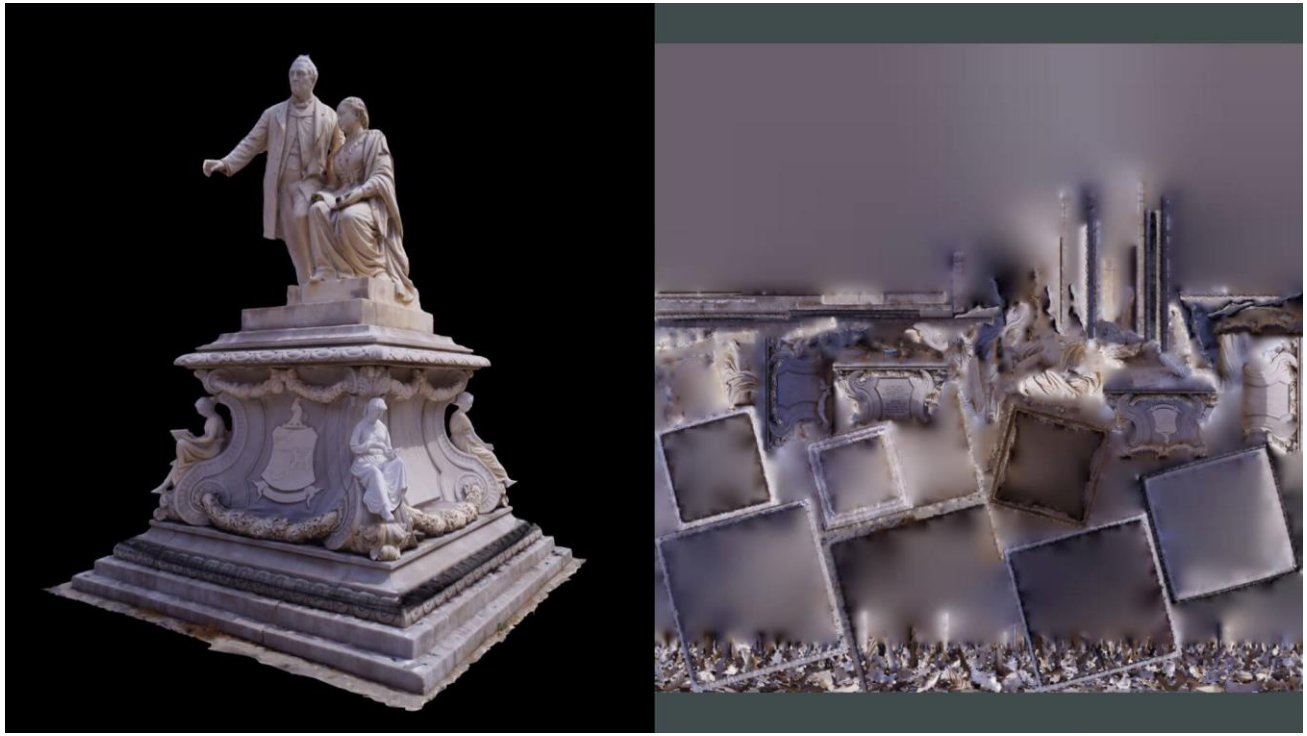
3D models - a 3D collection of x,y,z coordinates and texture+colour

3D model software: Sketch up, Blender

Pre-made models: Sketch fab, Unity store

(terminology: assets)

Constructing a 3D environment



Scan in an object or room using laser range finder (top end) or using image processing to get 3D shape from many photos (photogrammatic software e.g. Reality Capture)

https://sketchfab.com/3d-models/jane-thomas-holloway-034eb5c82a5f43b59362c2d7cc8fc634

The game engine

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Puts the objects into the world, can add texture/colour, adds lighting and can add sound sources, use it to programme behavior, 'physics', interactions

Unity: Open source, based on Javascript and C#

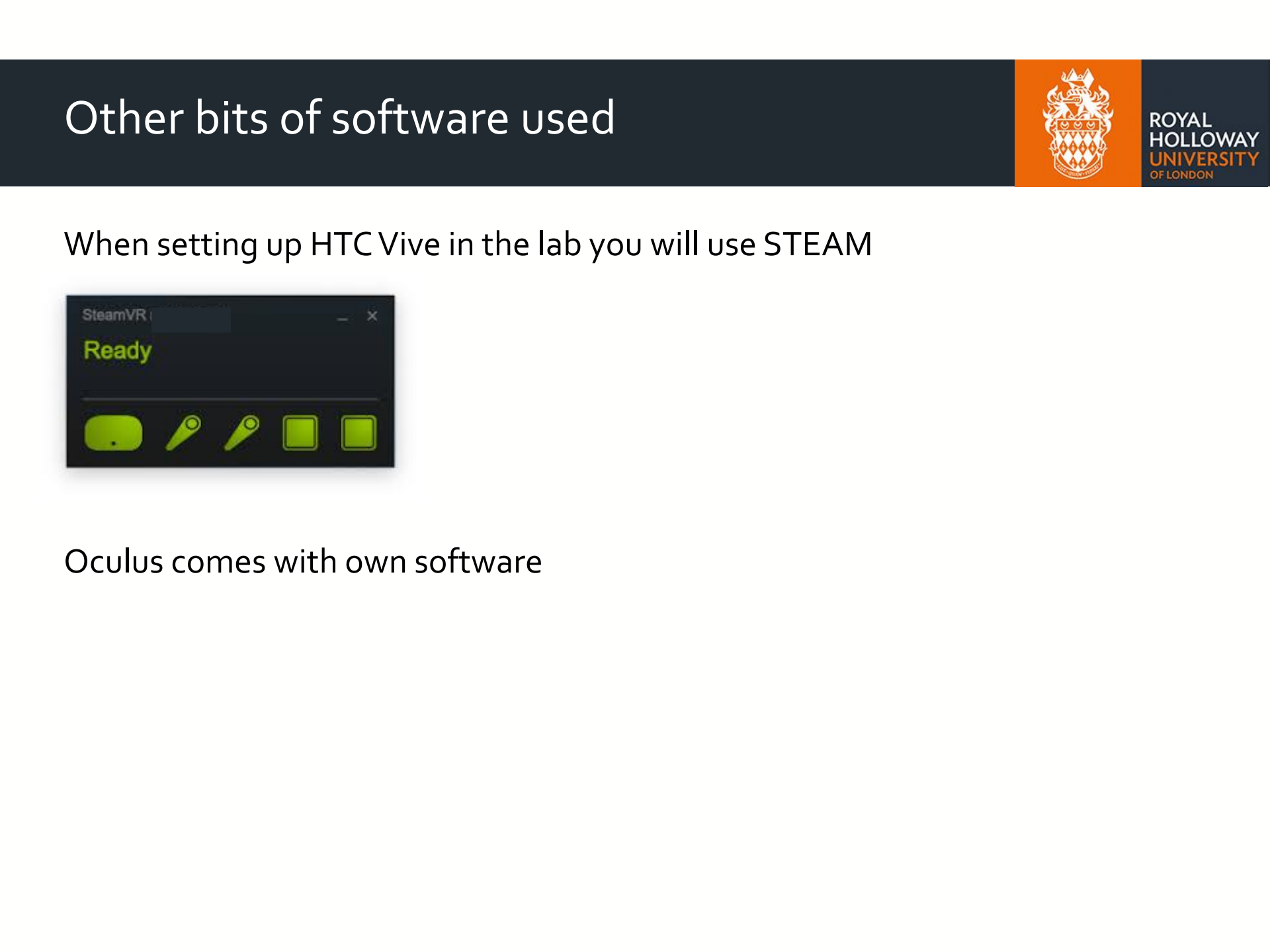
Unreal engine: Open source C++ based

Vizard: Proprietary, works with Python

Tips for getting started in unity

From unity.com https://learn.unity.com/ on coursera, udemy, edx, Unity MOOC (online courses)

Other bits of software used



When setting up HTC Vive in the lab you will use STEAM

Oculus comes with own software

Data that you can record

Full recording of the participant field of view or can have camera in VR scene and record from another point of view

Position in room

Head tilt and direction

Interactions

Elapsed time

Can ask participants to make responses in the environment (e.g. context driven pop-ups)

Extra

Eye tracking
Body tracking

Software for building VR experiments

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https://bonvision.github.io/pages/001_info/

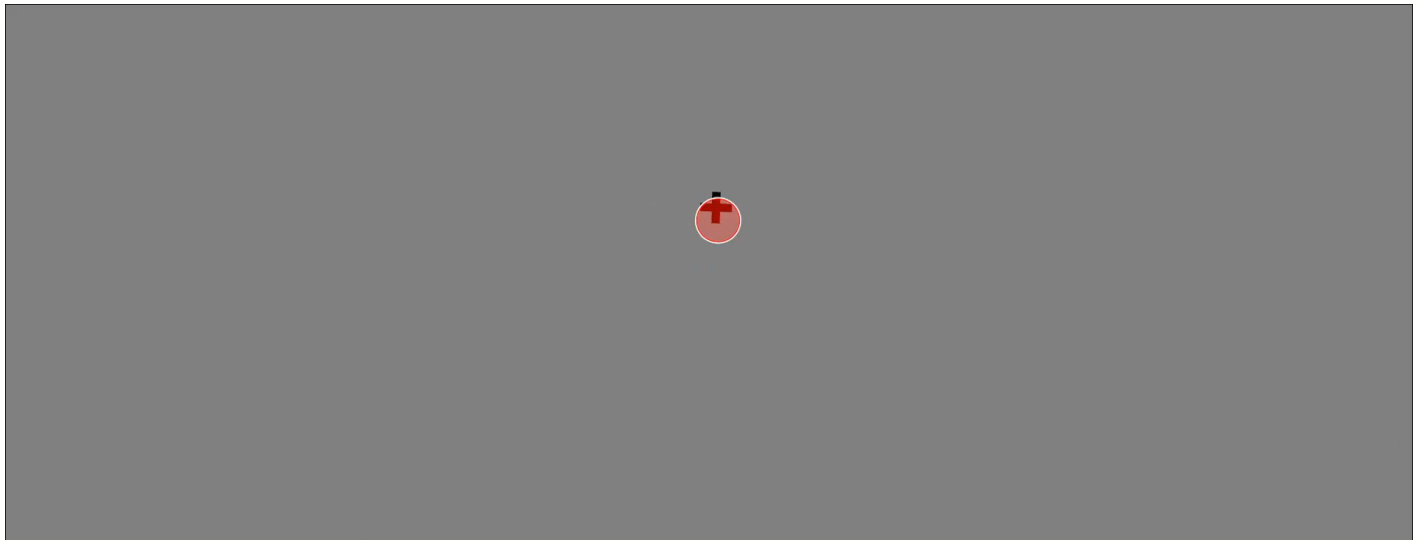
http://vrex.mozello.com/

https://github.com/immersivecognition/unity-experiment-framework

https://www.biomotionlab.ca/tux/

Software for eye tracking in VR

Tobii Pro lab – easy 360 image/video presentation (not stereo) with mapped on eye tracking



Software for eye tracking in VR

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Tobii Pro Lab analytics (discontinued) for easy extraction of eye position on surfaces in 3d environment

Each surface can count as a 'collider' – fixations automatically mapped to surfaces

https://www.youtube.com/watch?v=Zvv8LPrYxCU&list=PLqstc1LArUUQL_x8ITbkCQzDjpDgxCoqY&index=1&ab_channel=Do%C4%9FaG%C3%BCIhan

Advantage of VR for eye tracking versus mobile eye tracking

Considerations for an experiment

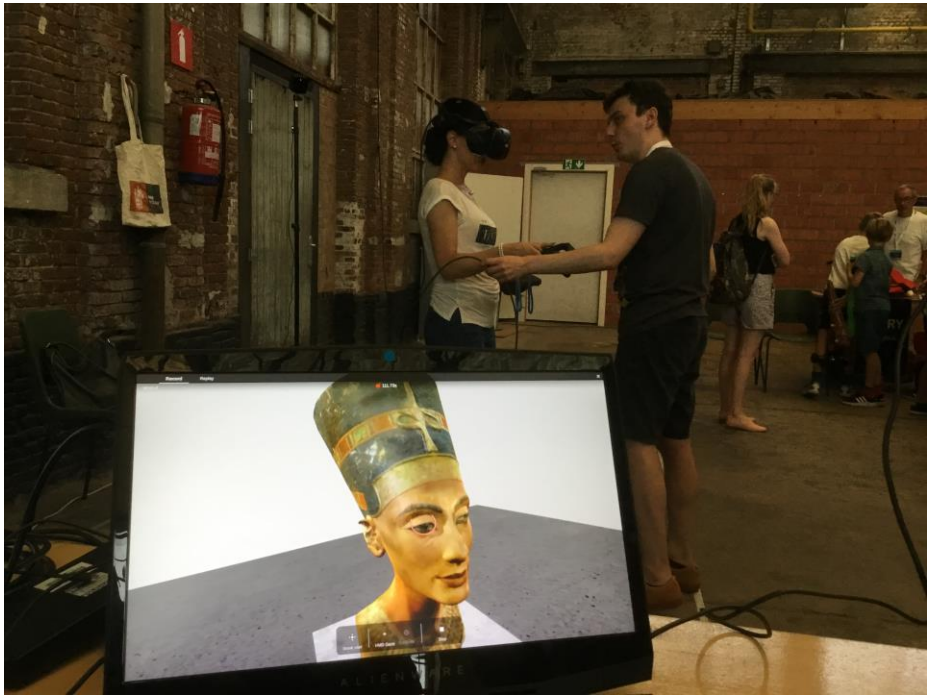
Location – usual requirements from lab space, no noise, interruptions

Seated? Spinning seat? Stability?

Walking?

Space limitations

Cable/remote



Considerations for an experiment

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Participants

Visual impairments? Same as with any visual experiment

Check for stereo vision – if this is crucial part of display (not everyone has stereo vision)

Previous experience of VR? (Currently very mixed, if they had experience did they feel sick?)

Older people – postural instability can be increased or contribute to sickness

Children – can wear some VR headsets, but can find them heavy and may not be able to adjust interpupillary distance enough

Best to include a practice/familiarisation segment

Responses?

- Can use controllers
- Could be verbal
- Could be through direction of walking or other task performance

- Sometimes simple keyboard, mouse, response button responses might be suitable
- Could be gaze based

Taken from: Vilar, E., Rebelo, F., & Noriega, P. (2014). *Human Factors and Ergonomics in Manufacturing & Service Industries*, *24*(6), 601-615.

Length of experiment

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Official government guidance

<30 min

at a time wearing a headset

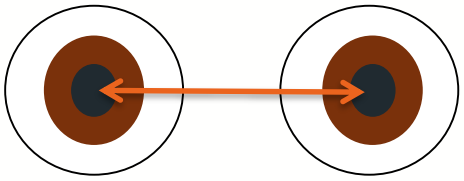
– need to break up longer experiments

Practicalities

Adjusting headset – experimenter may need to do this, need some check in there to make sure the view is not blurry and they see what you think they should

Need to make sure not too tight or too loose

Can adjust interpupillary distance – getting the location of the screens aligned with where the eyes are will make it sharper and reduce sickness/visual discomfort



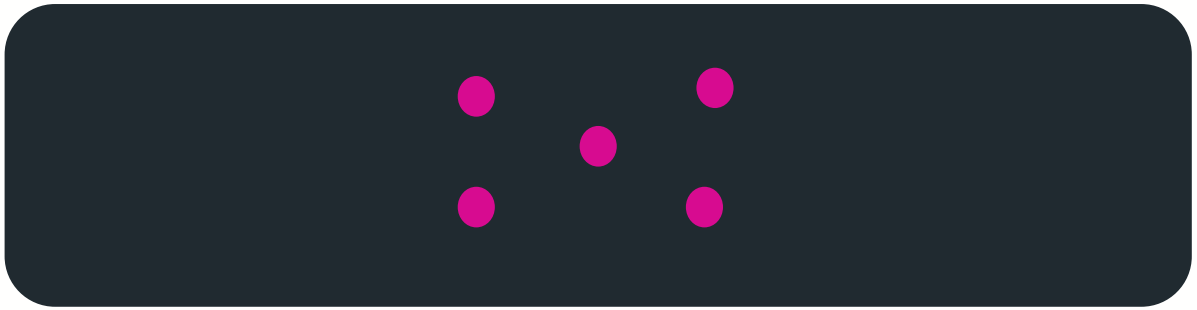
interpupillary distance

Eye tracking

Need to adjust headset so it is comfortable and eyes are detected by the eye tracker

Will need to run a calibration before recording

(Tobii software provides view of pupil position and calibration)



Hygiene

Paper inserts go inside the headset to avoid cross-contamination

Antiseptic wipes should be used to wipe down the headset where is often touched

COVID rules are currently being developed, but we will be getting a UV box for easy decontamination

Cyber-sickness

Participants should say if they feel sick and the experiment should be terminated

Percentage who get sick hard to estimates, as some stimuli may cause this more than others

It is worse where the visual does not match the physical (mostly vestibular) input, such as diving simulation, roller coaster, or the teleporting action

https://www.youtube.com/watch?v=Xap1KtF9VGY&ab_channel=SteadyEddie

Further info

Doga.gulhan@rhul.ac.uk

Szonya.Durant@rhul.ac.uk

http://pc.rhul.ac.uk/sites/vrlab/

Demonstrations of VR from the lab

https://www.youtube.com/playlist?list=PLqstc1LArUUQL_x8ITbkCQzDjpDgxCoqY