Revision

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Enter the code

3594 6723

Or use QR code

What we'll do today

- SIT module feedback
- Team Project peer review on TEAMMATES
- Revision

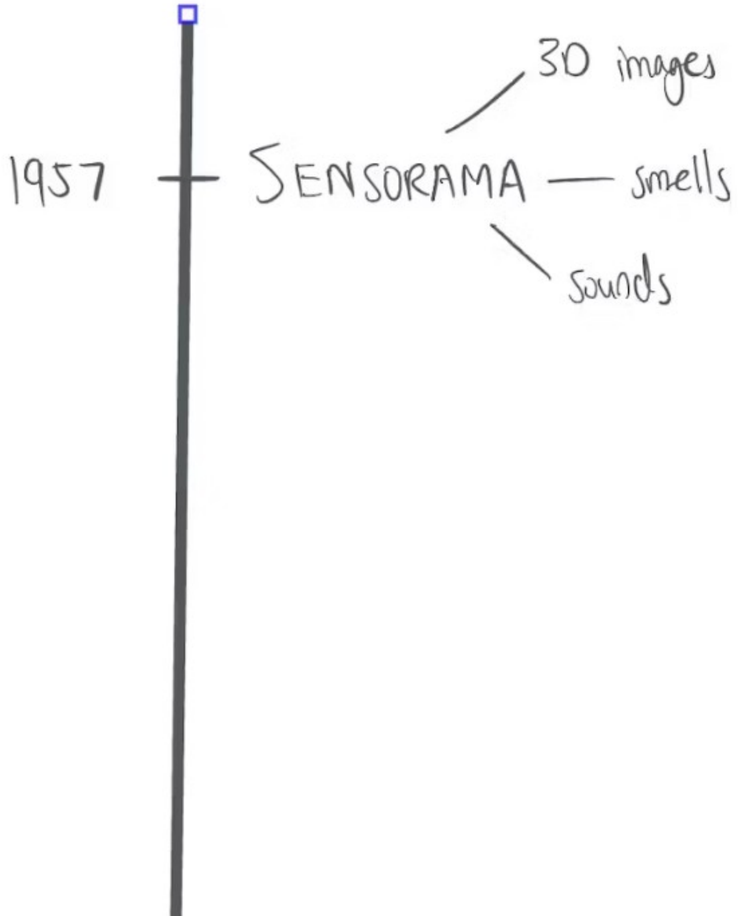
What are some terminologies you've (re)learned here that are most insightful to you?

75 responses

Foundational Concepts of Immersion

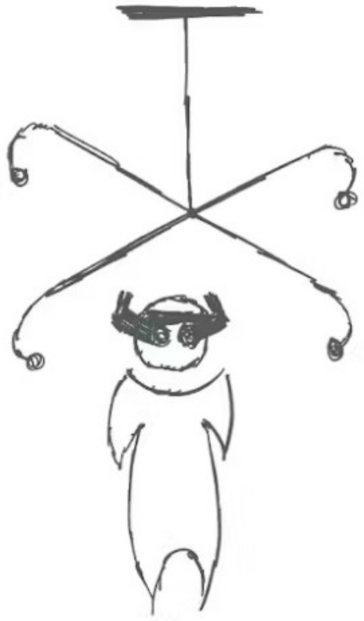
- → differentiate AR, VR, MR and XR
- → explain Milgram and Kishino's Reality-Virtuality Continuum
- → describe the historical evolution of immersive technologies

HISTORY XR



1968 — The Sword Of Damocles

The First HMD



2012 — Oculus Rift DK1

by Palmer Luckey

lightweight

good stereo 3D

WHAT R ?

VR

AR

MR

XR?

Different requirements different implementations

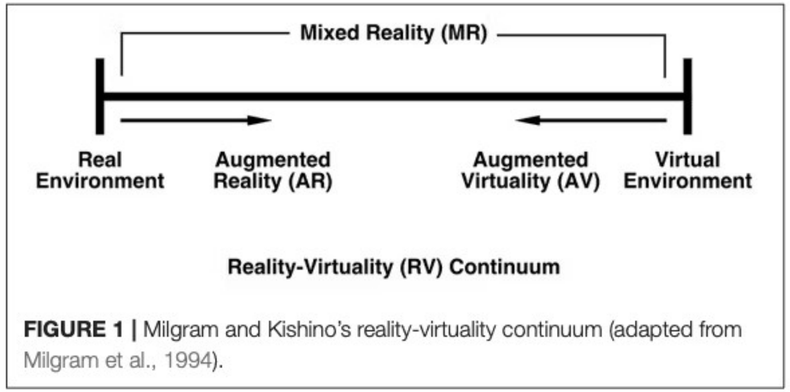


FIGURE 1 | Milgram and Kishino's reality-virtuality continuum (adapted from Milgram et al., 1994).

Milgram-Kishino's RV Continuum

- → not the immersification continuum...
- → originally meant for display technologies
- → https://doi.org/10.1117/12.197321

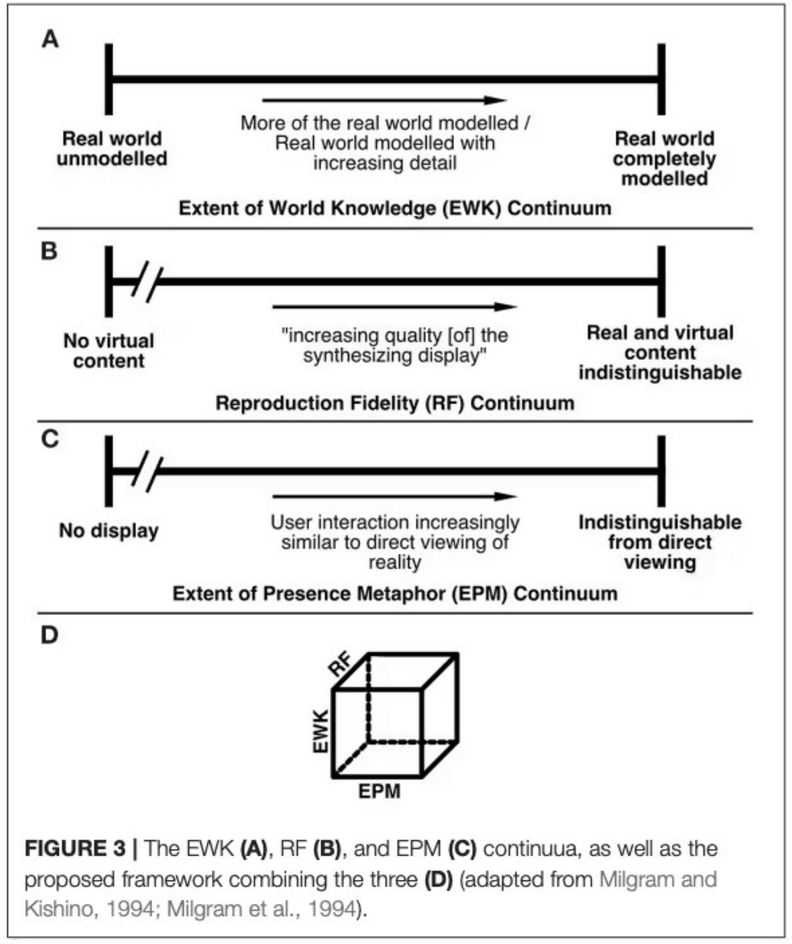
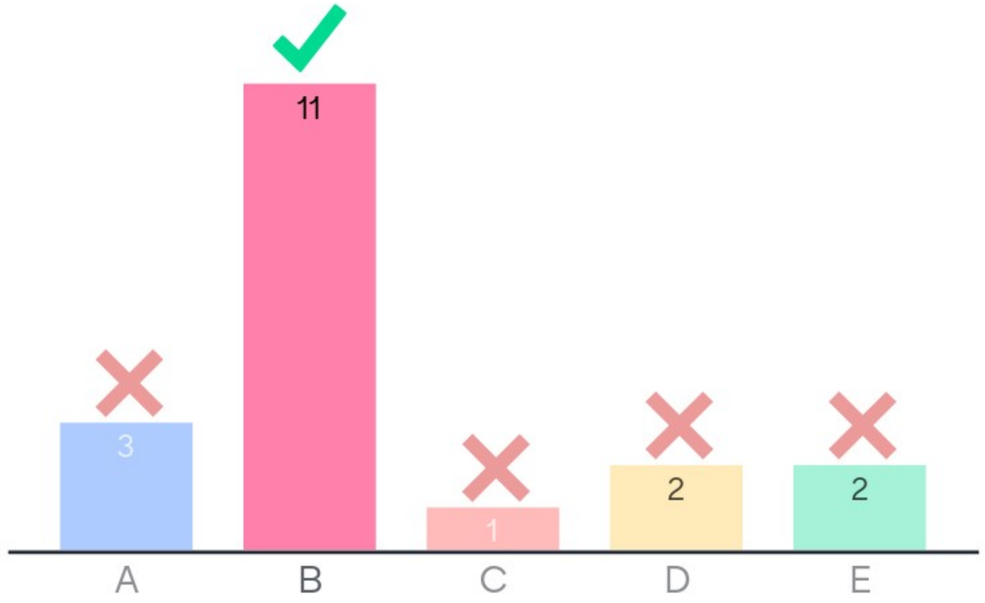


FIGURE 3 | The EWK **(A)**, RF **(B)**, and EPM **(C)** continuua, as well as the proposed framework combining the three **(D)** (adapted from Milgram and Kishino, 1994; Milgram et al., 1994).

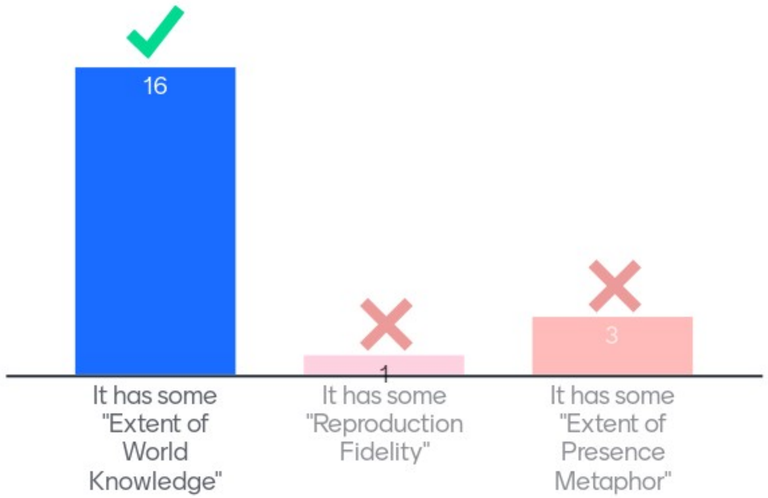
Dimensions of RV Continuum

- → EWK is how much system understands the real world
- → RF is how realistic the assets are
- → EPM is how interaction affords realism
- → https://doi.org/10.1117/12.197321

Where should Strava be placed on the RV Continuum?



Why is Strava not considered to be near the "Real Environment" end of the RV spectrum?



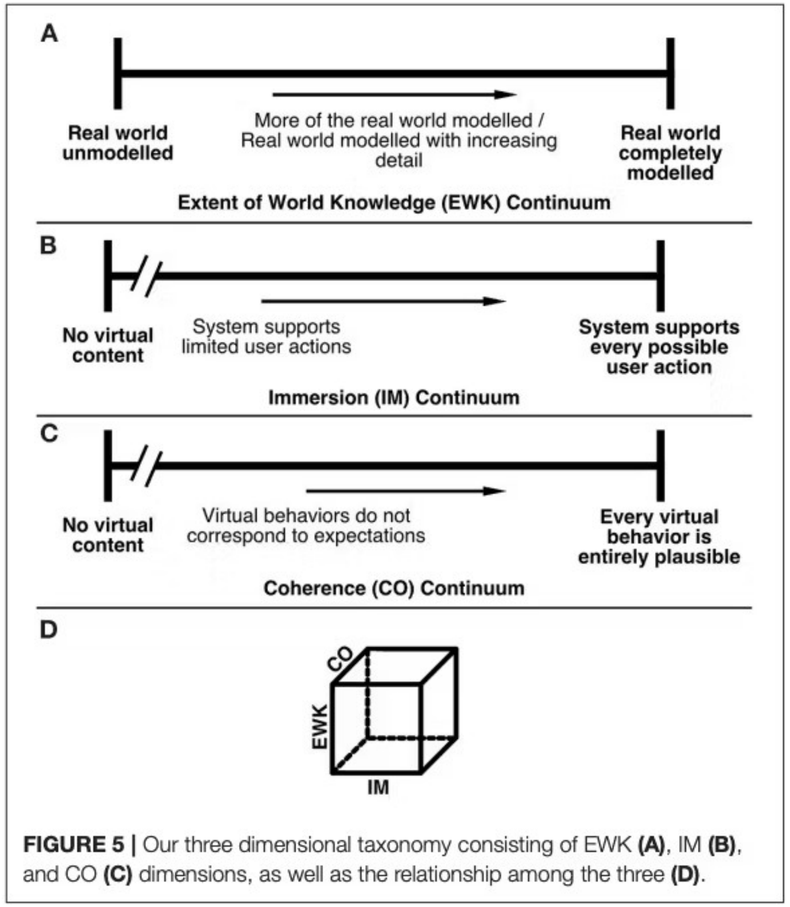
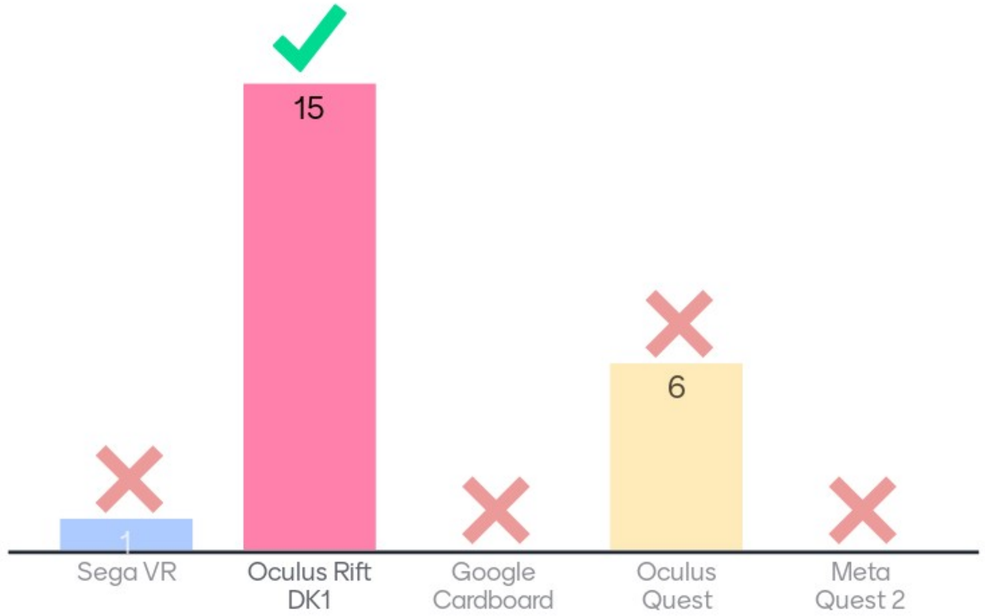


FIGURE 5 | Our three dimensional taxonomy consisting of EWK **(A)**, IM **(B)**, and CO **(C)** dimensions, as well as the relationship among the three **(D)**.

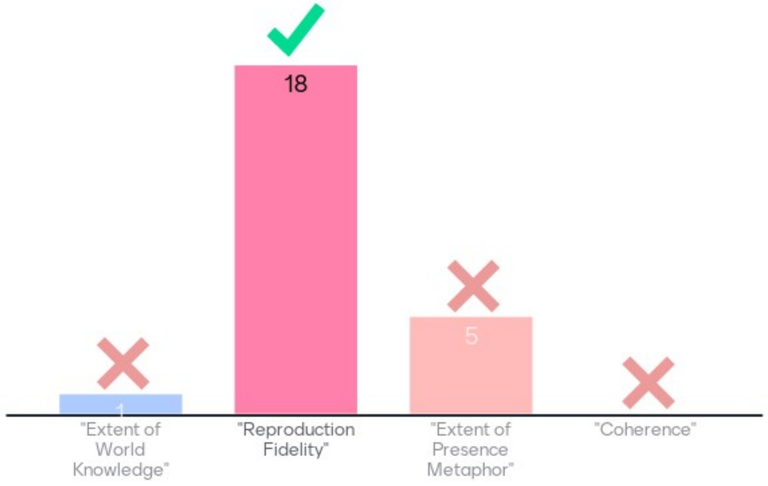
Revisiting the RV Continuum

- combined the RF and EPM into IM (our THE article came before this 😅)
- added CO to represent the user
- note that this but one academic paper
- common perception of MR is different
- https://doi.org/10.3389/frvir.2021.647997

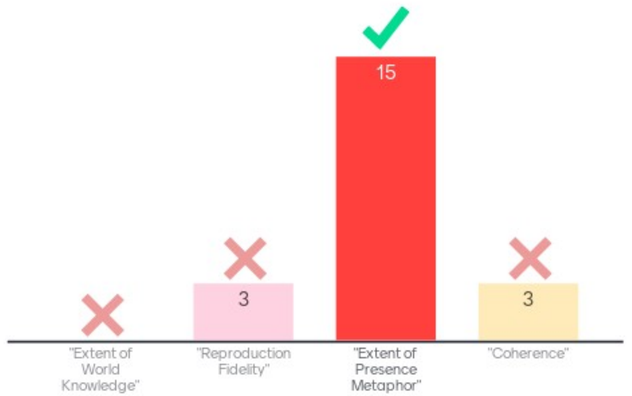
Which device sparked the current (21st Century) rise of VR?



The 3D models are extremely high quality. What dimension of the RV continuum is this referring to?

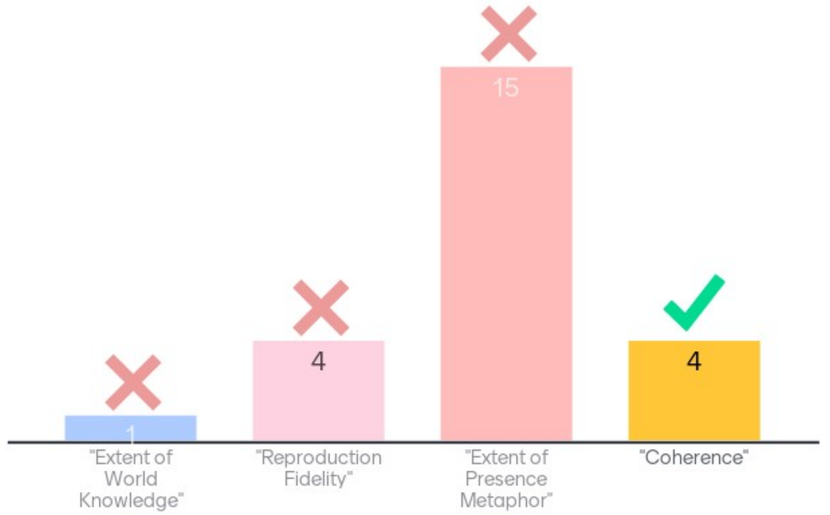


The stereo optics provide a perception of depth through an LCD display. What dimension of the RV continuum is this referring to?



Mentimeter

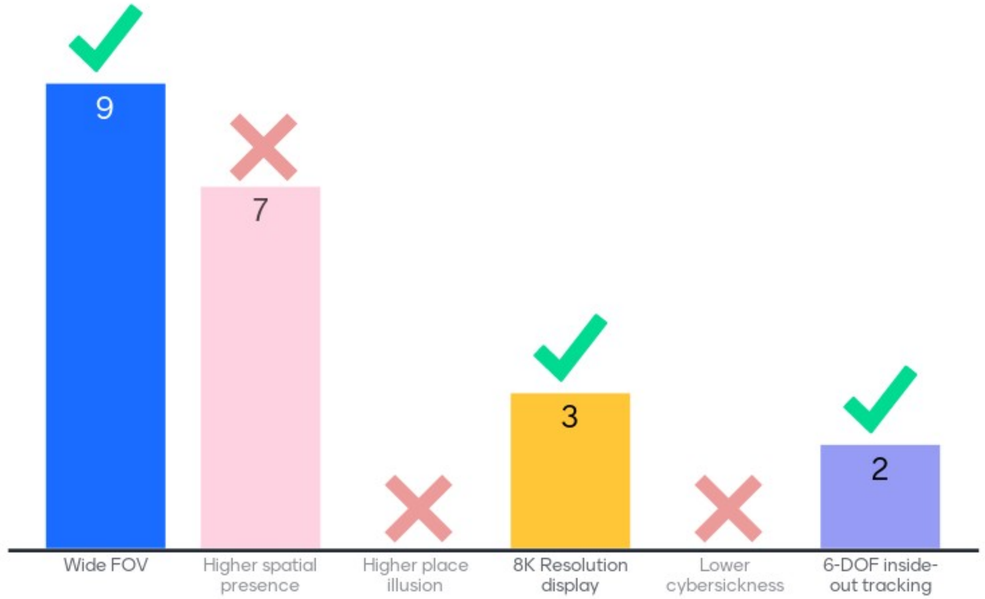
For a moment I believed that I was actually 1000ft above ground. What dimension of the RV continuum is this referring to?



Evaluating Immersive Experiences

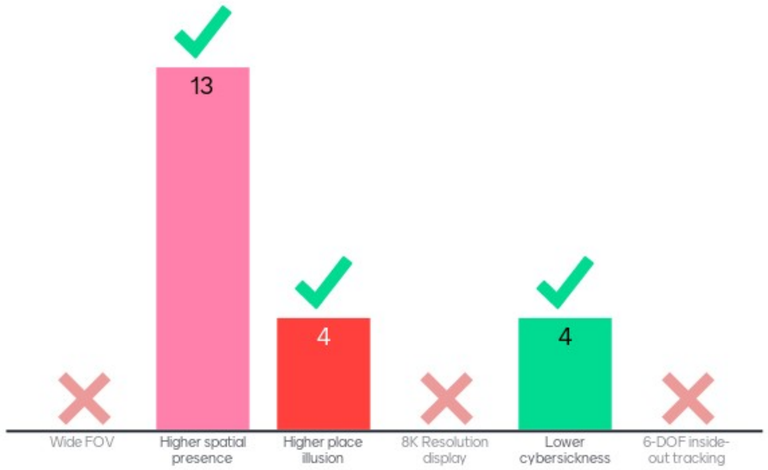
- explain immersion as system properties
- explain immersion as user experiences
- explain the key dimensions of presence, flow and cybersickness
- describe how to employ different quantitative and qualitative user research methods to evaluate presence, flow and cybersickness
- explain the role of affordances in immersive experiences

Which of the following describes immersion from a systems perspective?

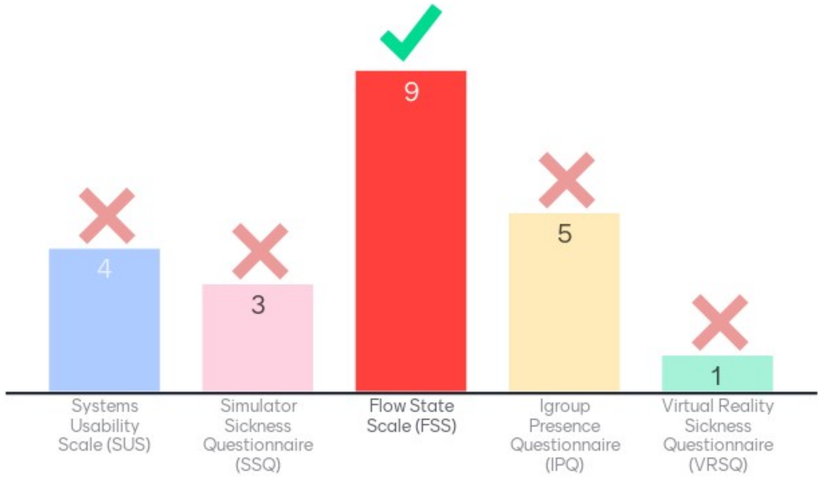


Mentimeter

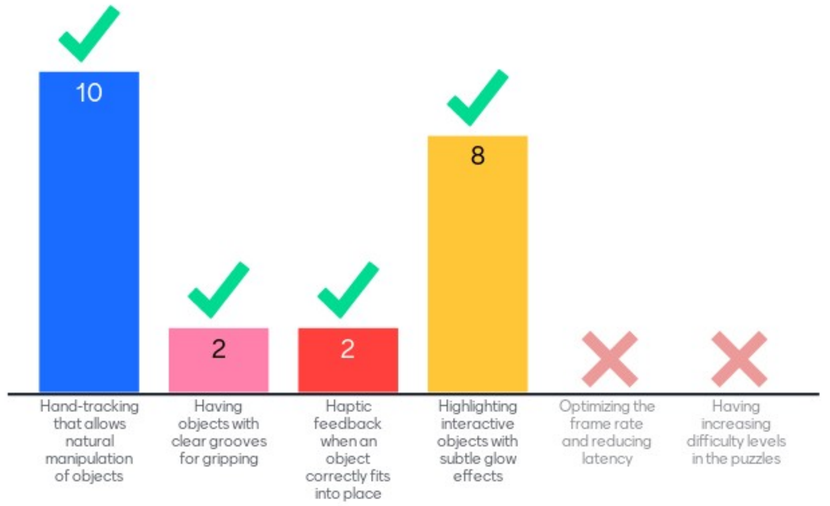
Which of the following describes immersion from an experiential perspective?



What is/are the possible famous validated questionnaires to use in the user studies, pertinent to the aims above?



Which of the implementation element(s) below would improve the affordances for interactions in this app?

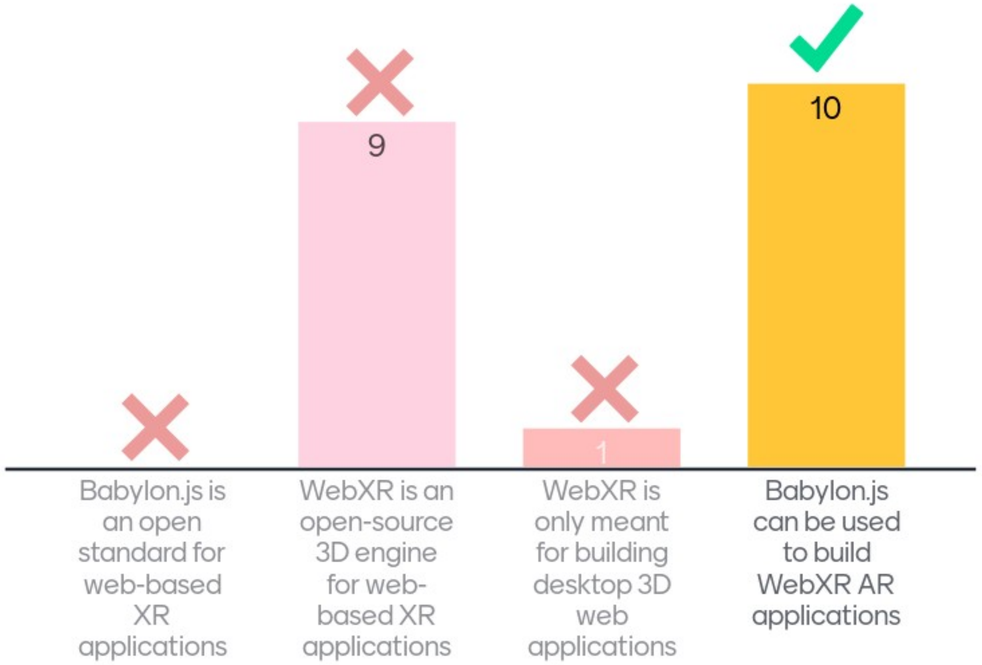


Development Tools

- describe common tools for developing immersive applications
- differentiate the accessibility implications of choosing different types of tools
- differentiate WebXR and OpenXR standards

Mentimeter

Choose the correct statement related to implementation tools.



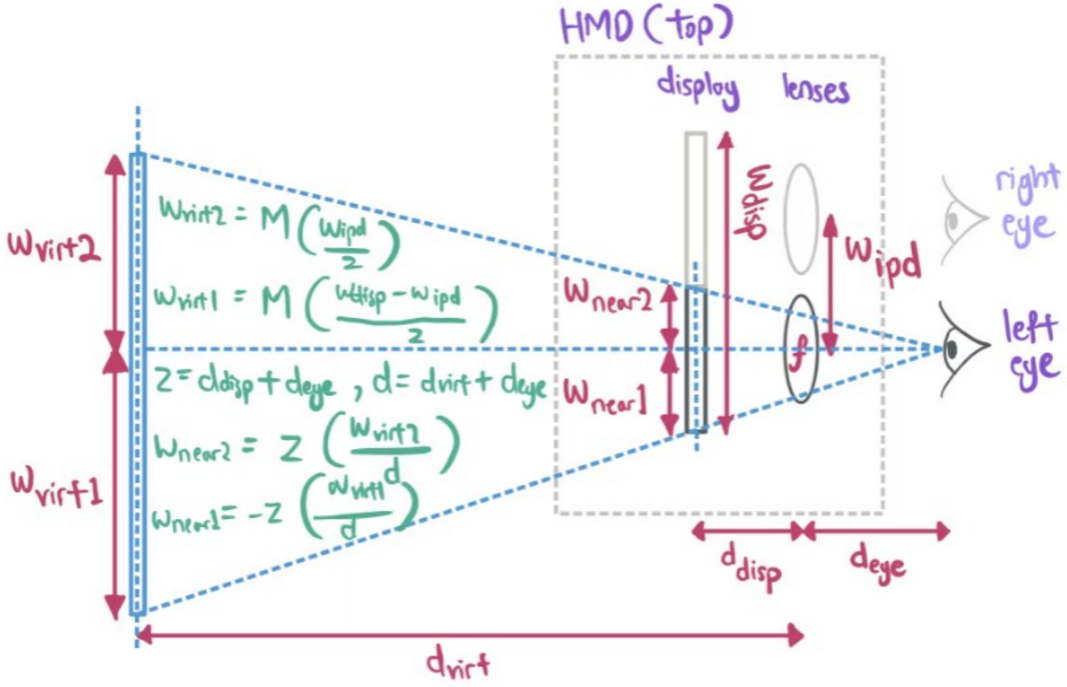
Hardware & Software Components

- describe common hardware components in XR devices
- explain the image formation process in typical XR HMDs
- describe common software components in immersive applications
- describe the architecture of a typical WebXR application

Mentimeter

describe common hardware components in XR devices

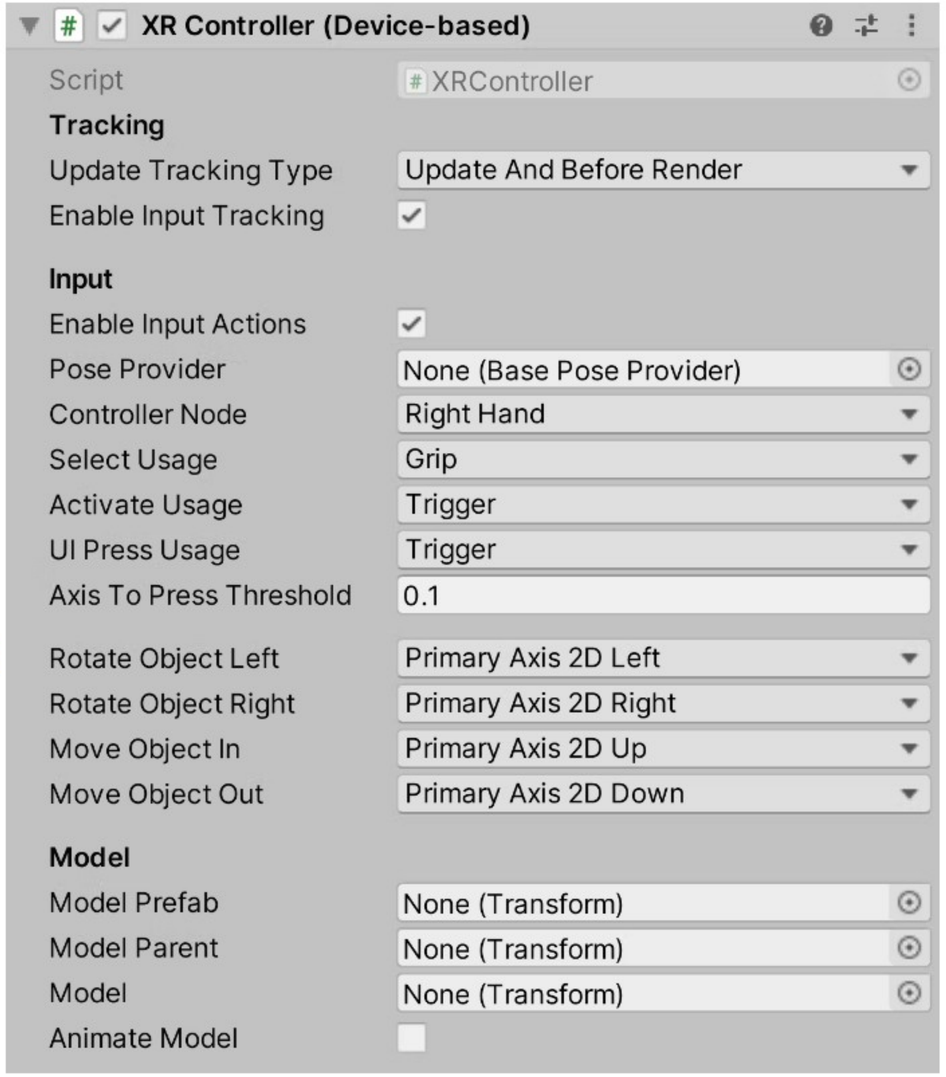
→ https://www.gamespot.com/articles/razer-reveals-open-source-vr-headset-the-osvr/1100-6424485/

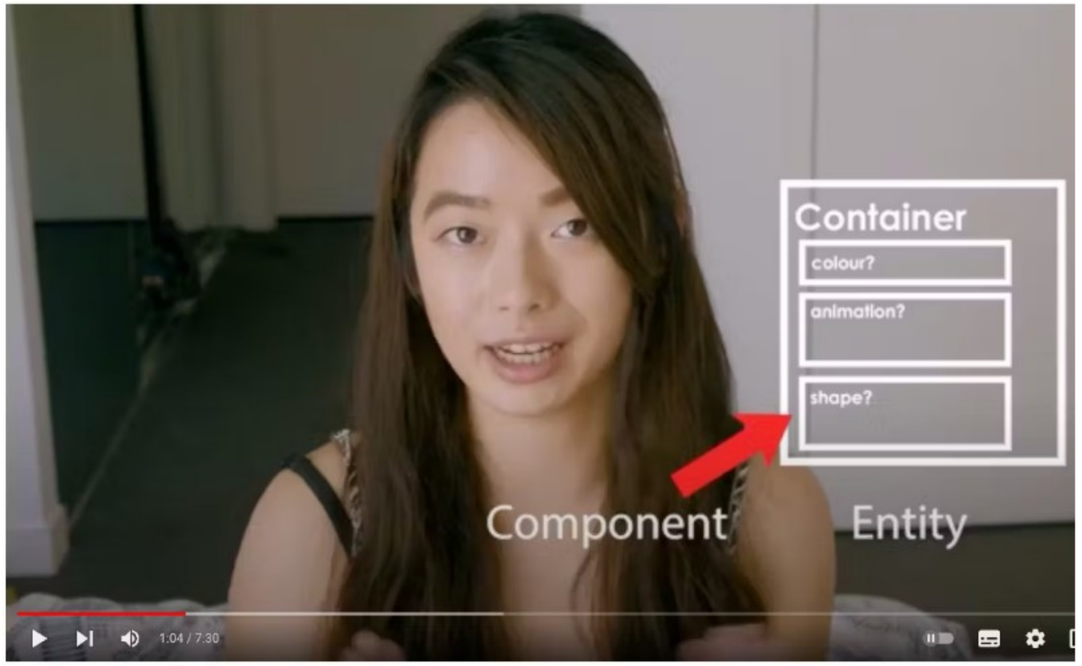


explain the image formation process in typical XR HMDs

describe common software components in immersive applications

→ https://docs.unity3d.com/Packages/com.unity.xr.interaction.toolkit@2.3/manual/xr-controller-device-based.html





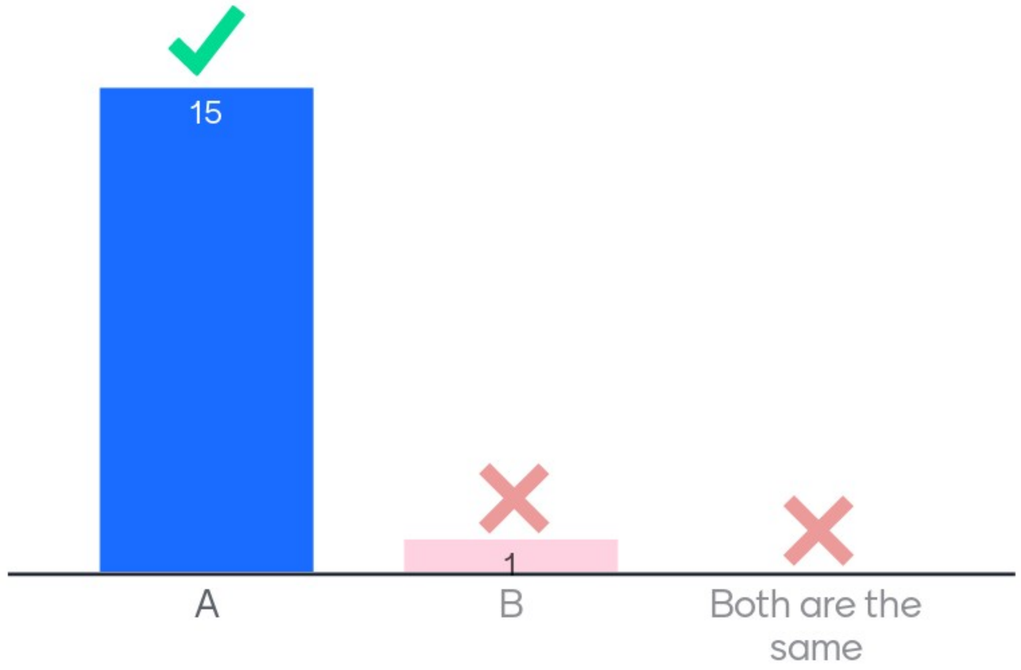
Aframe Webvr - VR Development Tutorial Series
Aframe Webvr - VR Development Part 3 - ECS Architecture

describe the architecture of a typical WebXR application

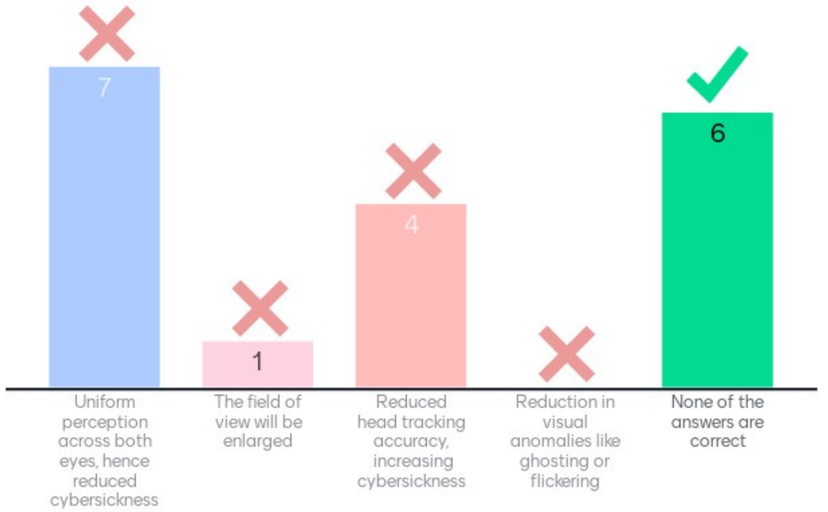
→ https://youtu.be/qB8Ejh_QdpE

What does changing the focal length of the lenses in an HMD affect?

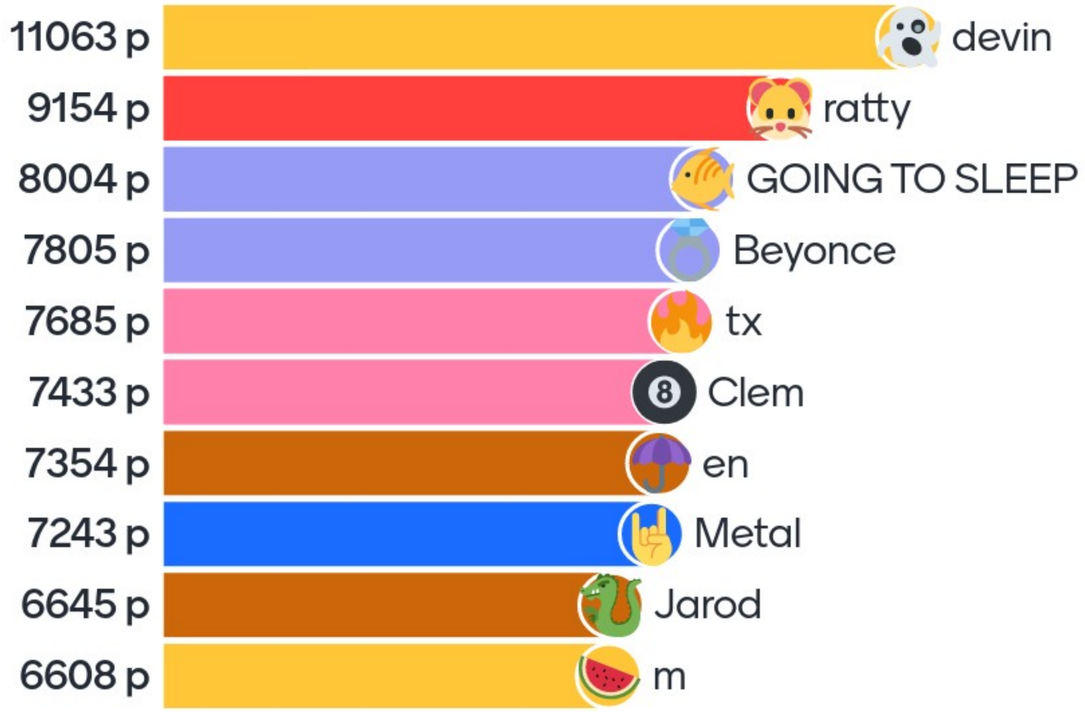
Which object is easier for the user to reach out and grab with his/her hands?



What effect does using the same projection matrix for both displays (or display partitions) for both eyes in a VR HMD have?



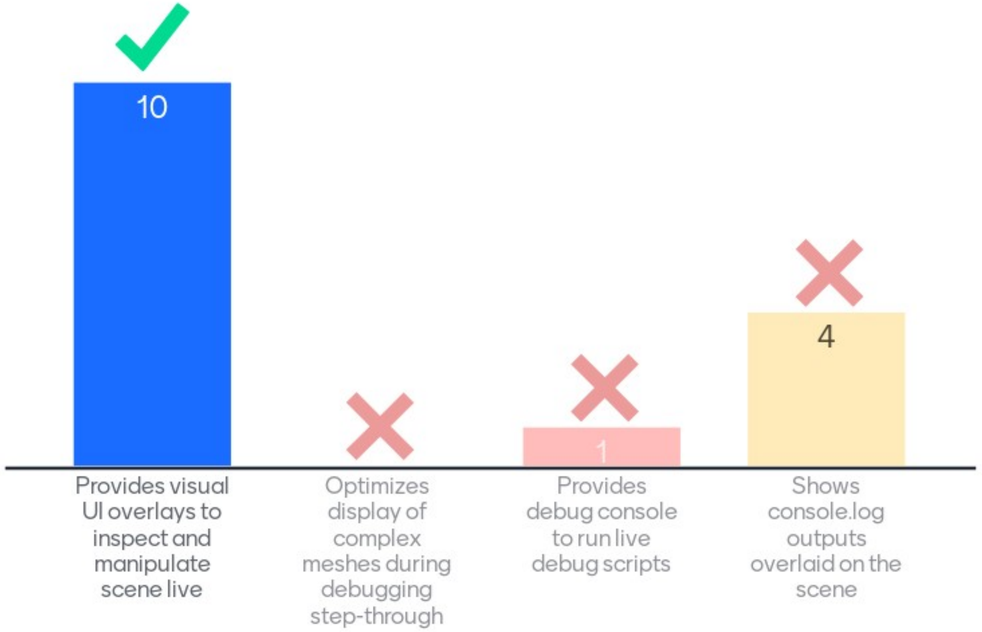
Leaderboard



Creating Virtual Environments

- create a 3D virtual environment with a skybox and geometric primitives in WebXR
- implementing a simple GUI in an XR application
- implement anchors to overlay 3D virtual objects in camera video in WebXR
- implement basic audio in WebXR applications
- **differentiate model-based vs image-based methods to create virtual environments**

What is the function of the debugLayer in the Scene class of Babylon.js?



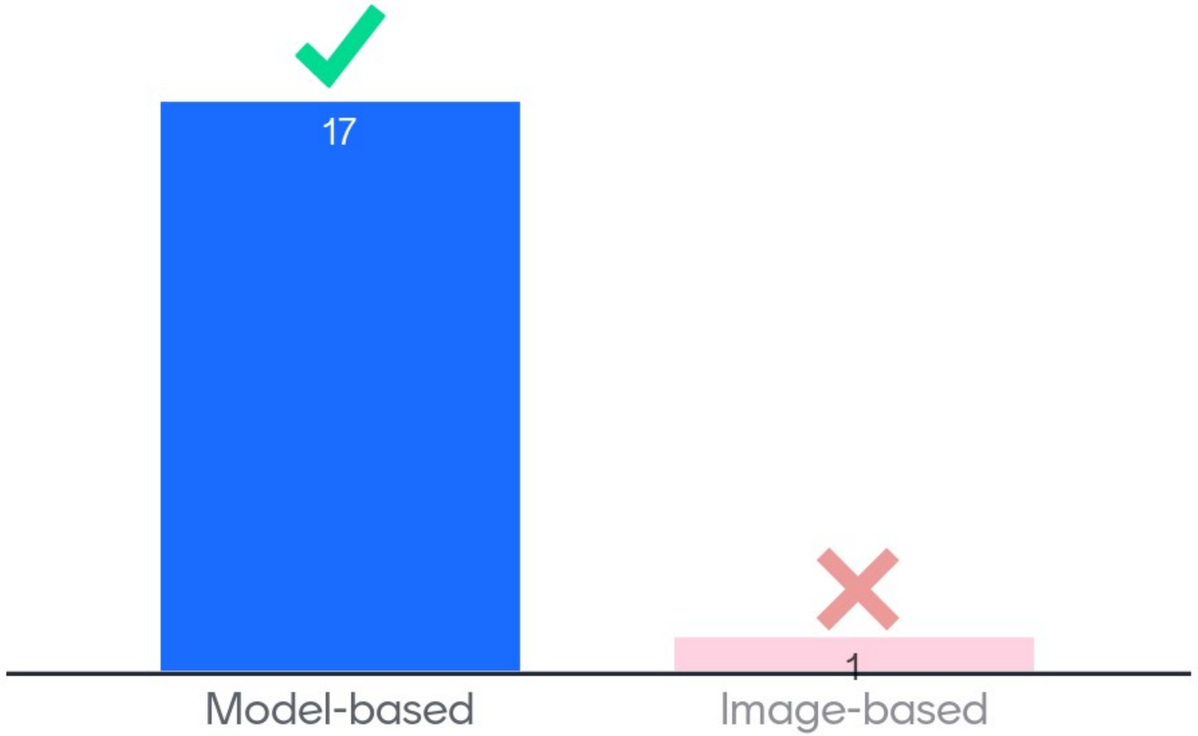
Model-based approach

- → hand-made 3D models using 3D modelling tools
- → requires deep technical art expertise
- → enables full interactive implementations

Image-based approach

- → 360 photos/videos
- → more accessible to untrained creators
- → limited to static surroundings
- → sometimes 3D reconstruction used to bridge towards model-based

What is the optimal approach?



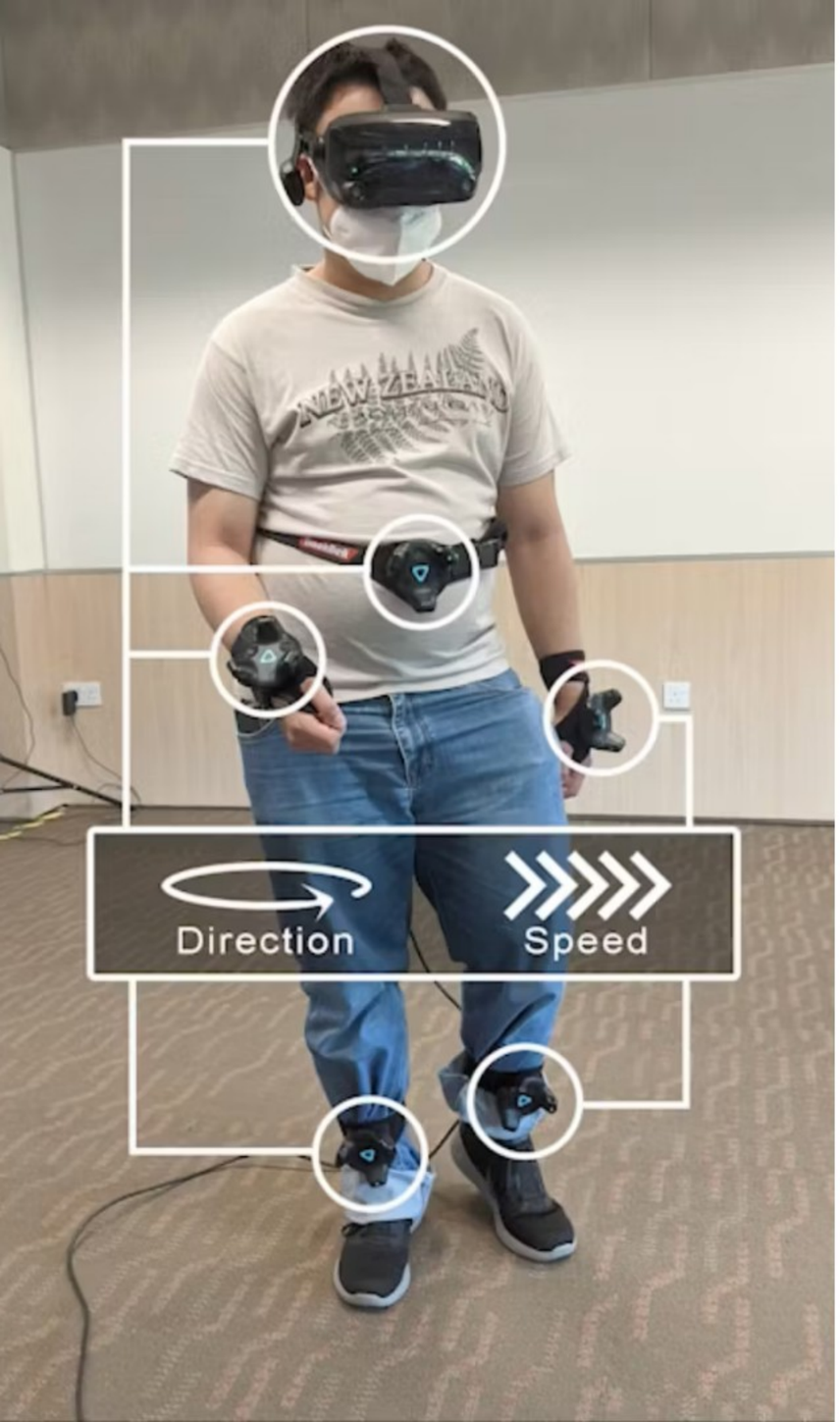
What is the API class in Babylon.js that will allow you to easily use 360 images as the skybox?

- Skybox ✗
- image.jpg ✗
- CreateBox ✗
- Videodome ✗
- backfaceculling=false ✗
- 360Image ✗

The correct answer is: PhotoDome

Interaction

- differentiate common interaction mechanics in immersive applications
- explain how different hardware components implement different interaction mechanics
- differentiate natural and artificial interactions in immersive applications
- apply interaction mechanics and authenticity considerations in designing different interaction use cases

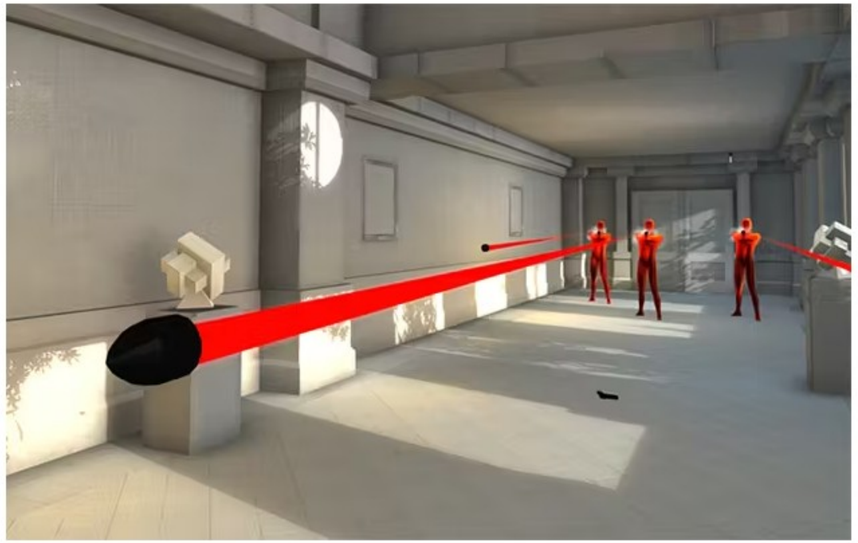


Interaction Mechanics

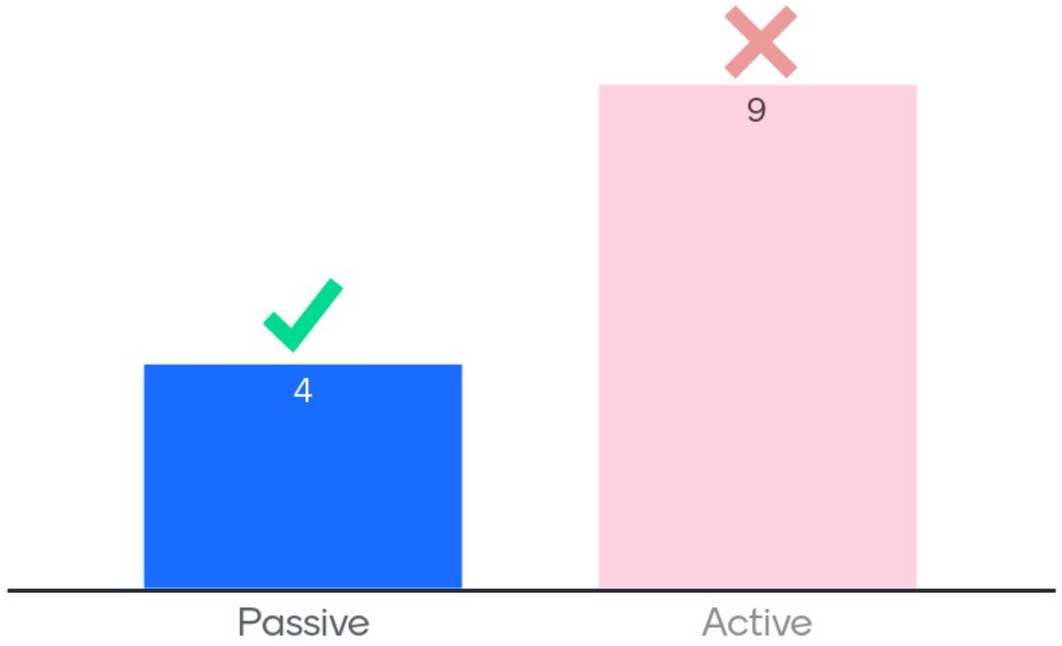
- viewpoint control
- hand gestures
- body gestures

Interaction Authenticity

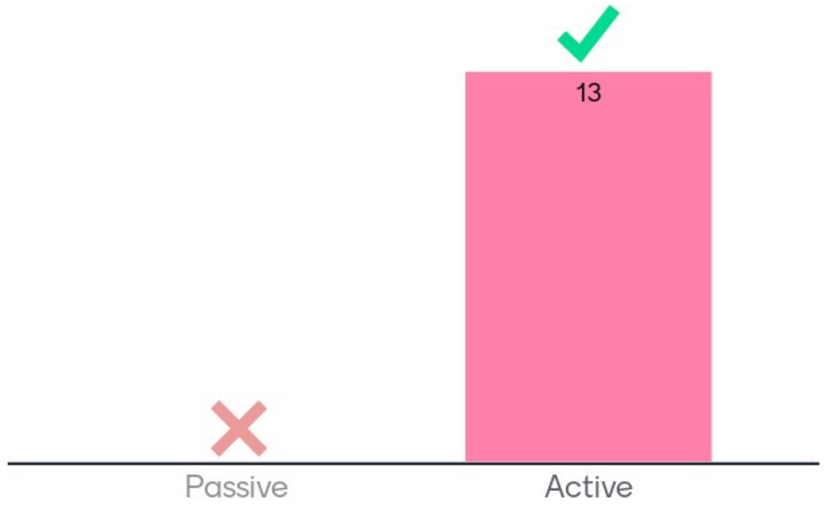
- → natural interactions
- → artificial magical interactions
- → artificial augmented natural interactions
- → https://www.engadget.com/2014-05-14-superhot-kickstarter.html

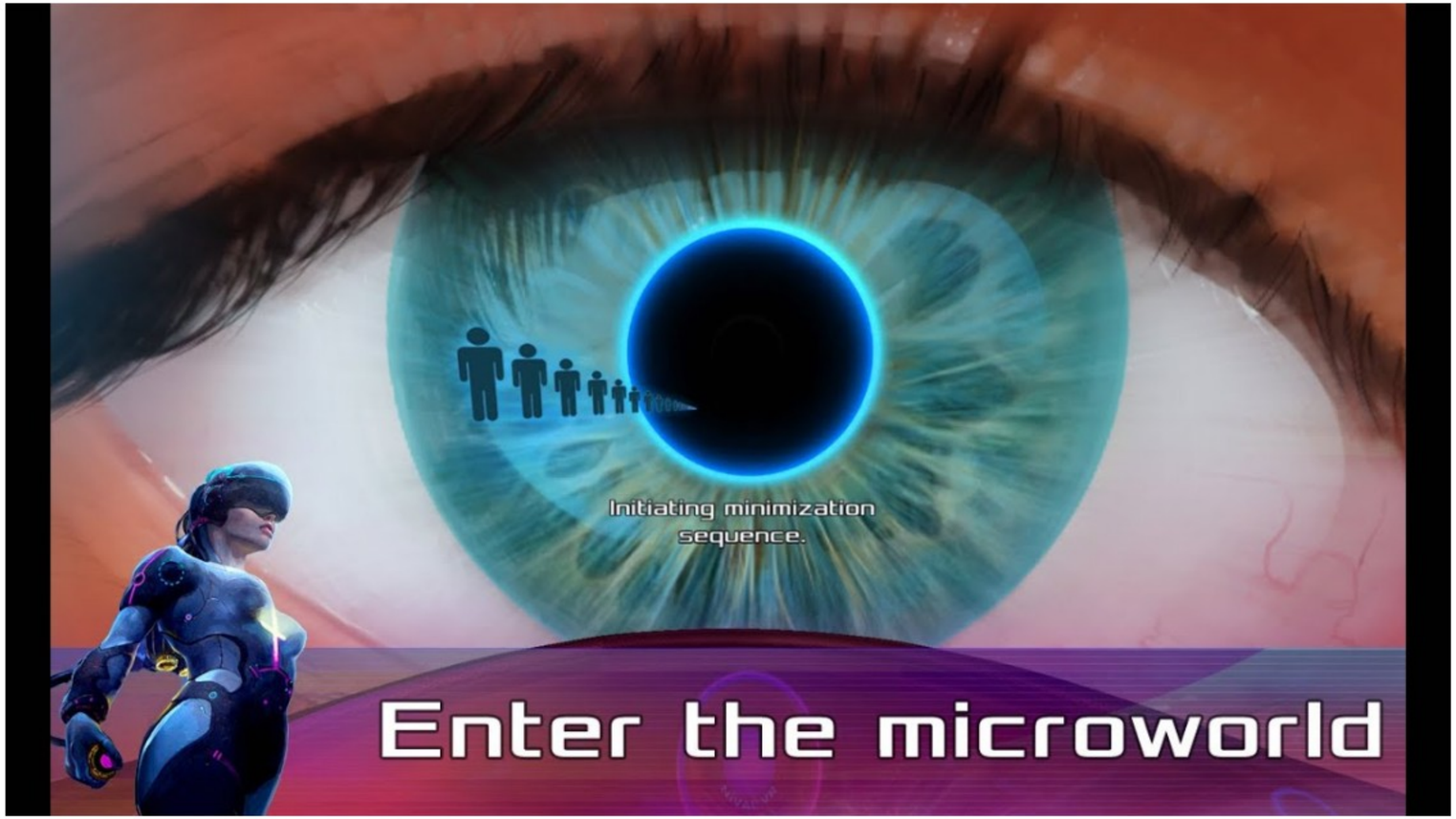


In the VR Bioreactor Training system, is viewpoint control a passive or active interaction mechanic?



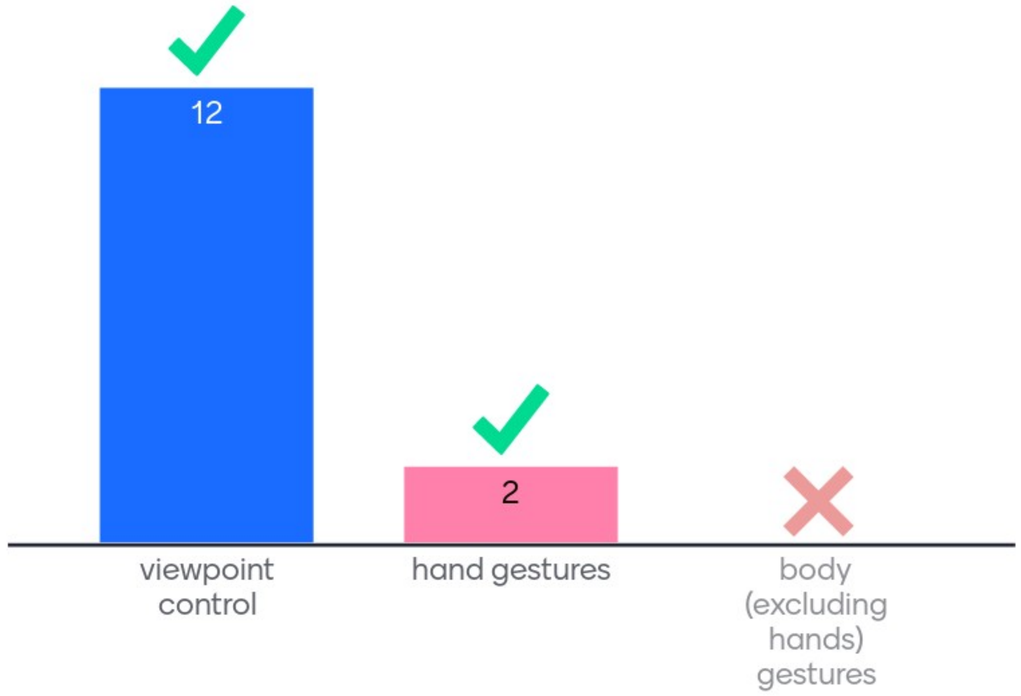
In the VR Bioreactor Training system, are hand gestures a passive or active interaction mechanic?



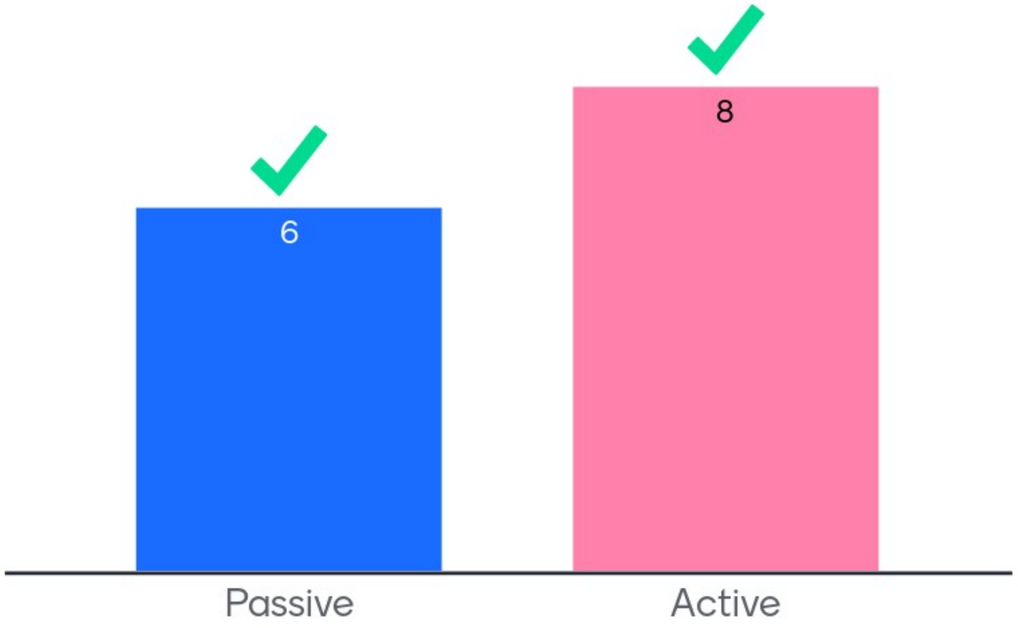


InMind VR

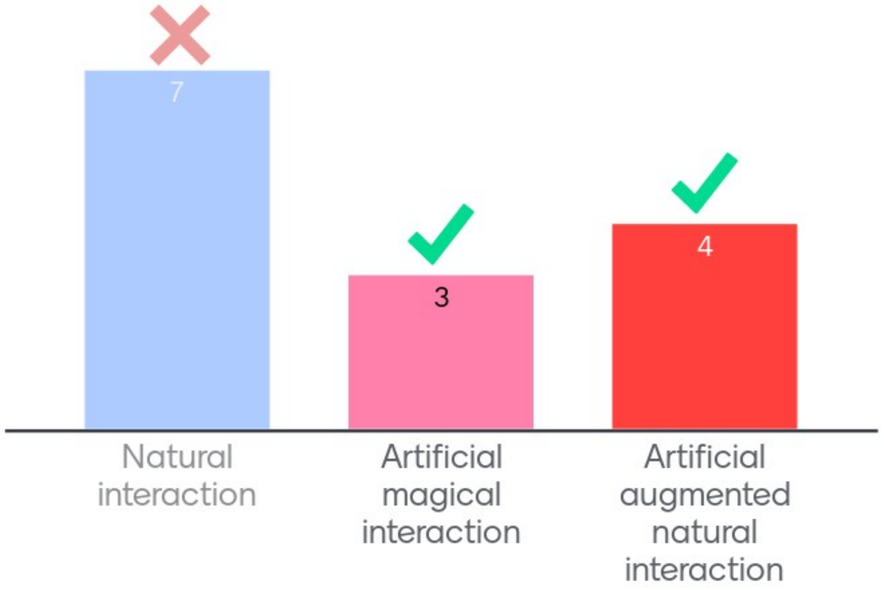
In the VR game InMind VR, what interaction mechanics were implemented?



In the VR game InMind VR, is viewpoint control a passive or active interaction mechanic?

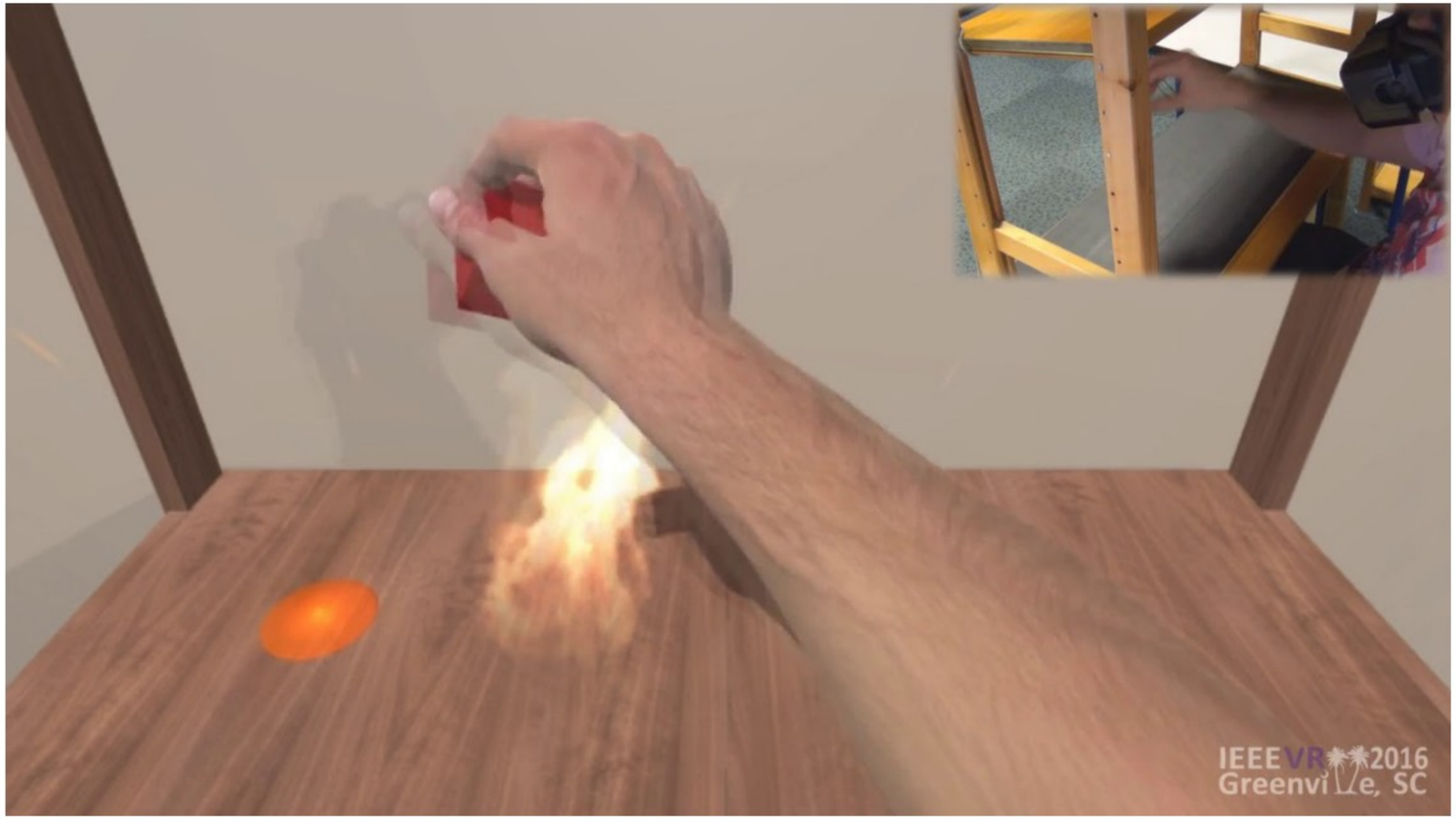


In the VR game InMind VR, what form of interaction authenticity is the eye-gaze point-and-click mechanic?



Embodiment

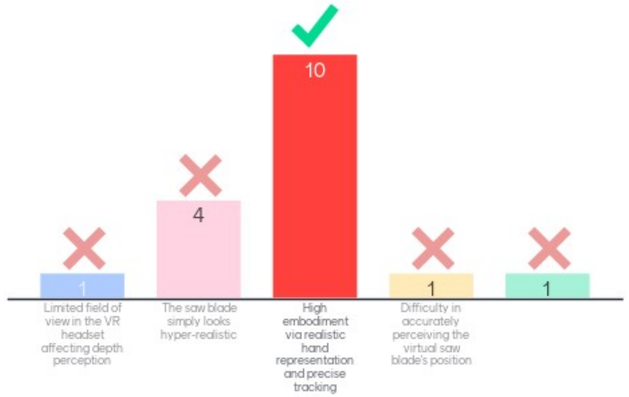
- perception that a virtual body is one's own, often correlated to Presence
- improve tracking fidelity
- implement multimodal sensory feedback: visual, auditory, haptic, etc.
- implement personalization: e.g., Meta's mirror



Virtual Embodiment: Effects of the Virtual Hand Representation (Argelaguet et. al.)

Mentimeter

Many users tend to route their hands behind the virtual saw blade when asked to place their hands in the target position. Why is the primary reason?



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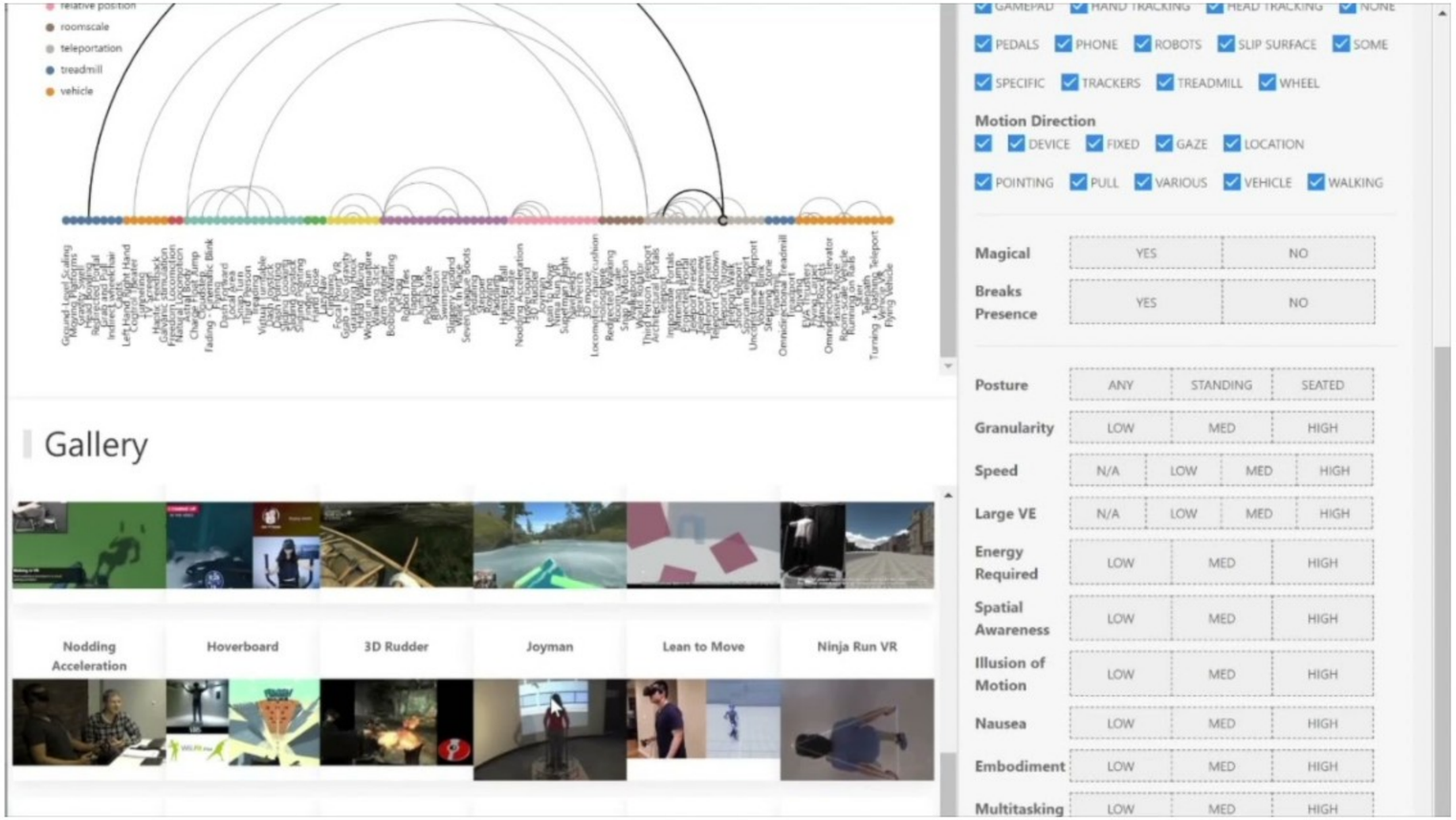
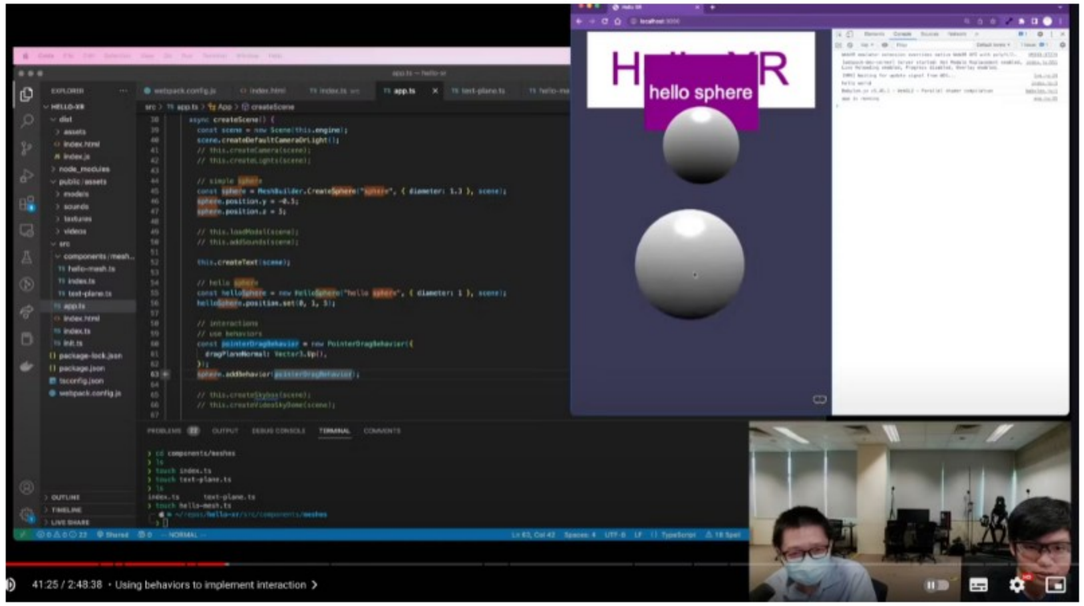


The locomotion vault

Select Answer

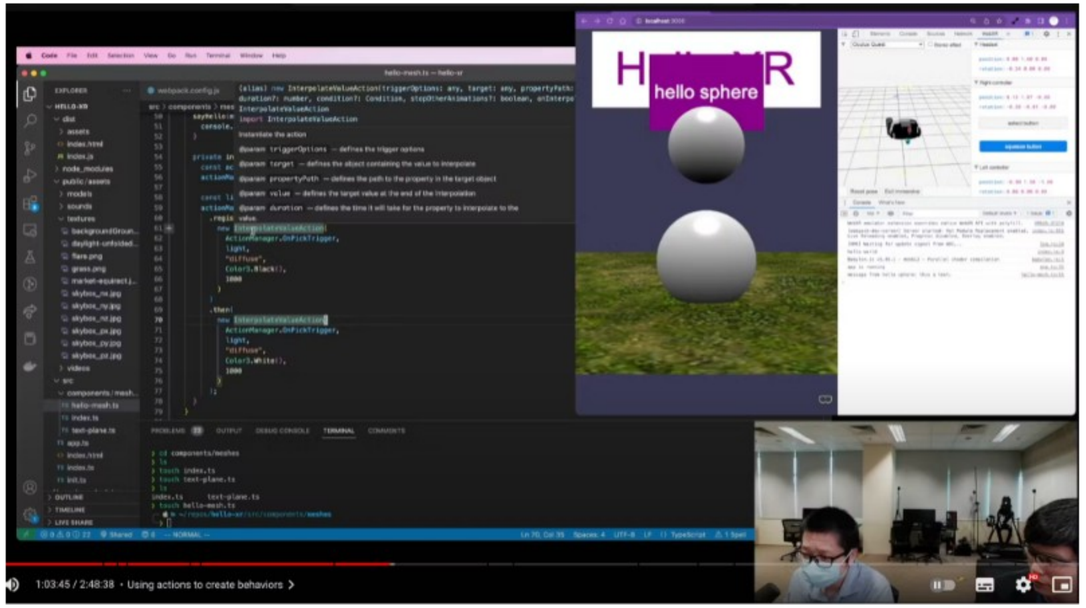
Implementing Interaction

- differentiate code constructs (behaviours, actions and observables) to implement interactions in WebXR
- implement various typical object handling interactions in WebXR
- implement various typical locomotion interactions in WebXR



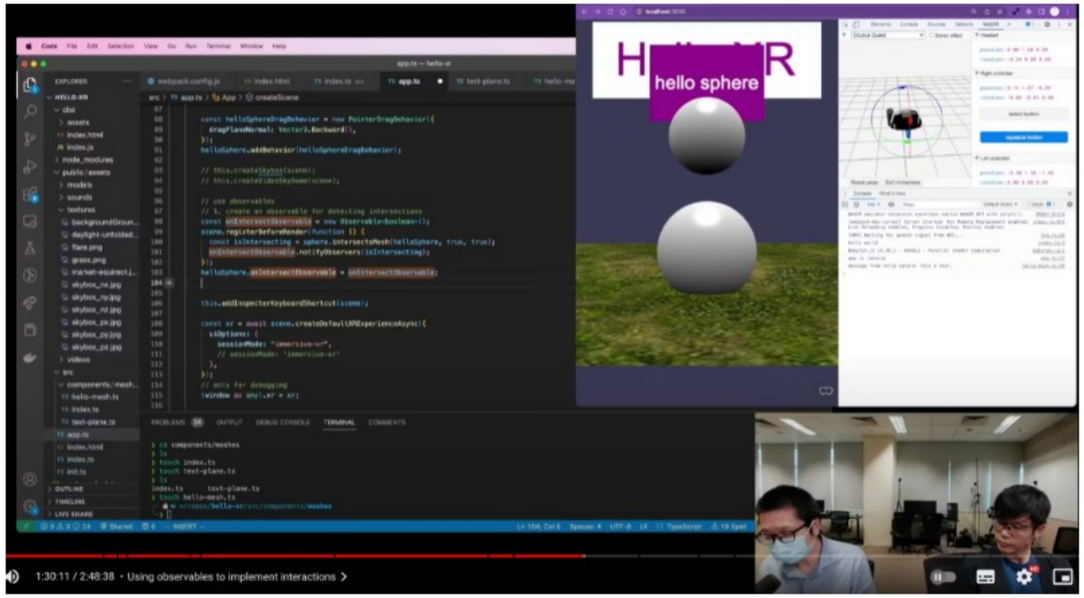
Behaviors

- Predefined, reusable interactions without custom code
- Common interactions like dragging, scaling, following, etc.



ActionManager

- Define property changes triggered by pre-defined events
- Customize interaction parameters (e.g., duration, conditions, triggers)

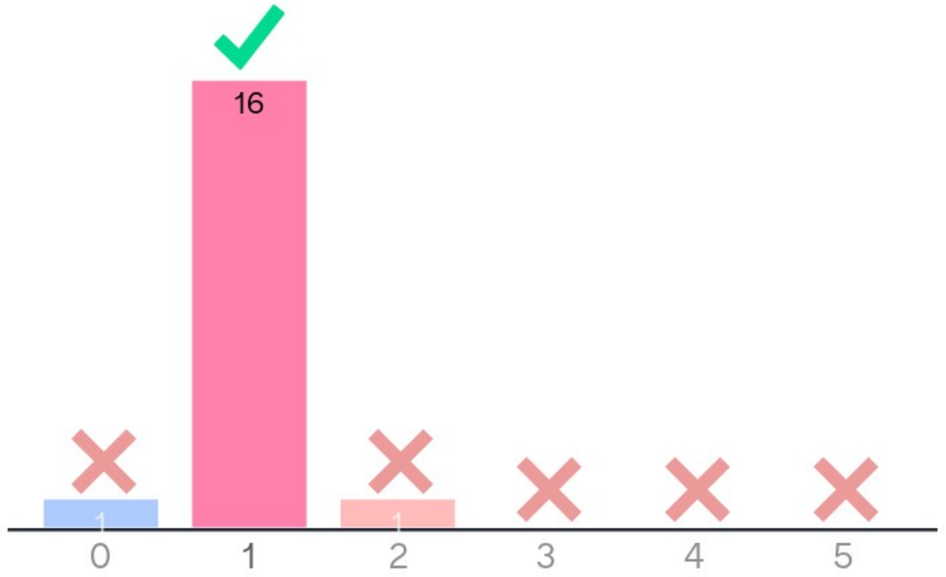


Observables

- General code construct for observer pattern
- Subscribe and receive notifications to events
- Fully customizable interactions

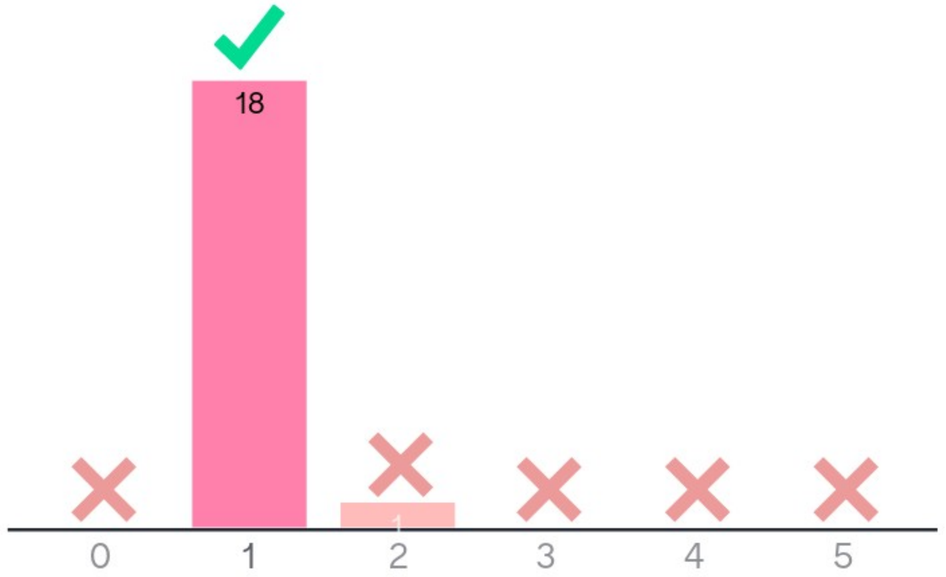
Mentimeter

In total, how many observers were used here?

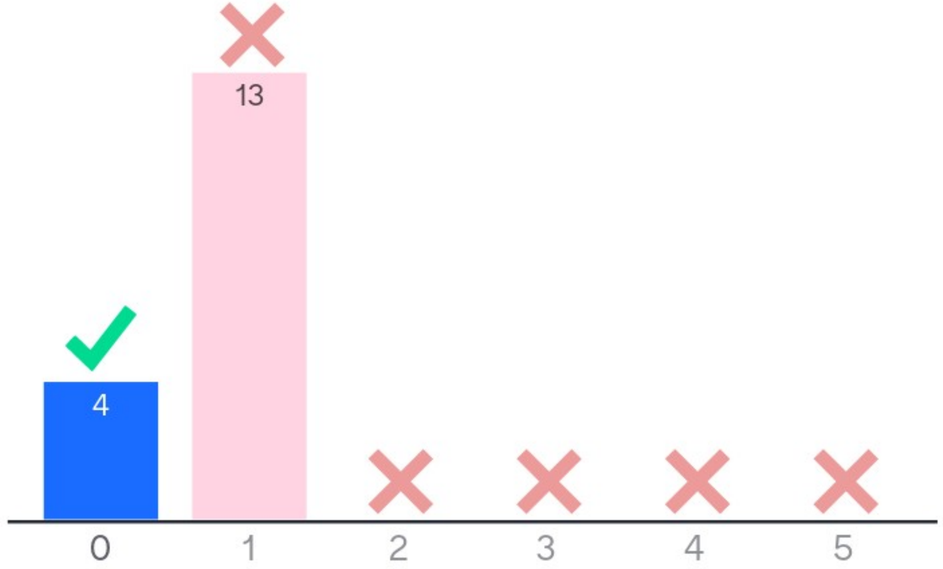


1

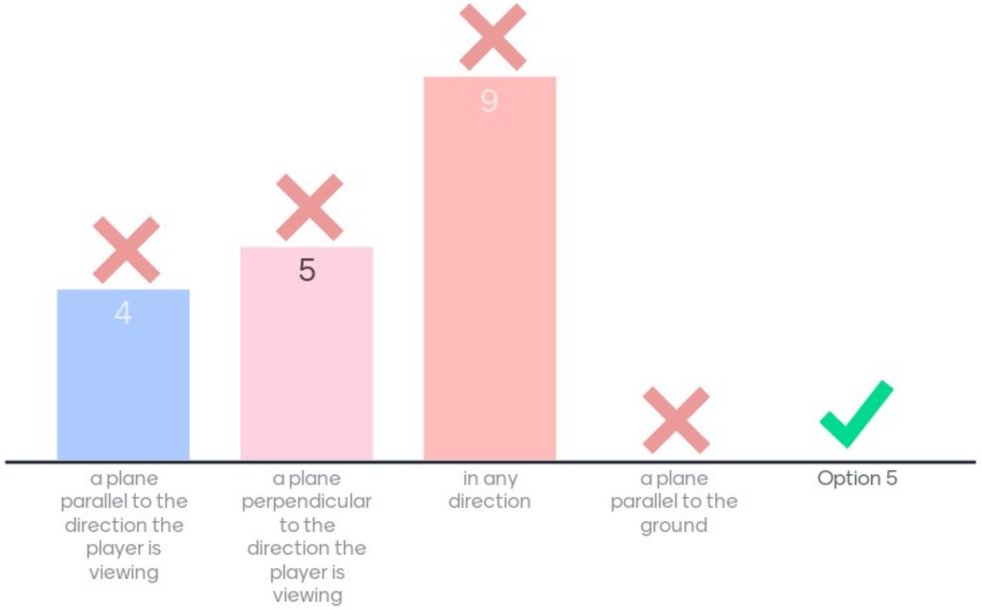
In total, how many observables did we operate on?



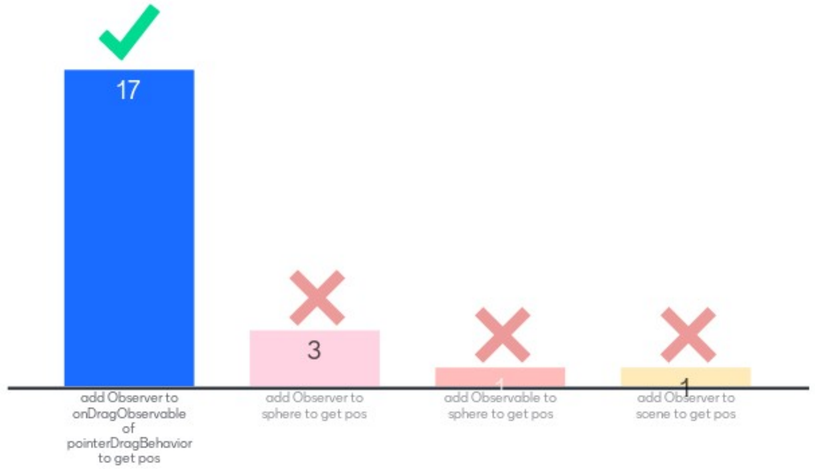
In total, how many observables did we create?



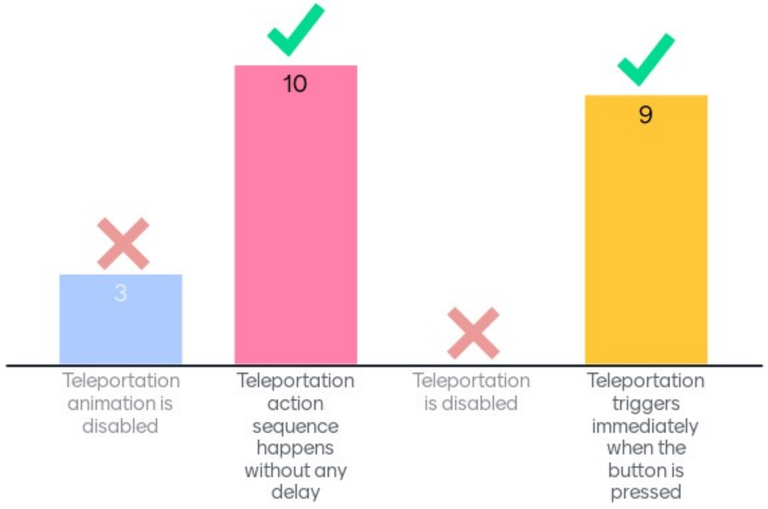
The following code allows the sphere to be dragged around...



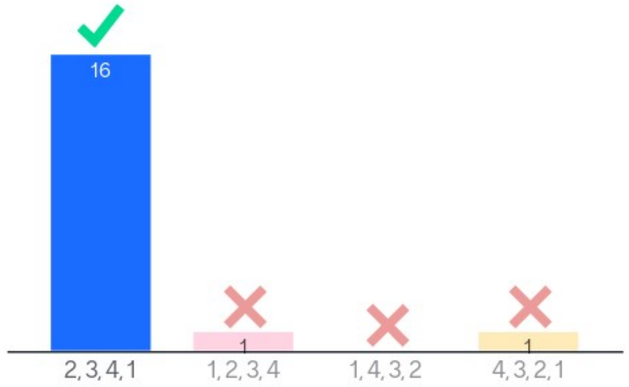
Can you suggest an improvement to the DEBUG CODE to get the position of the sphere only when it is being dragged?



What happens when I change timeToTeleport to 0 in the following Babylon.js code?



What is the order of the console logs in the following Babylon.js code? (Assume the rest of the code is correct and the scene is set up properly)



Case Studies

- appreciate the design and evaluation of immersive applications through real-world case studies
- design application features through the lens of immersion
- translate design into implementation from a systems perspective of immersion
- choose data collection methods to gather user experiences appropriate to experiential goals
- analyse data collected to form conclusions with respect to experiential goals

Case Study 1: VR Commuting Simulator

Designing for Immersion

It is first essential to consider all stakeholders of the application

- **Users** - the general public
  - that can come into a VR lab
  - who are interested to contribute feedback on commuting experiences
  - and perhaps curious about VR
- **Collaborator** - LTA
  - aim to have a VR system to evaluate commuting experiences
  - so as to obtain higher quality data and reduce operational costs

Designing for Immersion

- feel like actually in Singapore HDBs [PRESENCE]
- locomotion close to real walking [PRESENCE]
- clear goals and fluent performance during commute [FLOW]
- minimal nausea and disorientation symptoms [CYBERSICKNESS]

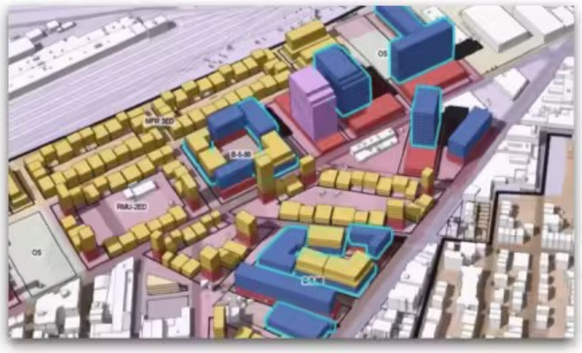
Design ➠ Implementation

feel like actually in Singapore HDBs [PRESENCE]

replicate the scale and visuals of a real HDB estate

Real-world 3D Scans

Custom Point Cloud Processor

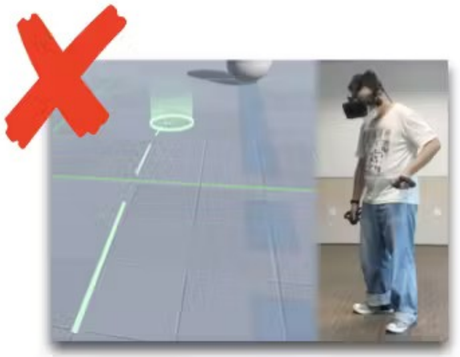


ArcGIS CityEngine

Design ➠ Implementation

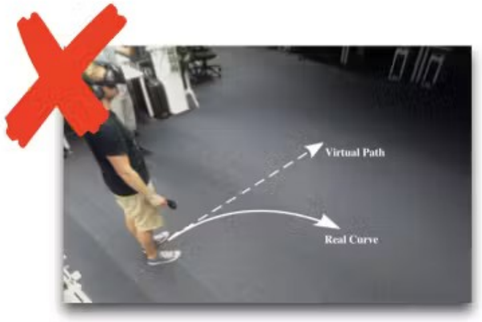
locomotion close to real walking [PRESENCE]
clear goals and fluent performance during commute [FLOW]

create a walking locomotion that is semi-natural yet easy to operate

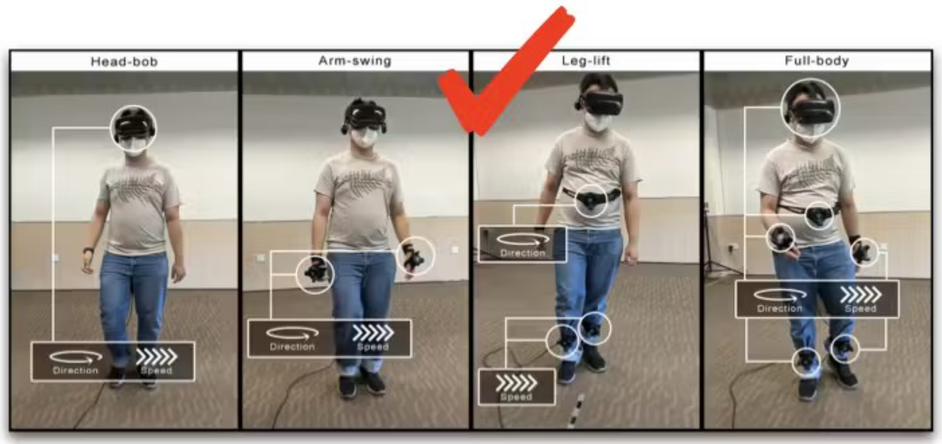


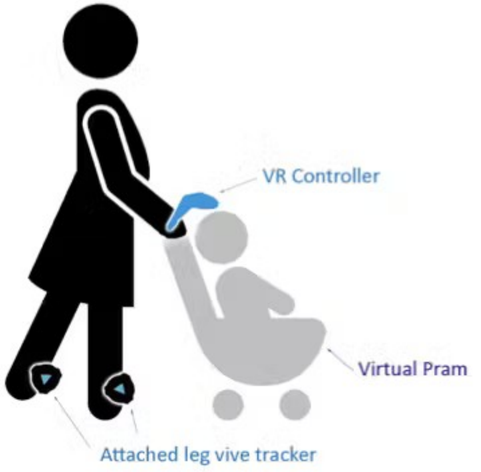
Teleportation

VR “slidemills”



Redirected Walking in VR
(Langbehn & Steinicke, 2018)



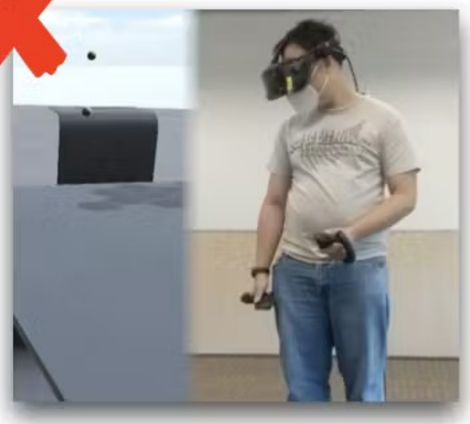


Mentimeter

Design ➠ Implementation

minimal nausea and disorientation symptoms [CYBERSICKNESS]

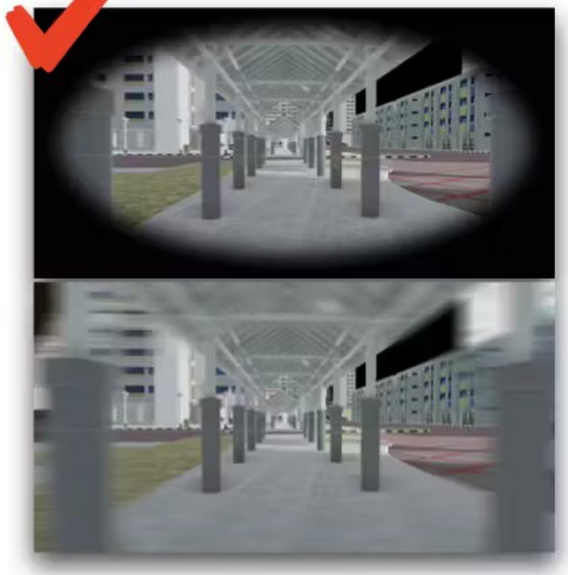
reducing common pitfalls that induce visual-vestibular conflict



Joystick

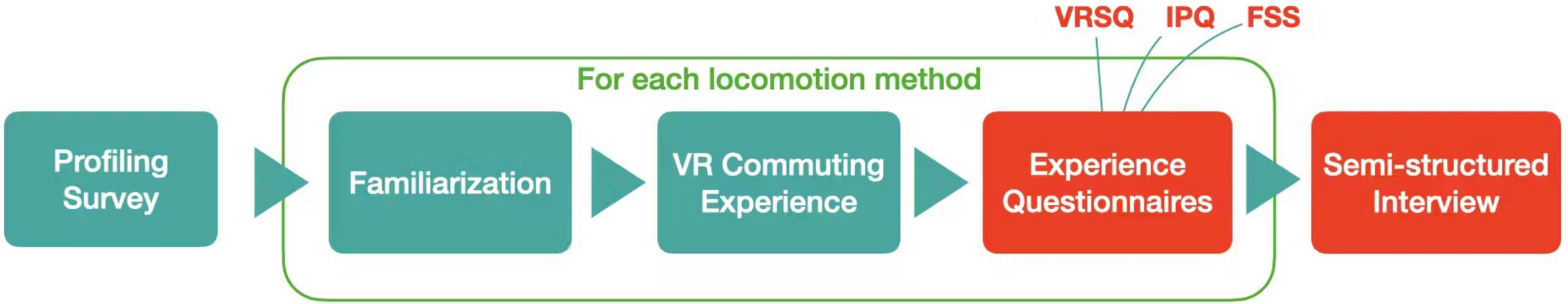
Stationary

Walking Actions

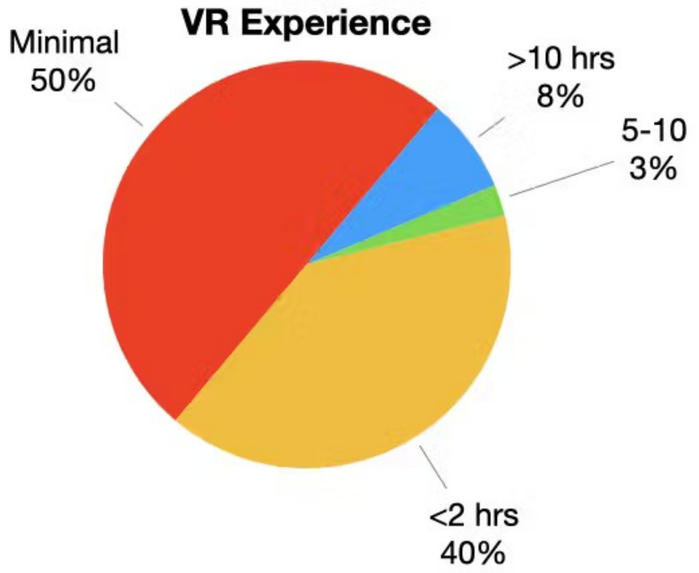


Visual mitigation during movement

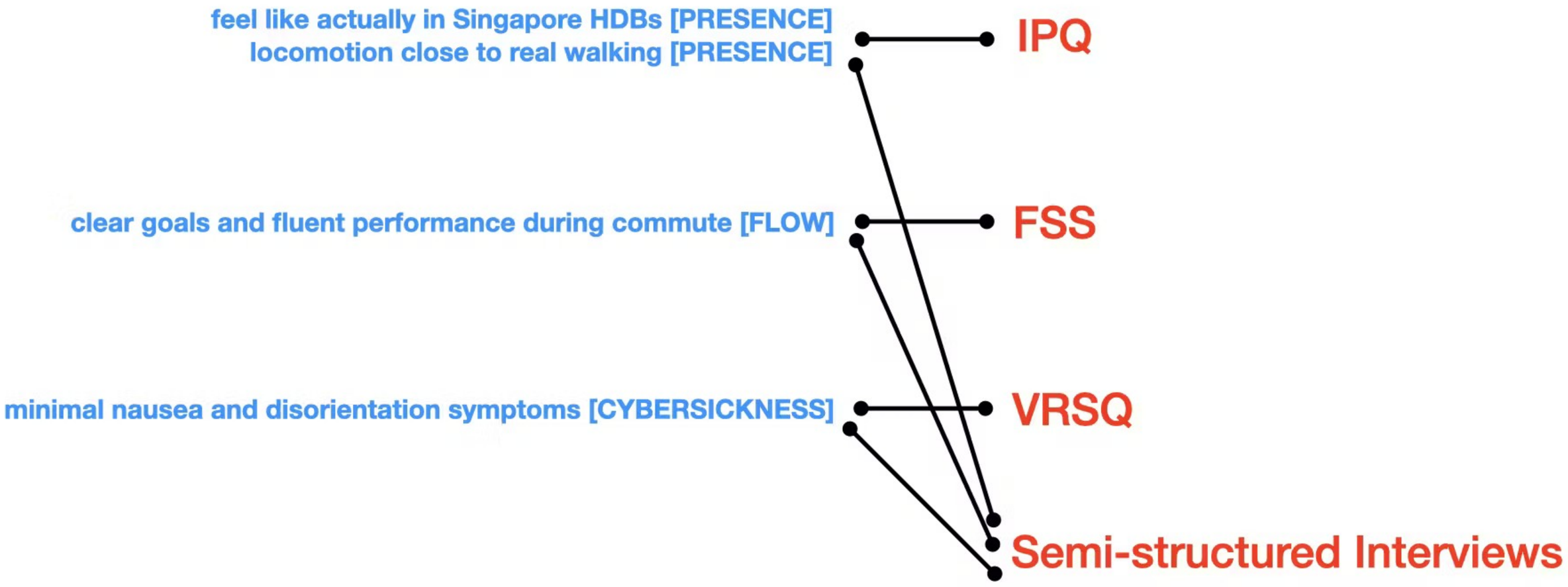
Data Collection Appropriate for Experiential Goals



40 participants **aged** 21-45

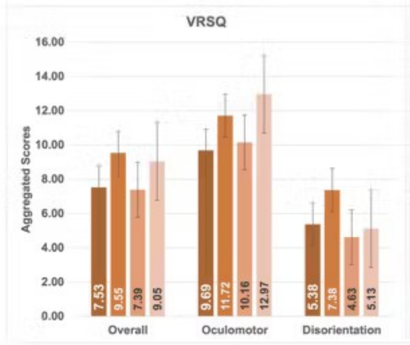


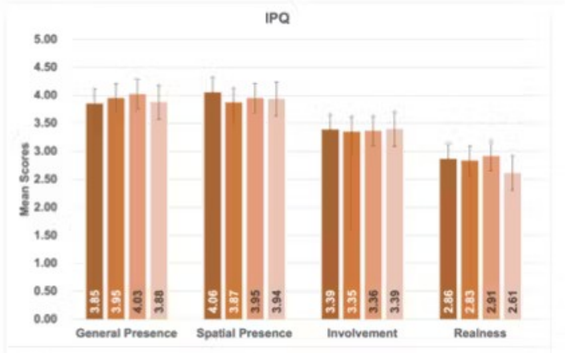
Data Collection Appropriate for Experiential Goals

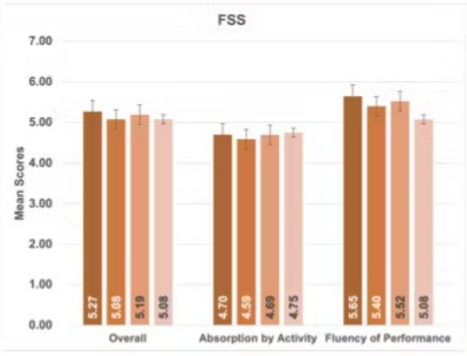


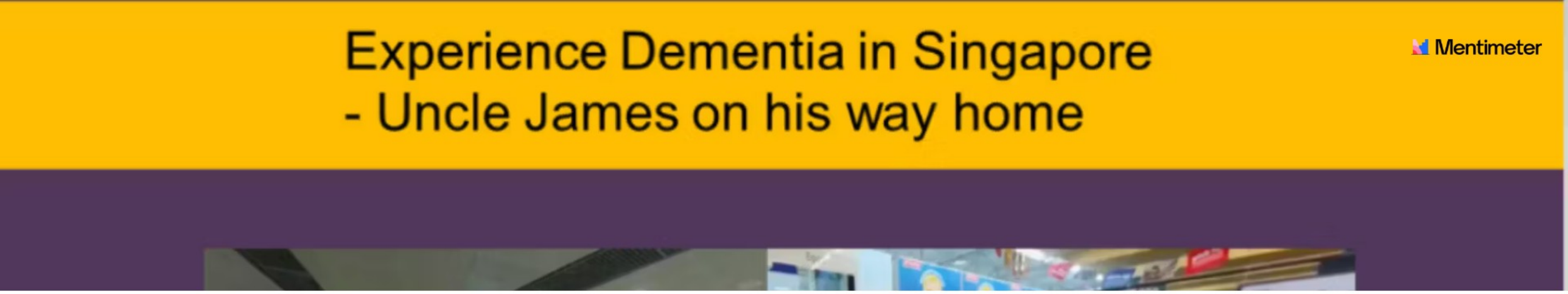
Analysing Data to Form Conclusions

		CONTEXTUAL CODES					
		HEAD-BOB	ARM-SWING	LEG-LIFT	FULL-BODY	GENERAL	Total across CONTEXTs
Minimal cybersickness with WIP exertion	FATIGUING	8	0	7	7	5	27
	EFFORTLESS	5	8	1	0	1	15
	CYBERSICKNESS	2	7	0	2	1	12
Leg-lift method facilitated most positive experiences	**POSITIVE-LOCOMOTION**	**6**	**7**	**25**	**1**	**6**	**45**
	NATURAL	4	4	18	1	0	27
	PRESENCE	2	1	6	0	5	14
	EASY-TO-FOCUS	0	2	1	0	1	4
	NEGATIVE-LOCOMOTION	**25**	**23**	**13**	**27**	**21**	**109**
	UNNATURAL	11	14	4	14	3	46
	UNSURE-HOW-TO-LOCOMOTE	6	7	8	6	8	35
	HARD-TO-FOCUS	7	1	0	2	1	11
	DISCOMFORT-EQUIPMENT	0	1	0	1	5	7
	CONSTRAINED-BY-TRACKERS	1		0	3	3	7
	CONSCIOUS-OF-APPEARANCE	0	0	1	1	1	3
Varying WIP gestures afforded by tracker positions	AWKWARD-WIP-TECHNIQUE	7	13	5	7	1	33
	ADAPTED-WIP-TECHNIQUE	7	7	5	7	2	28
	AFFORDED-BY-TRACKERS	3	8	5	2	1	19
Perception of control was important for WIP	LACK-SPEED-CONTROL	14	10	17	19	8	68
	LACK-DIRECTION-CONTROL	5	9	10	8	2	34
	LACK-MOMENTUM	1	1	2	4	5	13
Walking-"not"-in-place affects immersion	SPACE-CONSTRAINED	3	4	7	4	5	23
	REQUIRE-SPATIAL-AWARENESS	3	4	2	4	8	21
	UNSAFE	0	0	2	2	7	11
	DISEMBODIMENT	1	0	1	2	2	6
Visual qualities affect WIP motivations	UI-GUIDANCE-WORKS-WELL	0	0	0	0	27	27
	UI-GUIDANCE-CONSTRAINED-EXPLORATION	0	0	0	0	22	22
	INCLINED-TO-EXPLORE	3	2	0	1	15	21
	LACK-OF-MOTIVATION-TO-MOVE	0	0	0	0	8	8
	DESIRE-FOR-MORE-ASSETS	**0**	**0**	**0**	**0**	**45**	**45**
	DESIRE-FOR-MORE-REALISTIC-ASSETS	0	0	0	0	21	21
	DESIRE-FOR-ANIMATED-ASSETS	0	0	0	0	15	15
	DESIRE-FOR-SOUNDS	0	0	0	0	9	9









Experience Dementia

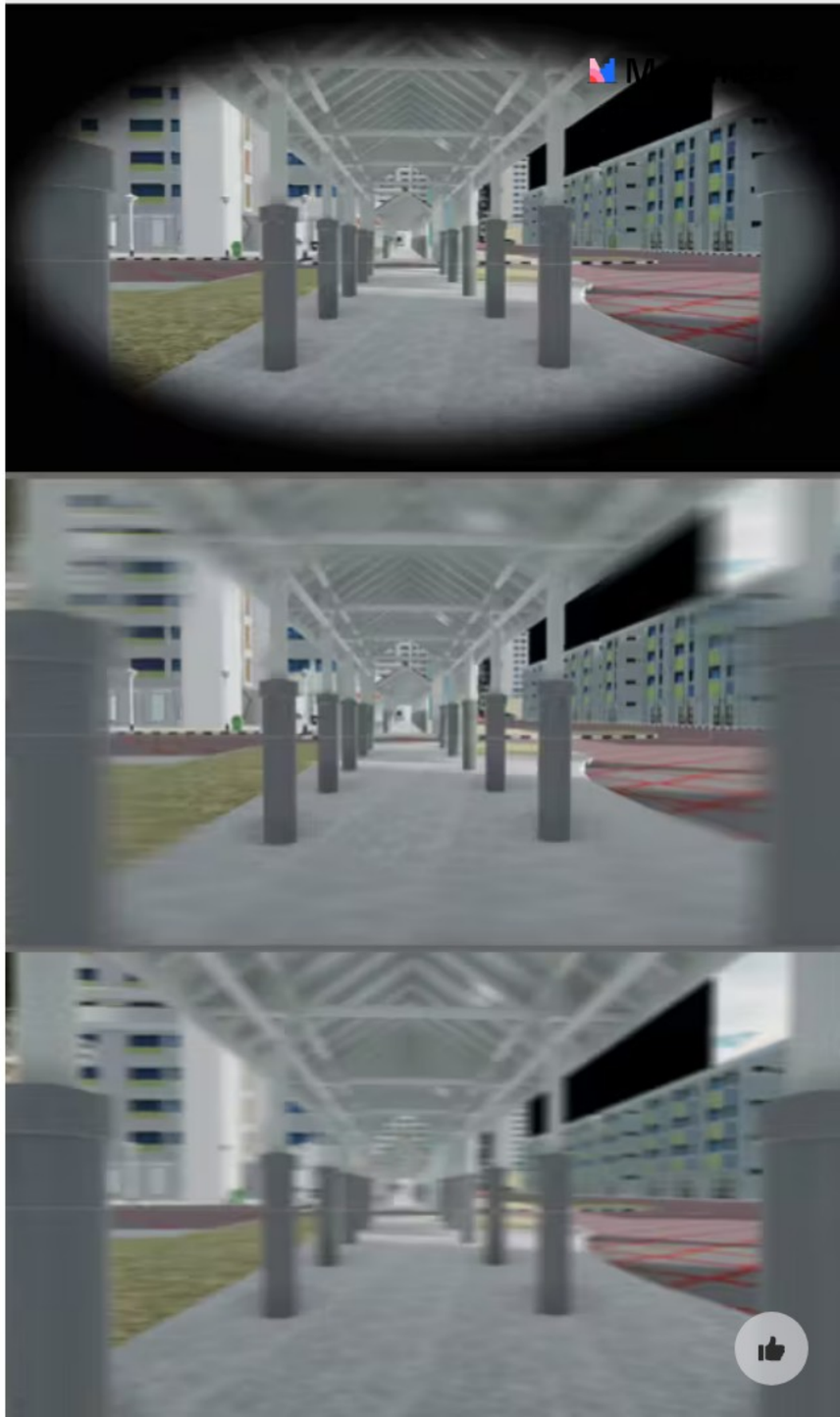
Design ➟ Implementation

improved immersion in VR over Desktop [PRESENCE]

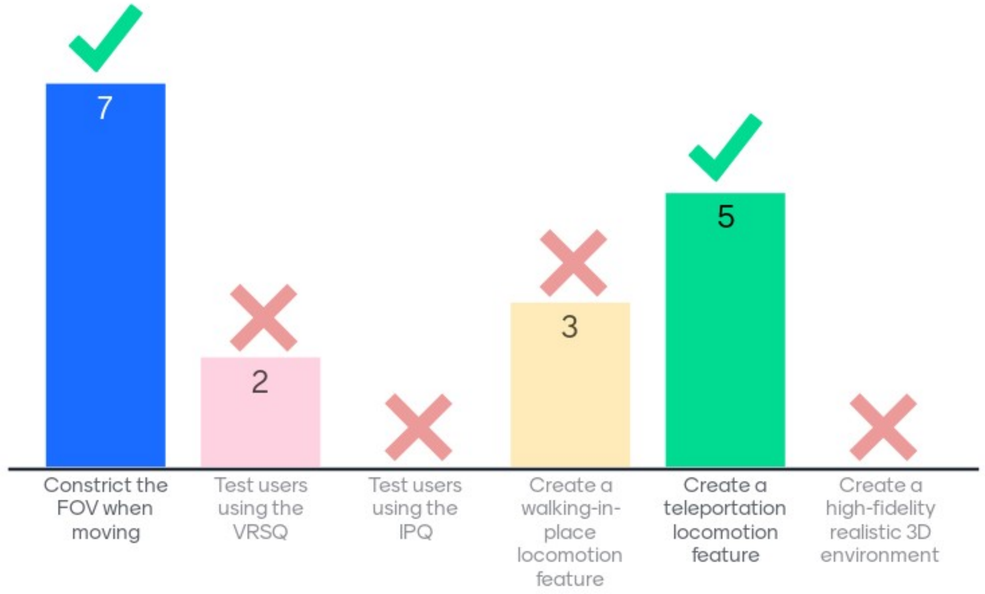
provide the most essential VR interaction mechanic - viewpoint control

Cybersickness

- We prototyped various ways to mitigate it...
- How the Presence and Size of Static Peripheral Blur Affects Cybersickness in Virtual Reality (Lin et. al. 2020)
- Narrative and gaming experience interact to affect presence and cybersickness in virtual reality (Weech et al. 2020)

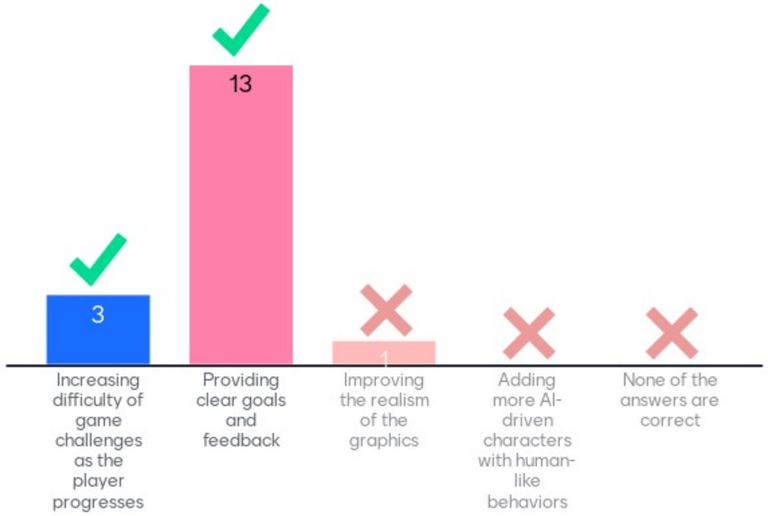


Which of the following implementations will this design translate into?



Mentimeter

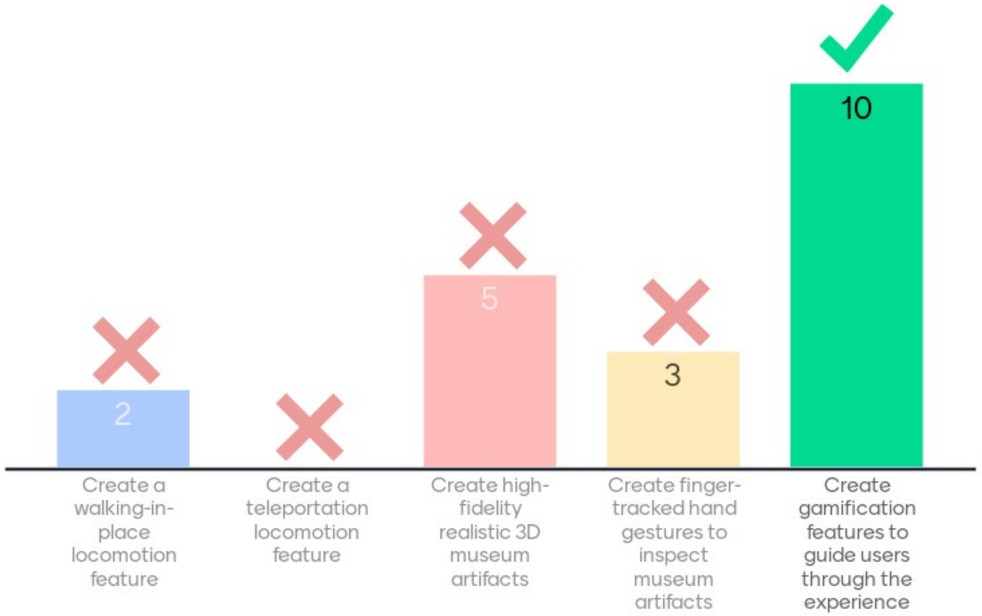
Which of the following element(s) enhances the experience of flow in a VR game?



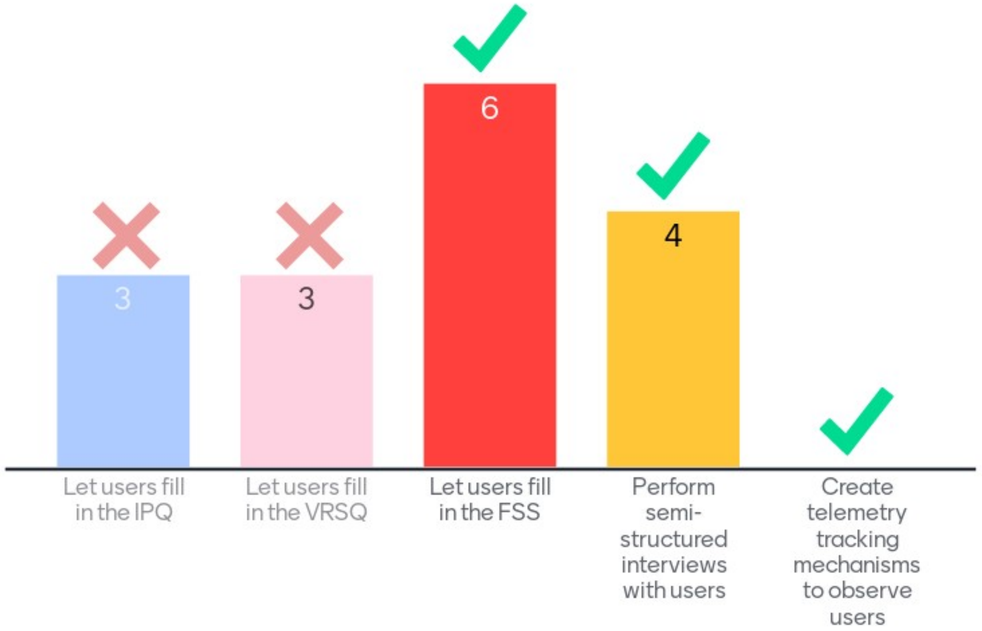
In our VR campus exploration game for the next release, a key focus is to reduce cybersickness. Which is/are suitable implementation approaches?

Mentimeter

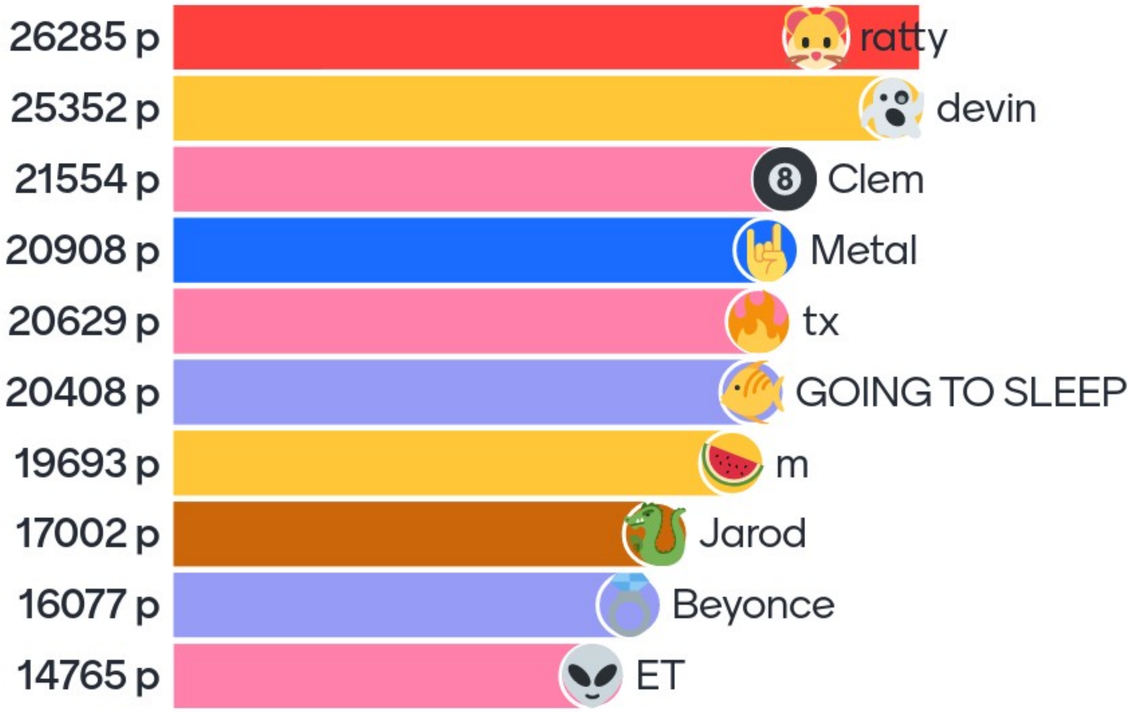
Which of the following implementations will this design translate into?



What data collection methods can be appropriate here?



Leaderboard



Ask me anything

8 questions
1 upvote