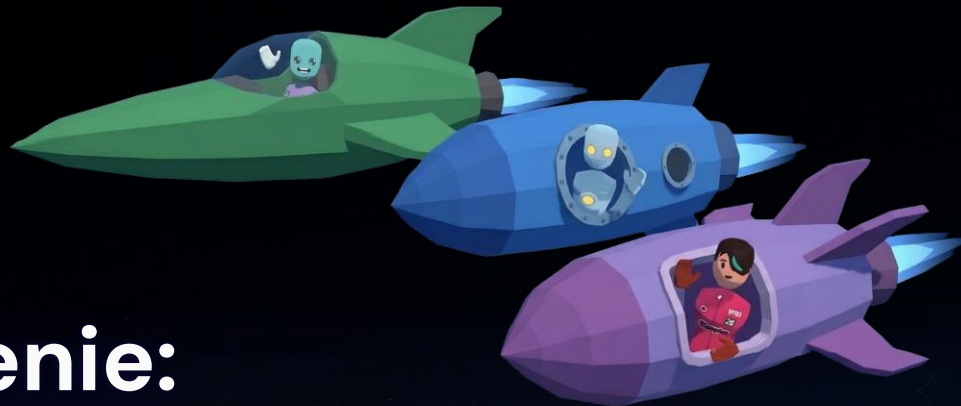


2026
IEEE VR
DAEGU, KOREA
MARCH 21-25, 2026



Ubiq and Ubiq-Genie: Integrating Generative AI into Social eXtended Reality



The 33rd IEEE Conference on Virtual Reality and 3D User Interfaces



IEEE



IEEE
COMPUTER
SOCIETY

IEEE
vgtc

Presenters

Prof Anthony Steed (Head of VECG Group, UCL)

Dr Nels Numan (former PhD Student, UCL)

Jingyi Zhang (PhD Student, UCL)

Ruijun (Phoenix) Sun (PhD Student, UCL)

Dr Daniele Giunchi (University of Birmingham)

Schedule

20 Minutes – General Overview of Social XR & Generative AI

30 Minutes – Overview of Ubiq

35 Minutes – Overview of Ubiq-Genie

5 Minutes – Q&A

ubiq.online

github.com/UCL-VR/ubiq

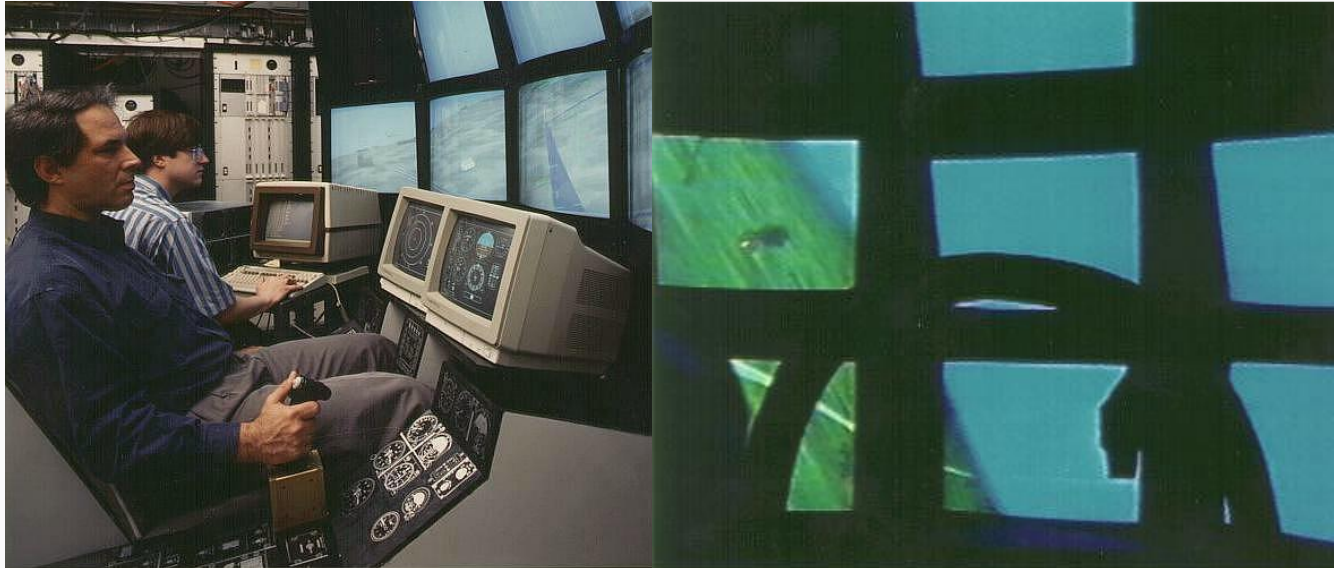
ubiq@cs.ucl.ac.uk

Overview of Social VR Platforms & Generative AI

As Hiro approaches the Street, he sees two young couples, probably using their parents' computers for a double date in the Metaverse, climbing down out of Port Zero, which is the local port of entry and monorail stop. He is not seeing real people, of course. This is all a part of the moving illustration drawn by his computer according to specifications coming down the fiber-optic cable. The people are pieces of software called avatars

— Neal Stephenson, *Snow Crash*,
1992

SIMNET

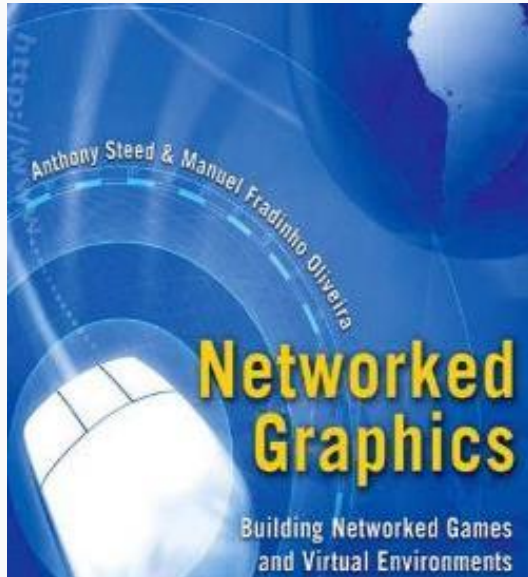


SIMNET aircraft simulation. Left: A view of the simulator control. Right: a view from the cockpit of an aircraft simulator. Images from (Harris, 1994)

DIVE (est. 1992, demo circa 1999)



Precedents



MUDs & MOOs

Habitat

SIMNET

Alphaworld / ActiveWorlds

Doom, Quake

Blaxxun (VRML)

SecondLife

High Level Features

Awareness

- Primary awareness: real-time social VR
- Secondary awareness: access as a group to a large space
- Tertiary awareness: access to a “universe” of people and places

Editing capabilities

Publishing and governance

Ownership rules

Research Questions

What should users look like?

How should we build the software?

How do we deal with latency?

What controls do the users want?

How will users move between different software?

How do we control access and rights?

How to integrate generative AI?



Social Virtual Reality Platform Comparison and Evaluation Using a Guided Group Walkthrough Method

Qiaoxi Liu¹ and Anthony Steed^{2*}

¹UCL Interaction Centre, University College London, London, United Kingdom, ²Department of Computer Science, University College London, London, United Kingdom

As virtual reality (VR) headsets become more commercially accessible, a range of social platforms have been developed that exploit the immersive nature of these systems. There is a growing interest in using these platforms in social and work contexts, but relatively little work into examining the usability choices that have been made. We developed a usability inspection method based on cognitive walkthrough that we call *guided group walkthrough*. Guided group walkthrough is applied to existing social VR platforms by having a guide walk the participants through a series of abstract social tasks that are common across the platforms. Using this method we compared six social VR platforms for the Oculus Quest. After constructing an appropriate task hierarchy and walkthrough question structure for social VR, we ran several groups of participants through the walkthrough process. We undercover usability challenges that are common across the platforms, identify specific design considerations and comment on the utility of the walkthrough method in this situation.

Keywords: collaborative virtual environment, cognitive walkthrough, usability inspection methods, consumer virtual reality, social virtual reality

OPEN ACCESS

Edited by:

Nadia Magnenat Thalmann,
Université De Genève, Switzerland

Reviewed by:

Aryabrata Basu,
Emory University, United States
Mark Billinghurst,

- Compared six platforms: Rec Room, AltSpace, VRChat, Big Screen, Spatial, Mozilla Hubs
- Pairs and groups doing joint tasks



Routes to Exploration

Can work with commercial platforms

- Hard to make the exact scenario you want
- Risk of (fast) code rot
- Risk to services
- Privacy concerns
- Walled gardens

WebXR can provide some necessary features

- Currently difficult to extend
- Relatively limited architectural choices

Generative AI



meshy.ai



marble.worldlabs.ai
(+ubiq!)

Generative AI is expensive

- Boundary between local and online models does move (c.f. PersonPlex)
- Typically, either run the model in every client, or every client calls an asynchronous API
- Ideally want to be agnostic to the number of users (i.e share the service between users)
- Want to use local models on best in class (local) GPUs (i.e. recruit capacity in distributed manner)

Hence Ubiq

Amongst other things ...

- Want to allow exploration of issues at all levels (networking through to management)
- Complete system, no external services necessary
- Support niche use cases
- Useful for teaching (uses Unity, lots of example)
- Support experimentation (examples)
- Open source (Ubiq is open source under Apache License: deploy as you wish, GDPR compliance, etc.)
- Broad client support (OpenXR, Quest, WebXR, desktop&phone, etc.)
- Supporting generative AI through distributed systems (client agnostic)

Research

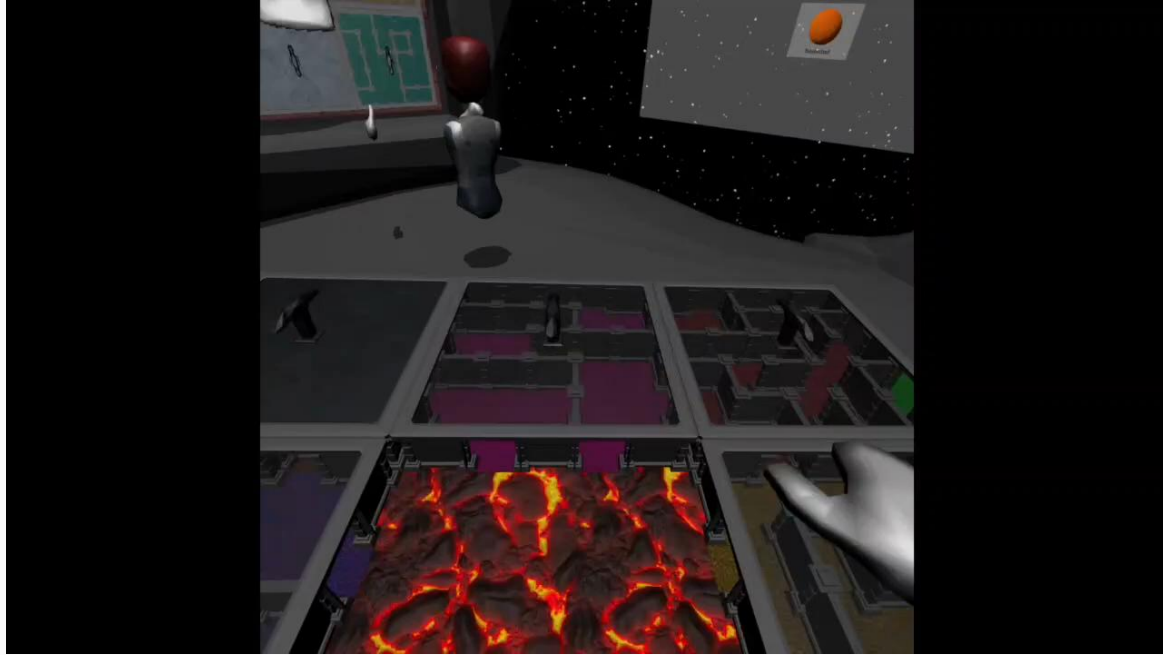
Demo
AR-VR-Desktop

Overview



Nels Numan

Teaching



Alex Greenen, Oliver Kingshott, Sara Caballero–Bruno **UCL** 

ubiq.online

github.com/UCL-VR/ubiq

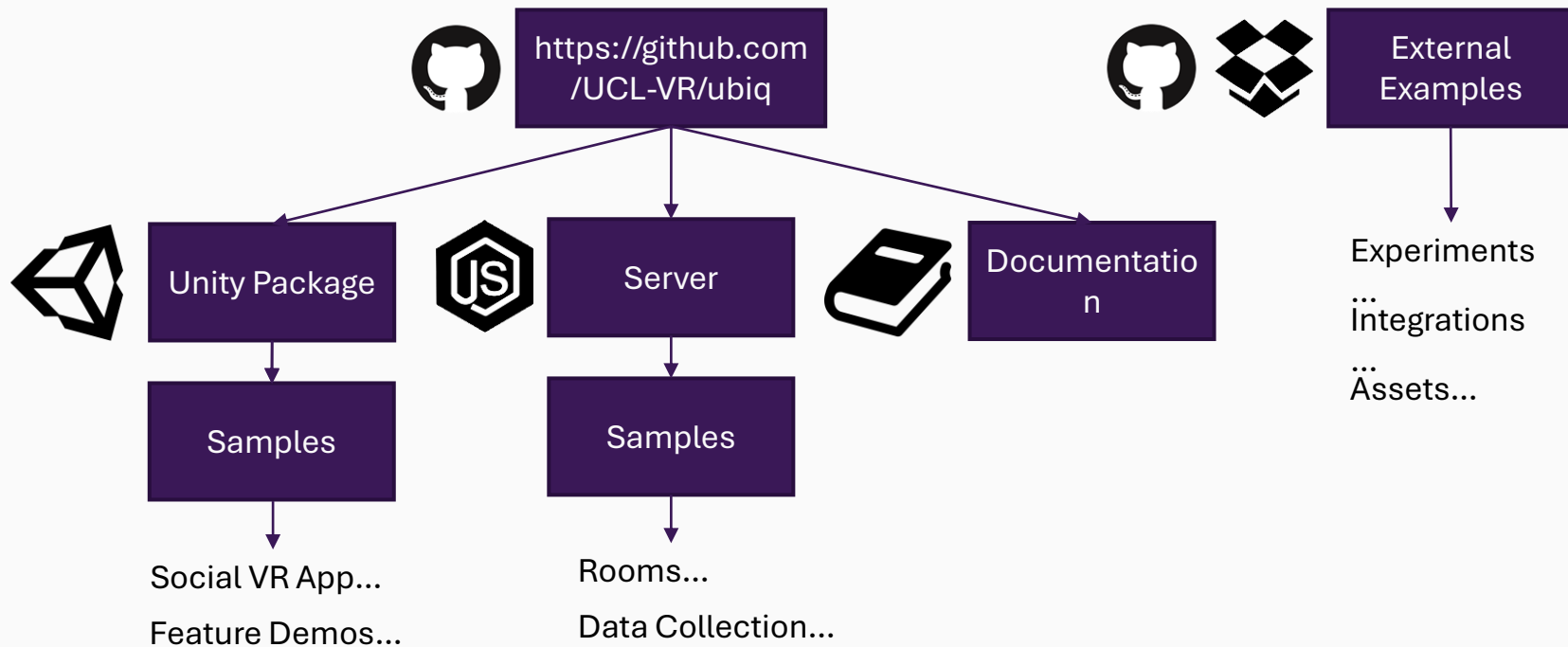
ubiq@cs.ucl.ac.uk

Overview of Ubiq

Let's try it out!

- (Conference Wifi permitting!)
- Web address: nexus.cs.ucl.ac.uk
- Cross compatible with built applications and with WebXR

Ubiq



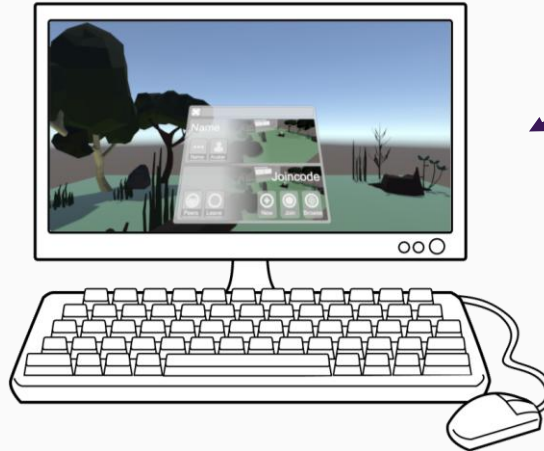
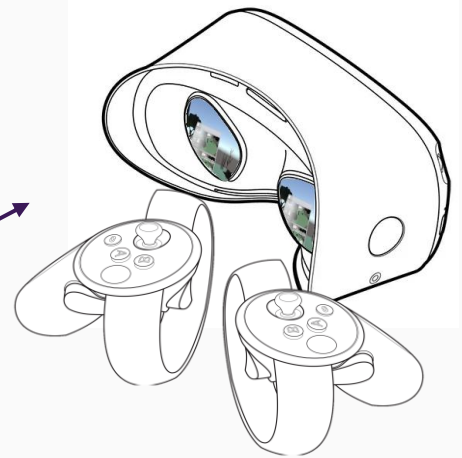
Ubiq Supported Platforms

Web (Desktop/Mobile/VR + WebXR)

Standalone VR (Quest/Pico)

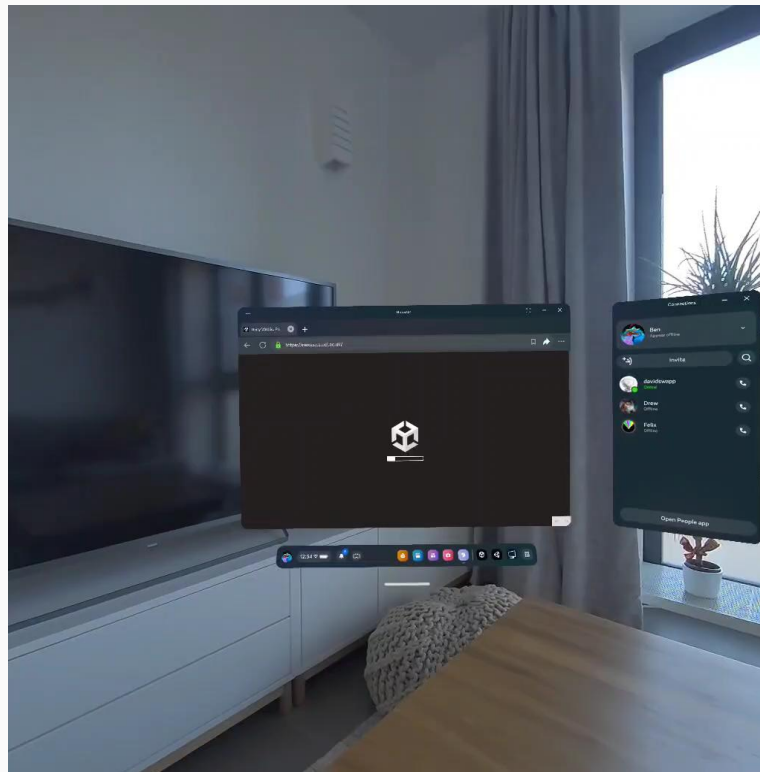
Desktop (Win/Mac/Linux)

Mobile (Android/iOS)



Why WebXR?

- Cross-platform without building multiple applications and without installation
- For researchers, deploy to participant headsets without needing developer permissions
- Can reach otherwise difficult platforms like the Vision Pro



Ubiq Features

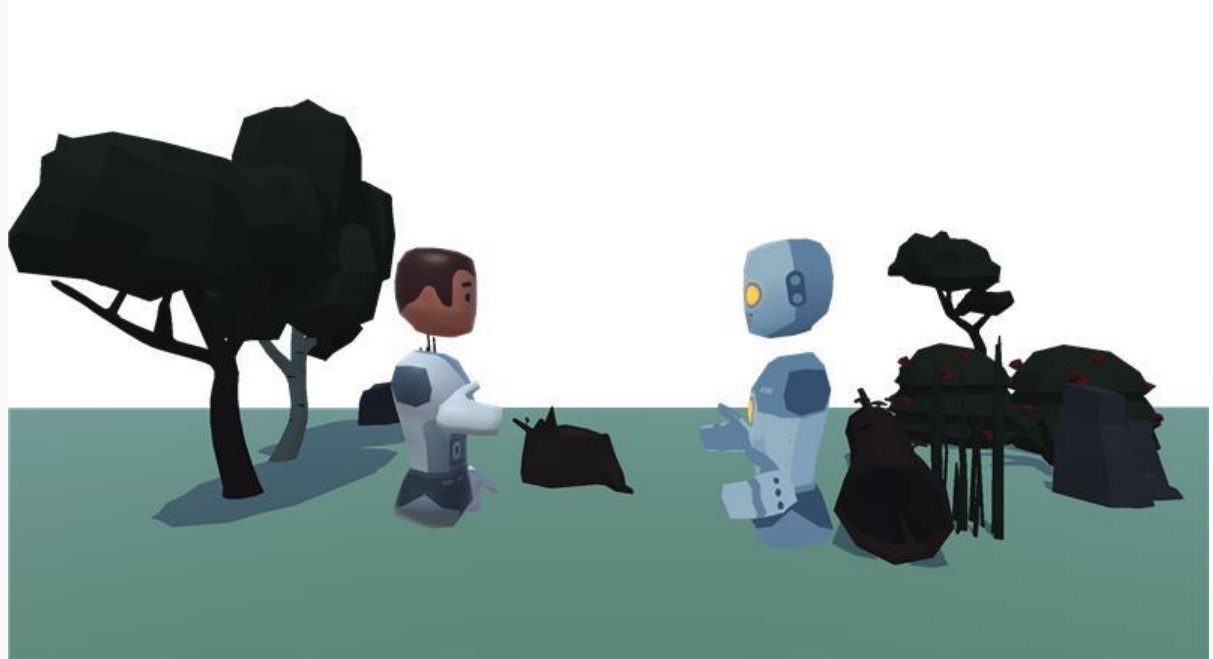
Avatar System

VOIP

Private/Public Rooms

Distributed Logging

Network Spawning

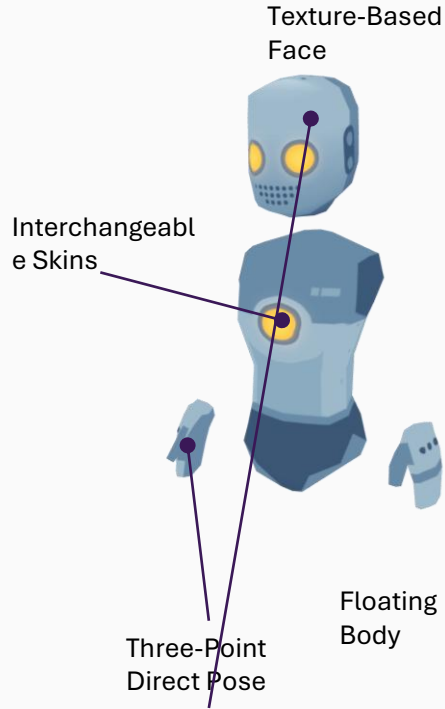
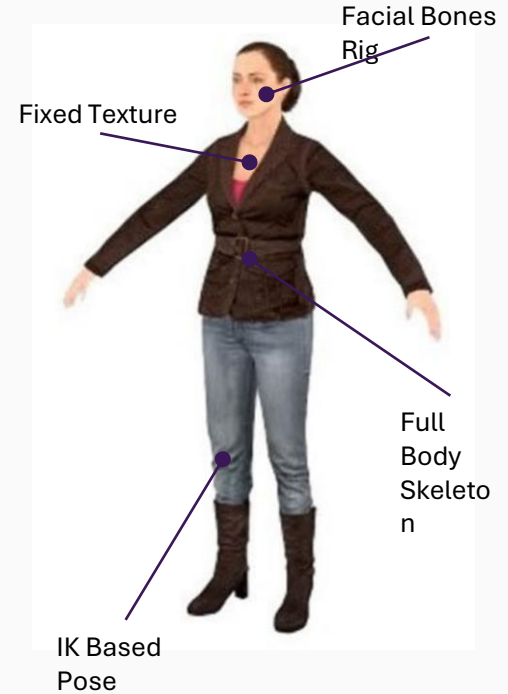


Features: Avatar System

Avatar Control

Avatar Spawning

Avatar Networking



Features: VOIP

Peer-to-Peer over WebRTC

Cross-platform

Benefits from WebRTC features:

- End-to-End encryption
- Supports modern codecs (e.g. Opus)
- Built into browsers

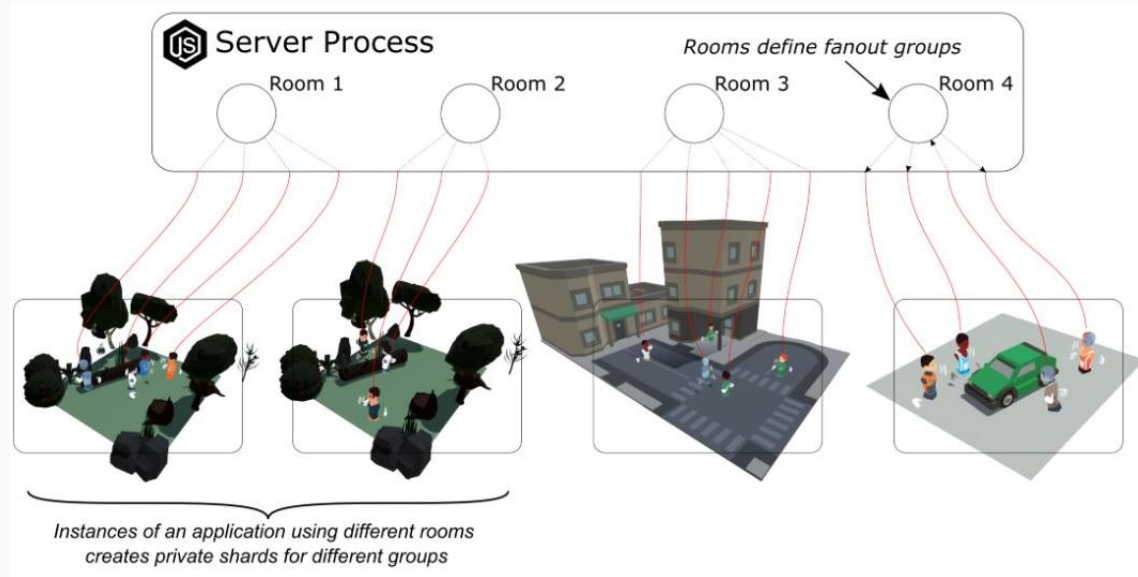


Features: Rooms System

One server manages many rooms

Server/room architecture helps to resolve race conditions and rendezvous

Supports joining by GUID and by human readable 'joincode'

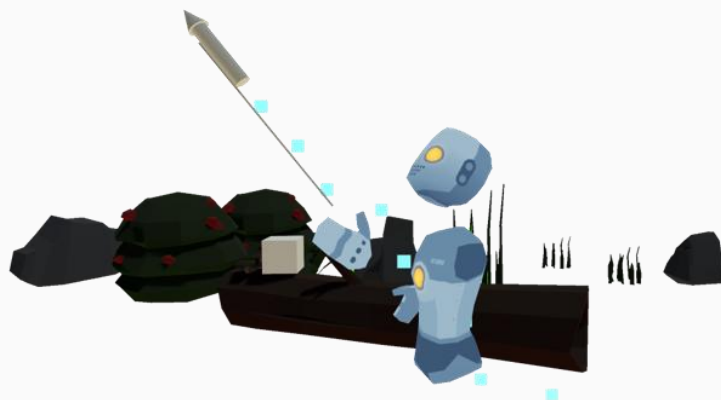


Features: Distributed Logging

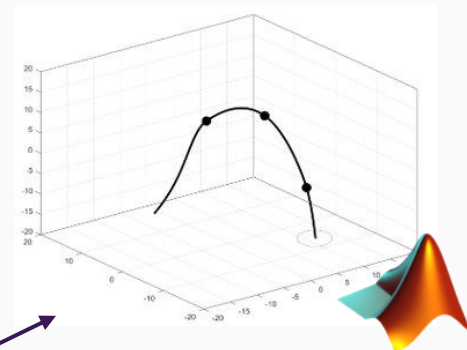
Logs will persist until consumed by a peer

Can be structured for analysis (in e.g., Matlab)

Zero-allocation in Unity

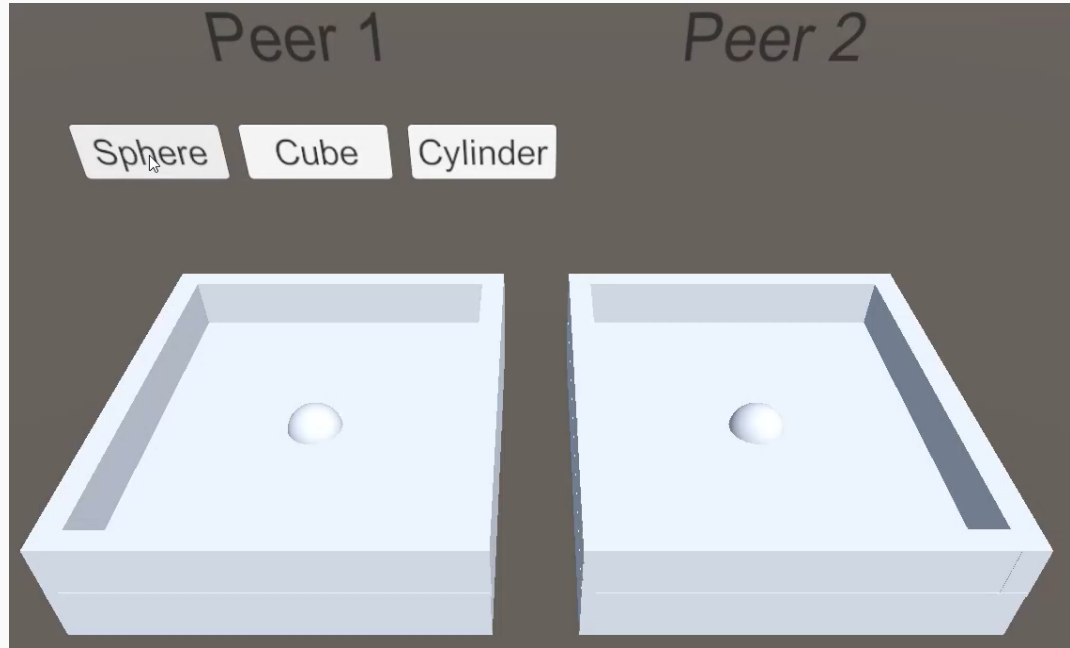


```
LogEmitter::Log(Position)
```



Features: Network Spawning

- 'Scoped' spawning
- Objects can belong to a Peer or the Room, and will be cleaned up when that Peer or Room leave 'scope'

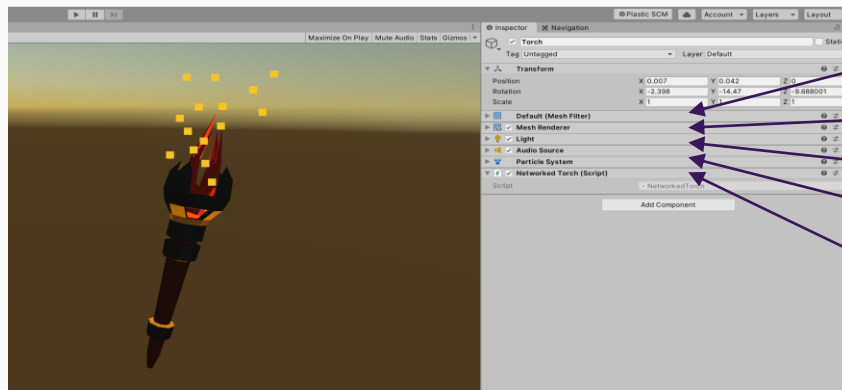


Learning Resources

- Demo scene – Fully featured social VR example
 - In Unity package samples:
Ubiq/Samples/Demo (XRI)
- Examples – Live documentation
 - In Unity package samples:
Ubiq/Samples/Examples
- Docs – Online documentation
 - <https://ucl-vr.github.io/ubiq/>

Ubiquitous Networking Primitives

- Can be used to extend Ubiquitous's functionality
- Three kinds of primitives:
 - Messaging
 - Properties
 - Blobs



Static Mesh Rendering

Lighting

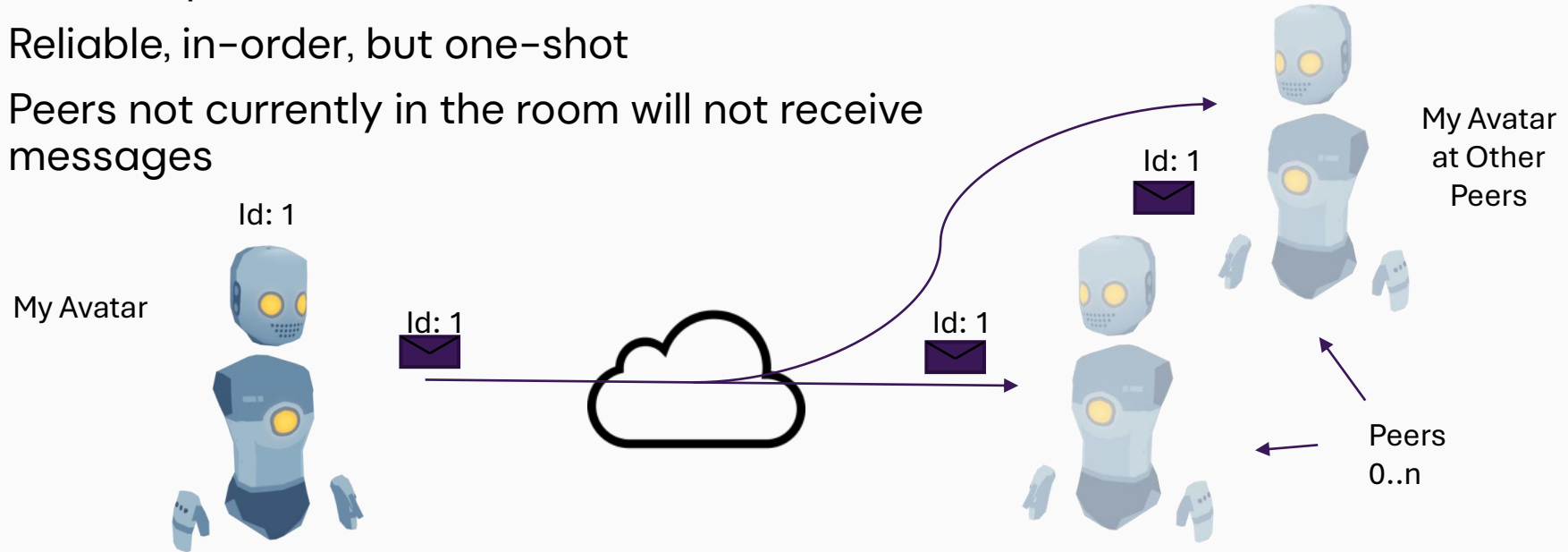
Sound Effects

Fire Effects

Network Behaviour

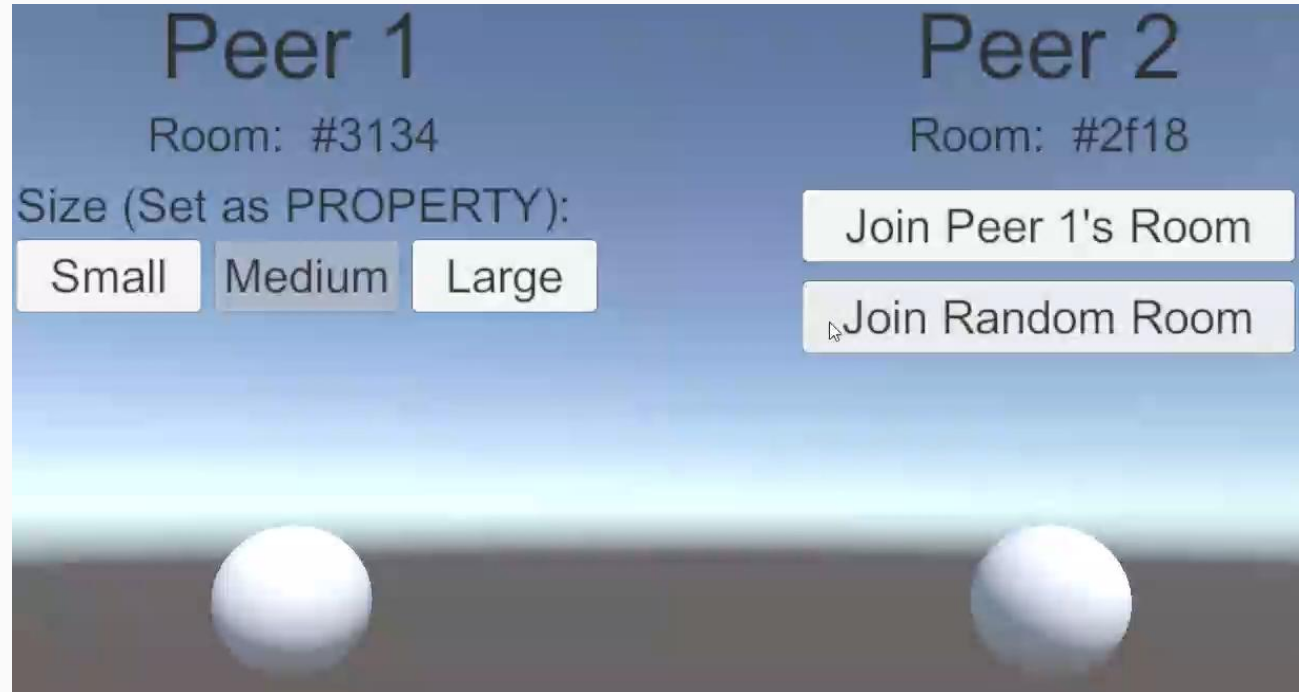
Networking Primitives: Messaging

- Will be multicast to all objects with the same ID on other peers
- Reliable, in-order, but one-shot
- Peers not currently in the room will not receive messages



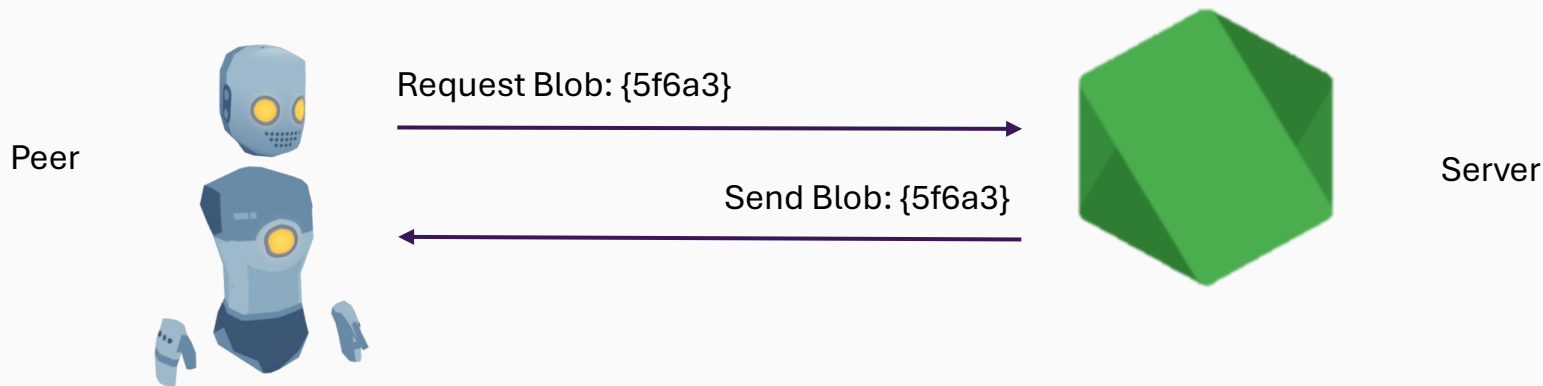
Networking Primitives: Properties

- Synced dictionaries, one per Peer, one for the Room
- Server handles collisions
- Late joining peers will receive previously set properties



Networking Primitives: Blobs

- Stored in the server and available on-request
- Not automatically synced
- Intended for large or infrequently used data



How Do I... Use Different Avatars?

- But how do you get Ubiq-compatible avatar prefabs?
- We include prefabs for Rocketbox and ReadyPlayerMe avatars
- For others, build custom prefabs using Ubiq's Avatar Input system
- Example: Meta Avatars by Klara Brandstaetter (see new paper in conference!)



Roadmap

Recently completed:

- Full WebXR support for all features
- Out of the box support/sync for hand tracking
- UPM packaging

Goals for this year:

- Fully integrate experimental Motion-Matching based XR animation
- Documentation overhaul
- Lightweight room/data persistence
- Browser-based server admin

Summary

Ubiq is a Unity **package**, concerned with the **social** and **networking** aspects of **distributed XR** applications.

It is a **message passing** library, with **samples** that implement a fully-functional **social VR platform**.

It targets use cases **excluded** by common **monetisation methods**.

It is meant to be used by **developers** to **easily** build **niche** social XR applications...

... primarily for **research** and **teaching**.

Ubiq Paper at IEEEVR 2026

Supporting Bi-Directional Collaboration with Unmodified Immersive Applications Using AccompliceVR

Ruijun Sun and Anthony Steed

University College London

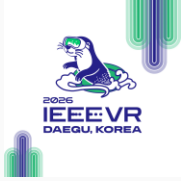
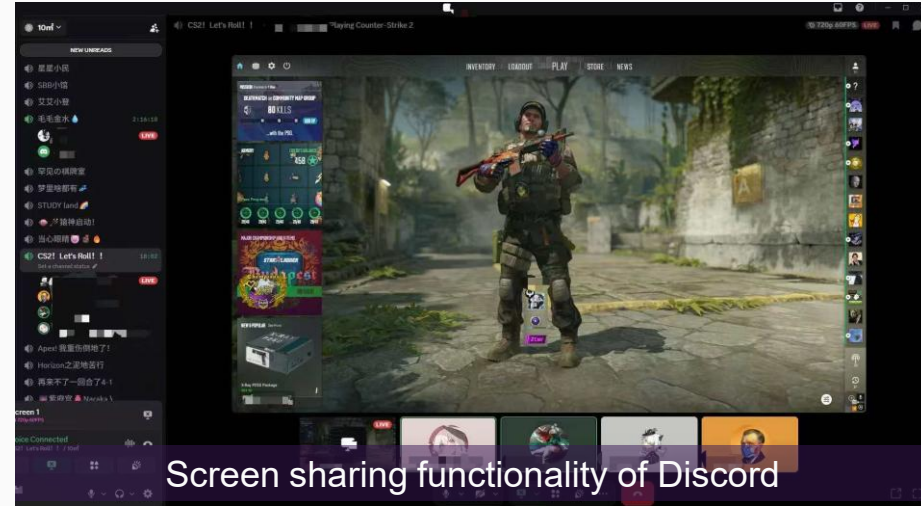
Paper for TVCG Special
Issue



Motivation

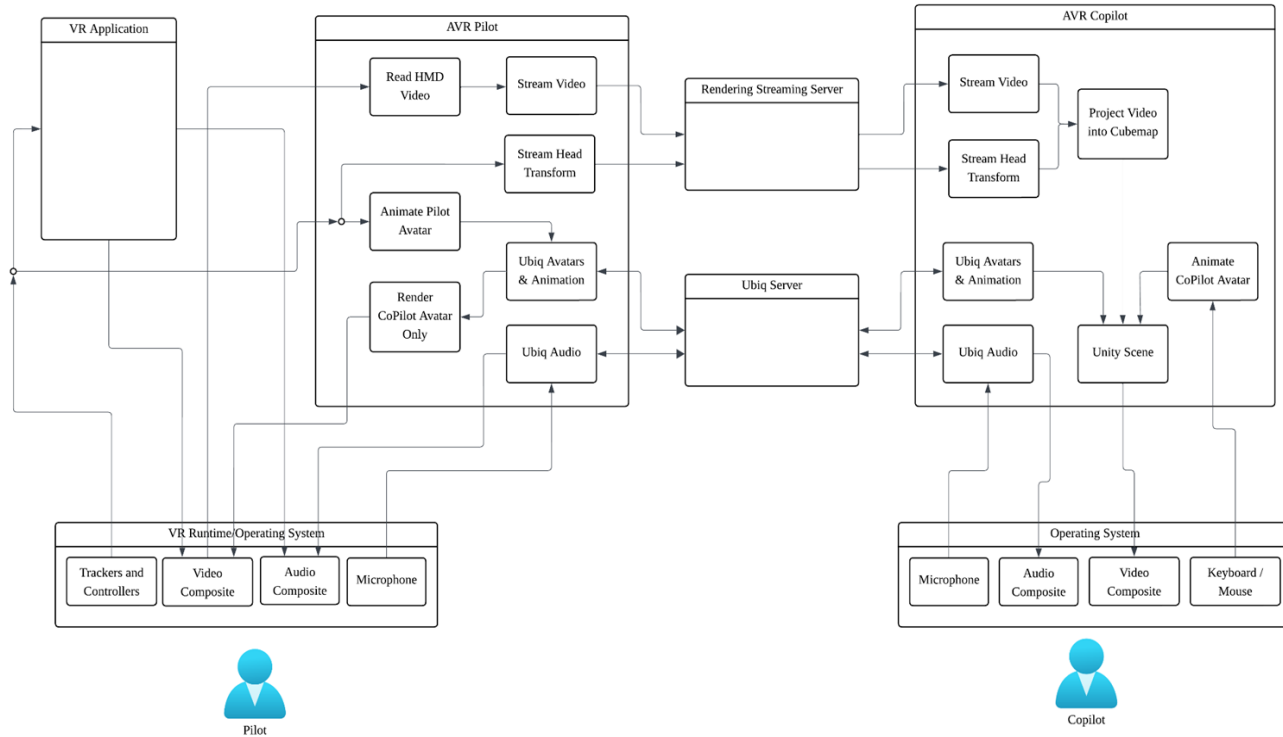
Bidirectional Collaboration – Non-VR spectators can have agency to explore, VR player can better understand assistance from remote spectators

Unmodified Application – System should work with existing applications without violations of policies or illegal engineering of source codes

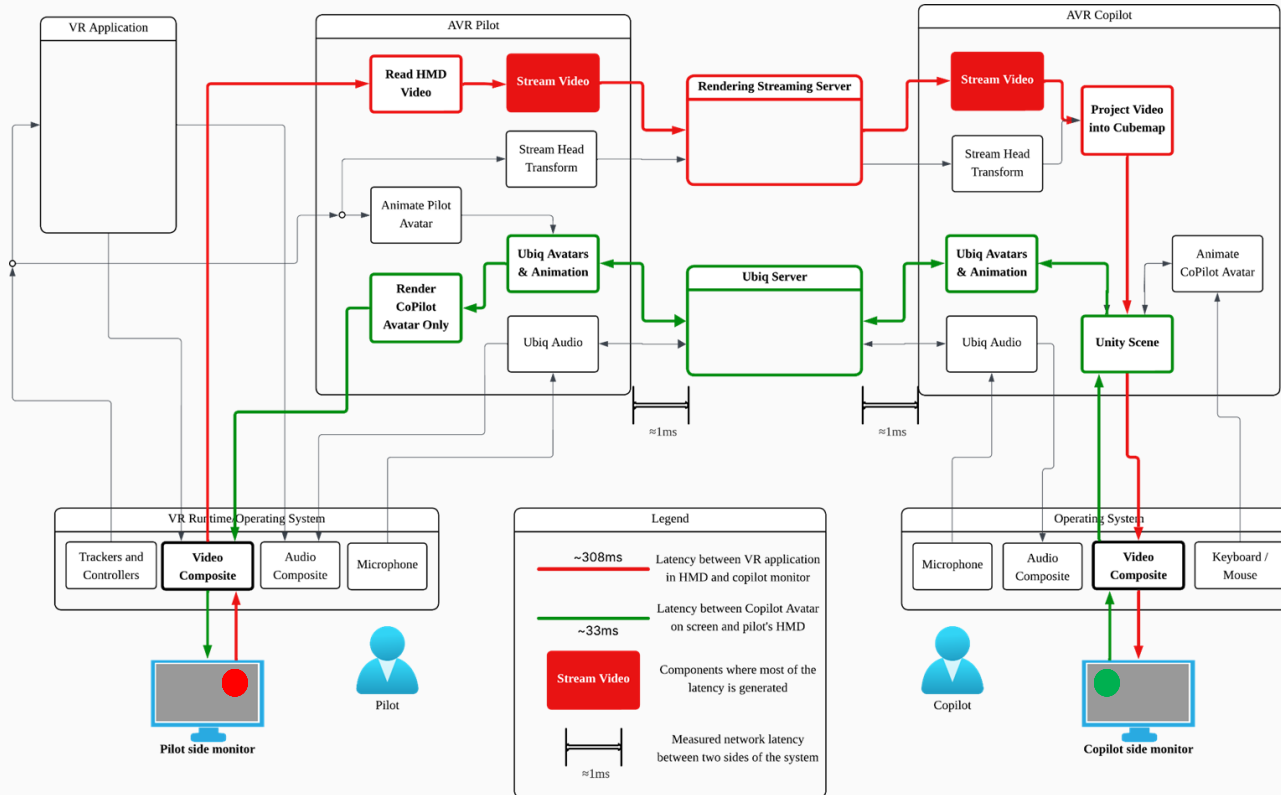




System Architecture



System Specification



- Compatibility tested with 10+ applications
- Rendering latency around 300ms, avatar interaction latency around 30ms
- Rendering burden of the system is negligible upon testing (~3 fps drop for SkyrimVR and ~1 fps for Job Simulator)

Pilot Side Design



Avatar projected as overlaying artefact

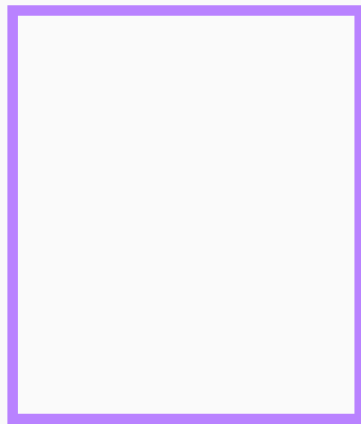


Pilot's view recorded from SteamVR

Copilot Side Design



Reconstructed panorama



Frame projection and removal



Want to learn more about AVR?



Paper title: Supporting Bi-Directional Collaboration with Unmodified Immersive Applications Using AccompliceVR

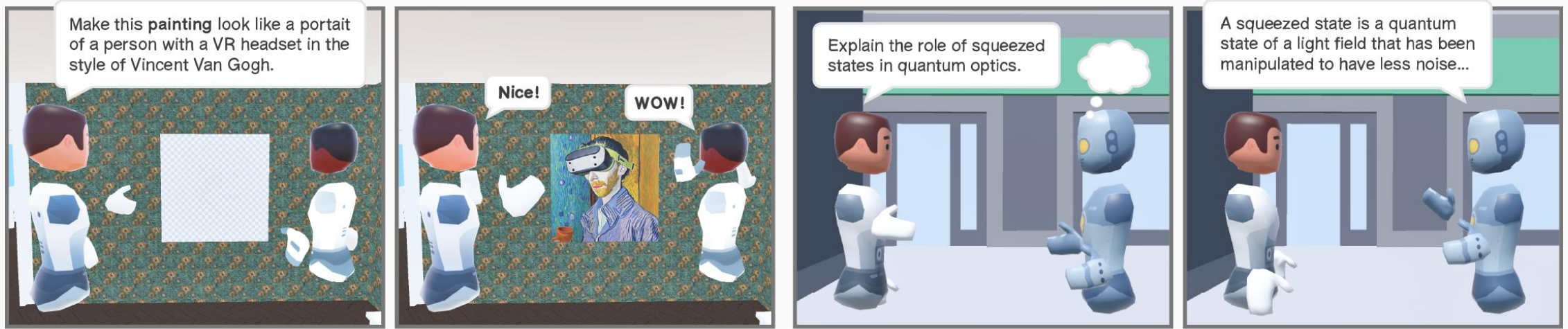
- Time: 2 p.m. to 3 p.m. Tuesday, March 24th
- Location: Room 323 (Paper session 25)
- Contact emails: phoenix.sun.20@ucl.ac.uk
a.steed@ucl.ac.uk
- Source code of the project available at:
github.com/PhoenixSun17/AccompliceVR

Overview of Ubiq-Genie

How do we build *collaborative* XR+AI systems that are not bottlenecked by today's AI ecosystem:

- 1 Compute-heavy models unsuitable for on-device XR use
- 2 Python-centric AI tooling misaligned with XR runtimes
- 3 Fragmented APIs across cloud and open-source frameworks
- 4 Limited support for multi-user AI applications
- 5 Monolithic pipelines that hinder modularity and iteration

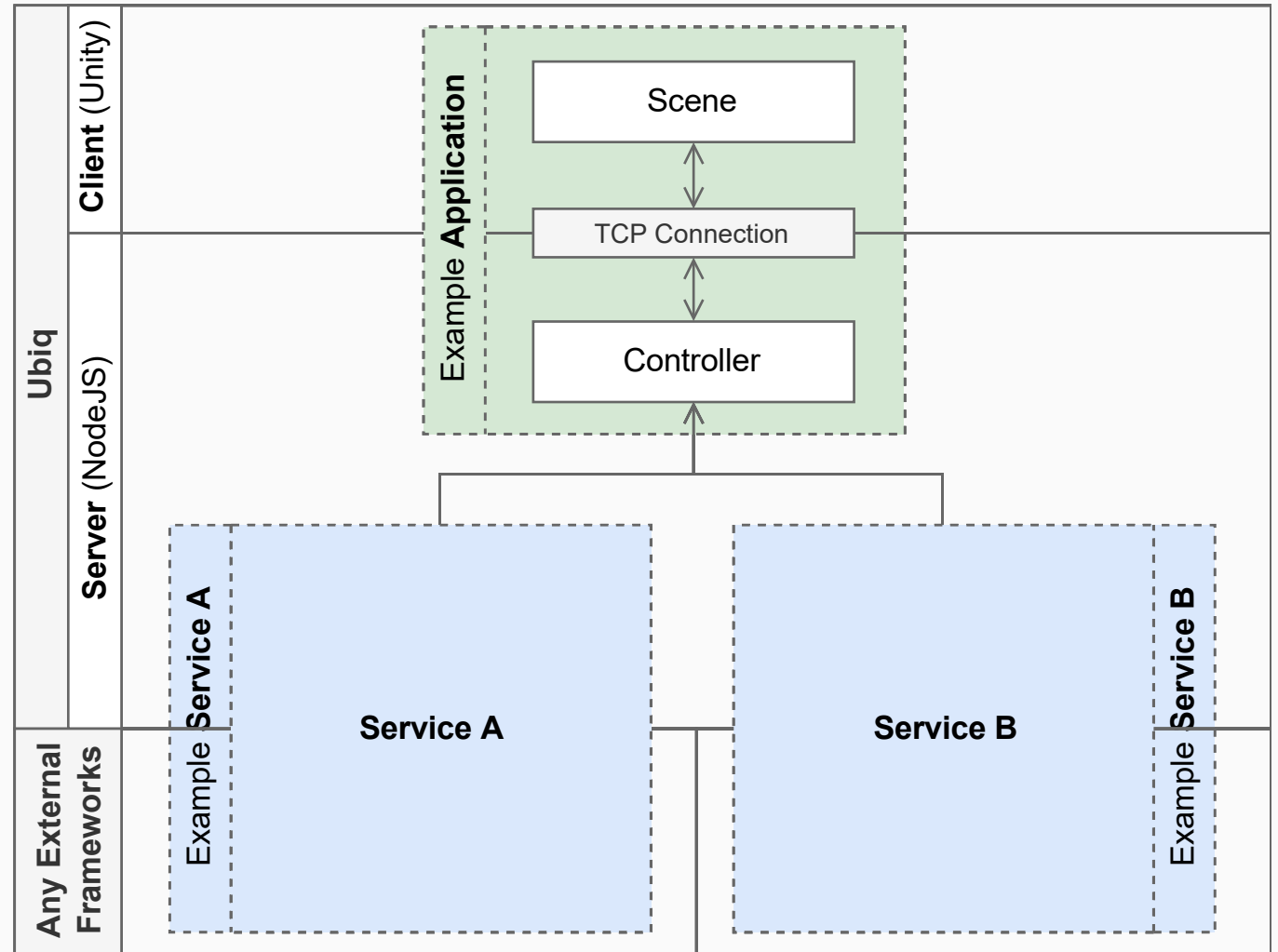
Ubiq-Genie



- Extension of **Ubiq** to integrate *generative AI* with *social XR* experiences
 - Provides a *server-client structure* to handle compute-heavy processes
 - Unifies *heterogeneous* AI services behind common interfaces
 - Supports real-time multi-user interaction (user-specific data, WebRTC audio/video streams)
 - Enables modular AI pipelines written in any language

Architecture

- **Applications** communicate with one or more **services**
- Each service is responsible for a specific functionality (e.g., *speech-to-text*)
 - Each service has one or more possible providers
- Child processes may be implemented in any language (e.g., Python, Java, C++) and communicate over stdio



Services



Speech-to-text



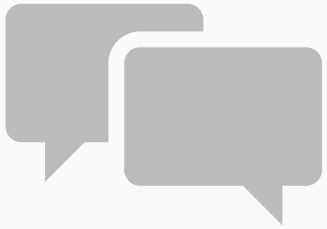
Text-to-speech



Text-to-image



Visual question
answering (VLM)



Text-to-text
(LLM)



Voice cloning
(text-to-speech)

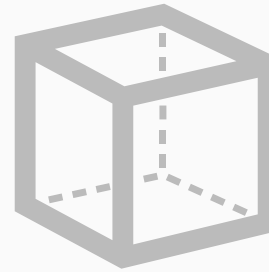


Image-to-3D



Audio-to-audio

Running Local AI Models

Work

www.canirun.ai/?status=can-run

CanIRun.ai updated 2d ago

[compare] [tier list] [docs] [why]

Can I Run AI locally?

Find out which AI models your machine can actually run.

GPU Apple M3

VRAM 8 GB

BW ~100 GB/s

RAM 8 GB

CORES 10

Estimates based on browser APIs. Actual specs may vary. WebGPU

9 RUNS GREAT

7 RUNS WELL

4 DECENT

3 TIGHT FIT

5 BARELY RUNS

40 TOO HEAVY

Q Search models...

Can run (S/A/B)

All tasks

All providers

All licenses

Sort: Score

List

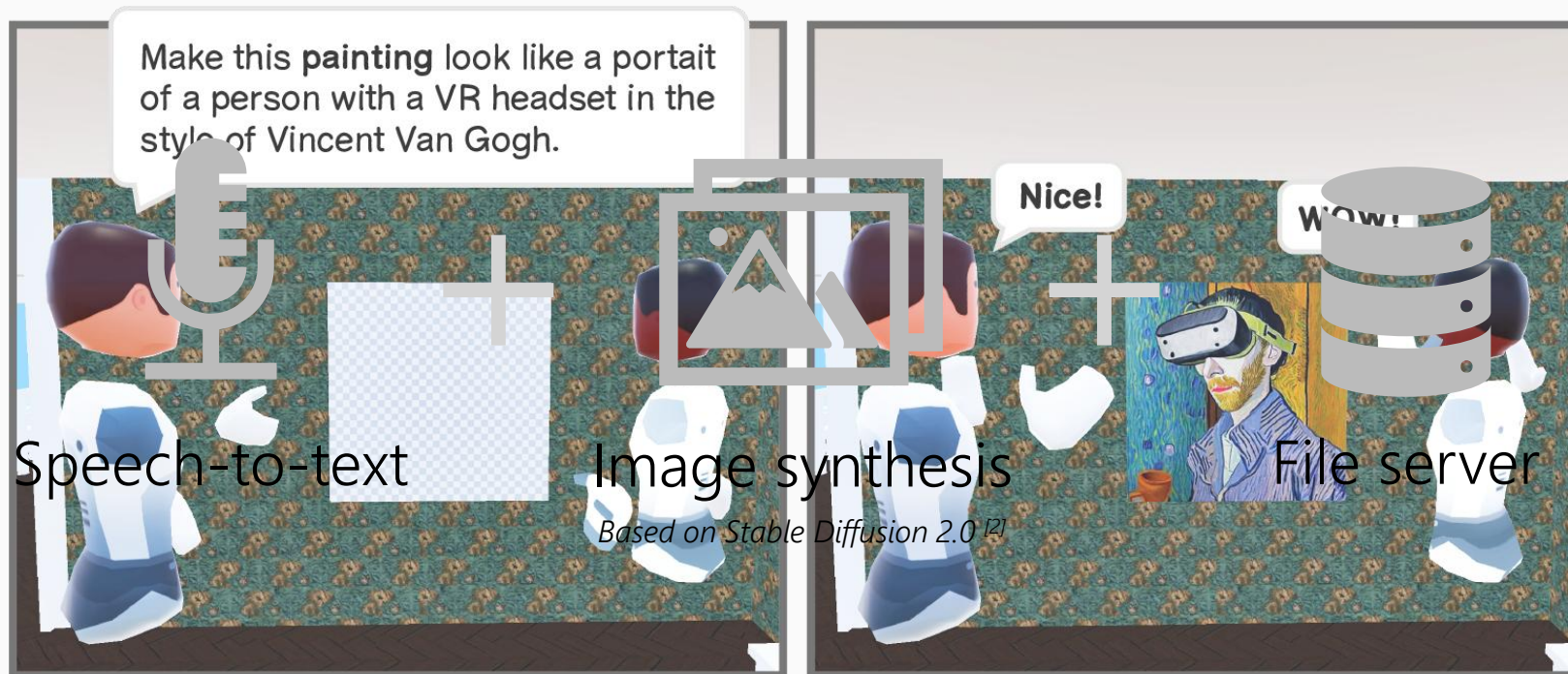
Qwen 2.5 Coder 1.5B	Apache 2.0	1 year ago	0.8 GB	10%	32K ctx	~81 tok/s	RUNS GREAT	93/100
DeepSeek R1 1.5B	MIT	1 year ago	0.8 GB	10%	64K ctx	~81 tok/s	RUNS GREAT	93/100
Qwen 3.5 0.8B	Apache 2.0	1 month ago	0.5 GB	6%	32K ctx	~130 tok/s	RUNS GREAT	92/100
Llama 3.2 1B	Llama 3.2 Community	1 year ago	0.5 GB	6%	128K ctx	~130 tok/s	RUNS GREAT	92/100
Gemma 3 1B	Gemma	1 year ago	0.5 GB	6%	32K ctx	~130 tok/s	RUNS GREAT	92/100
TinyLlama 1.1B	Apache 2.0	2y ago	0.6 GB	8%	2K ctx	~108 tok/s	RUNS GREAT	92/100
Qwen 2.5 72B	Apache 2.0	11 months ago	72.0 GB	100%	32K ctx	72 tok/s	RUNS GREAT	91/100

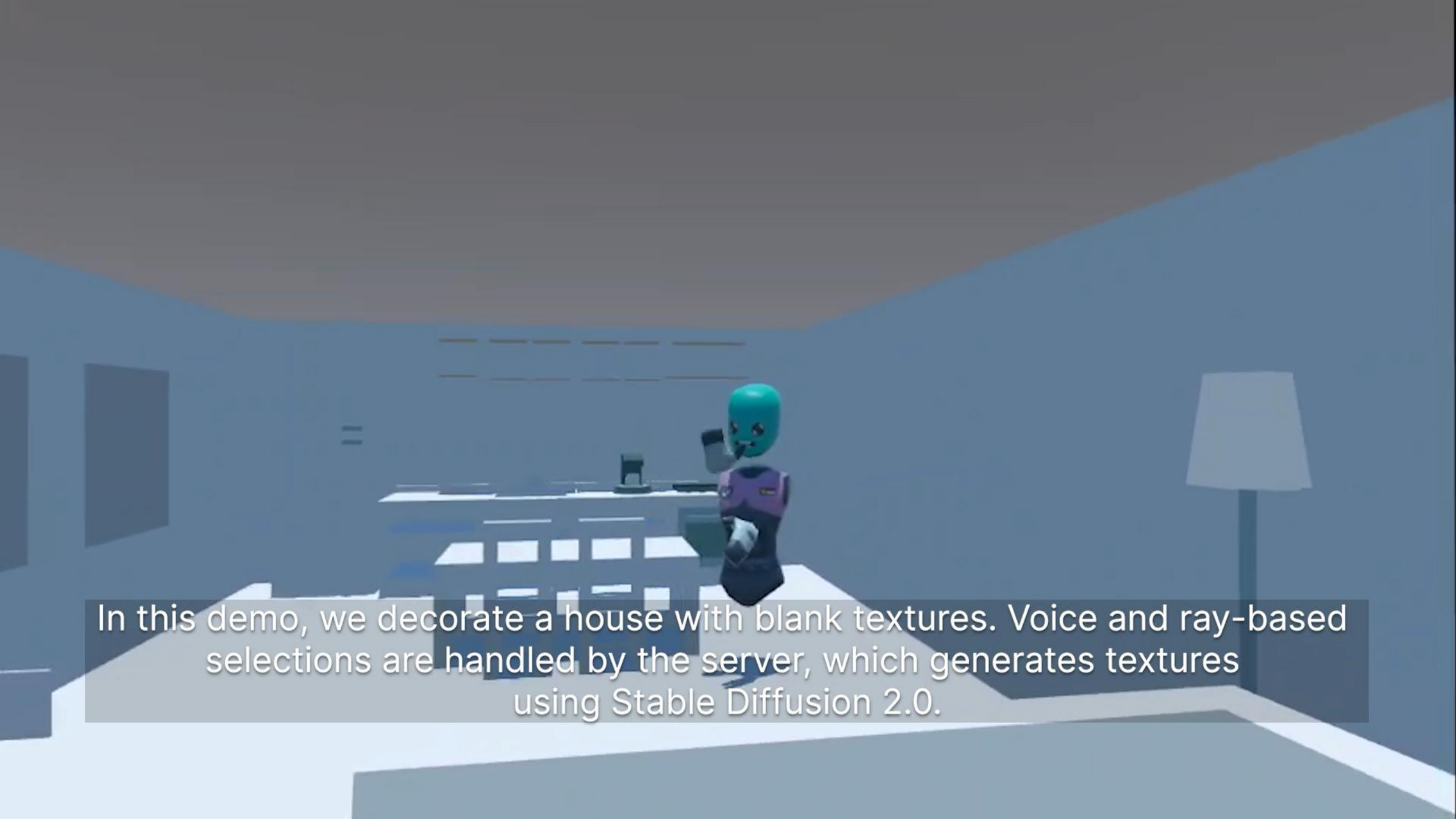
canirun.ai



Prototype: Object Texture Generation

- Collaboratively generate **textures** within a CVE with **voice prompts**
 - Optionally combined with ray-based selection to select targets





In this demo, we decorate a house with blank textures. Voice and ray-based selections are handled by the server, which generates textures using Stable Diffusion 2.0.

Prototype: Scene Describer

- Generate verbal descriptions that describe a WebRTC stream
 - Use a virtual or real camera and pass a RenderTexture to MediaTrackManager



Visual question
answering (VLM)



Text-to-speech



Console

Clear Collapse Error Pause Editor

MediaTrackPeerConnection:Log (string) (at Assets/Scripts/MediaTrackPeerConnection.cs:486)

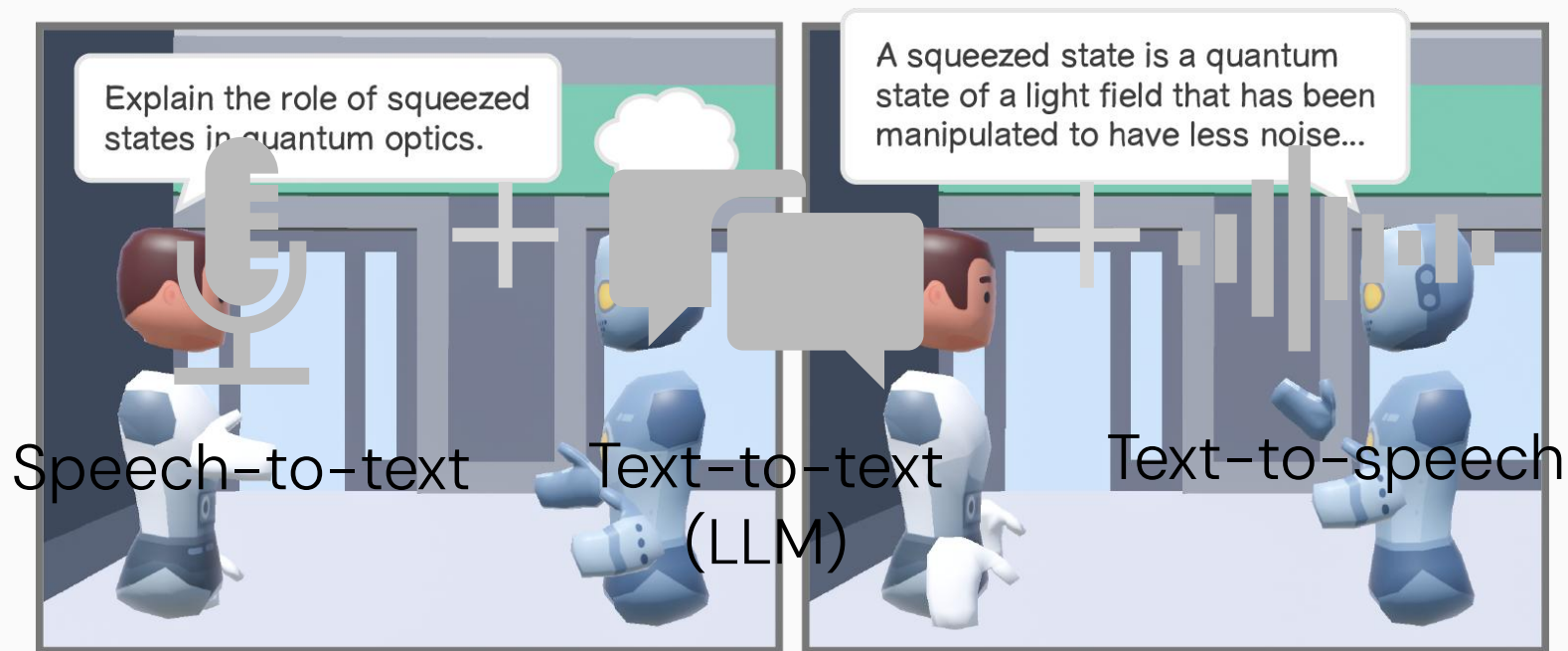
[00:42:59] [MediaTrackPeerConnection:765733d1-7516-4c8f-8e1b-b8aafdacbbb8] ICE state: Connected
UnityEngine.Debug:Log (object)
MediaTrackPeerConnection:Log (string) (at Assets/Scripts/MediaTrackPeerConnection.cs:486)

[00:43:10] DescriptionTrigger: Spacebar pressed — sending trigger to server
UnityEngine.Debug:Log (object)
DescriptionTrigger:Update () (at Assets/Scripts/DescriptionTrigger.cs:27)

18 22 0

Prototype: Conversational Agent

- Collaboratively interact with a conversational agent
 - Play a quiz, ask complex questions, conduct multi-party conversations, etc.



Live Demo

NVIDIA PersonaPlex

Tutorial

Creating your first Ubiquitous-Genie application

- Base sample data flow:
 - Python prints `Hello world!` every 5 seconds
 - `BaseService` emits data
 - `BaseApplication` sends JSON payload to Unity on `NetworkId(99)`
- **Let's check it out!**

✨ *Vibe Coding* with Ubiq-Genie

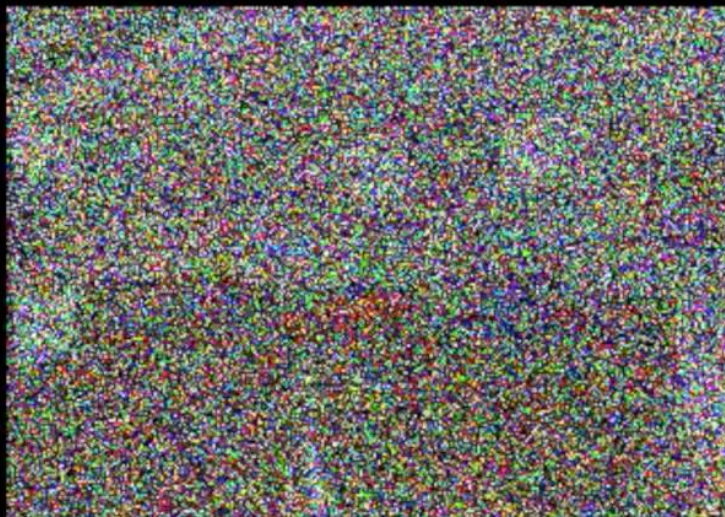
- Service and applications are prototyped with ease using the latest agentic coding tools such as Claude Code and Codex
- An `llm.txt` file will be included in an upcoming release
- Recent Unity MCP tools may be integrated to further accelerate development

MultiGen: Level-Design for Editable Multiplayer Worlds in Diffusion Game Engines

Ryan Po¹, David Junhao Zhang², Amir Hertz², Gordon Wetzstein^{*1}, Neal Wadhwa^{*2}, Nataniel Ruiz^{*2}

¹Stanford University, ²Google

diffusion models are
real-time game engines

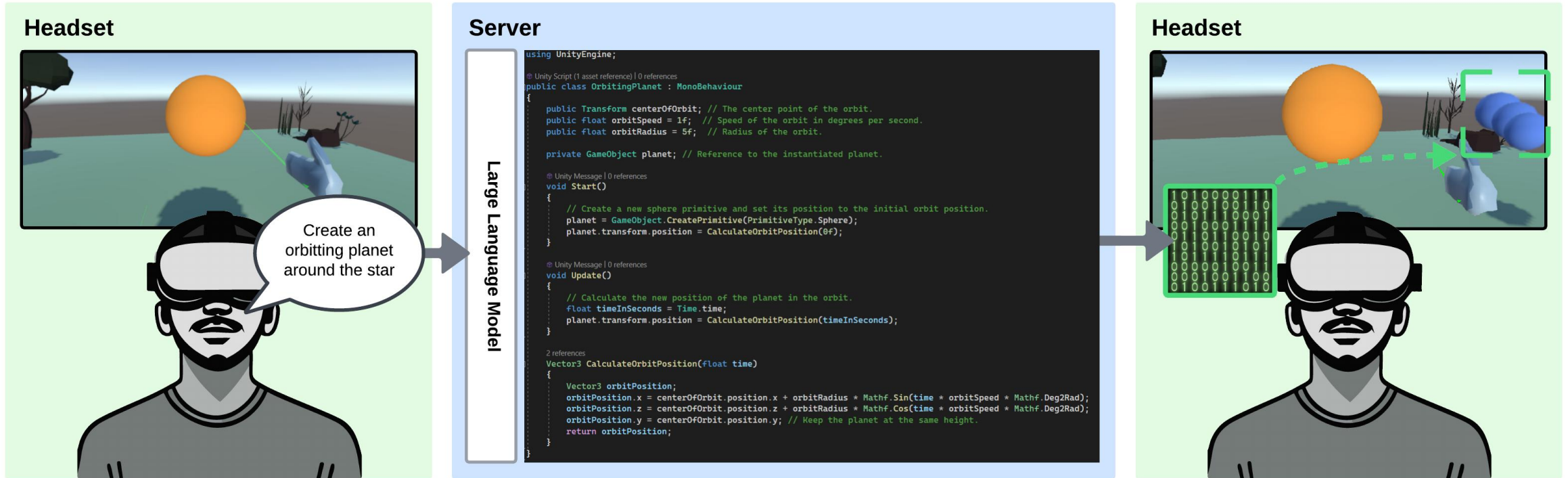


github.com/ucl-vr/ubiq-genie

Recent Ubiquitous Genie Papers

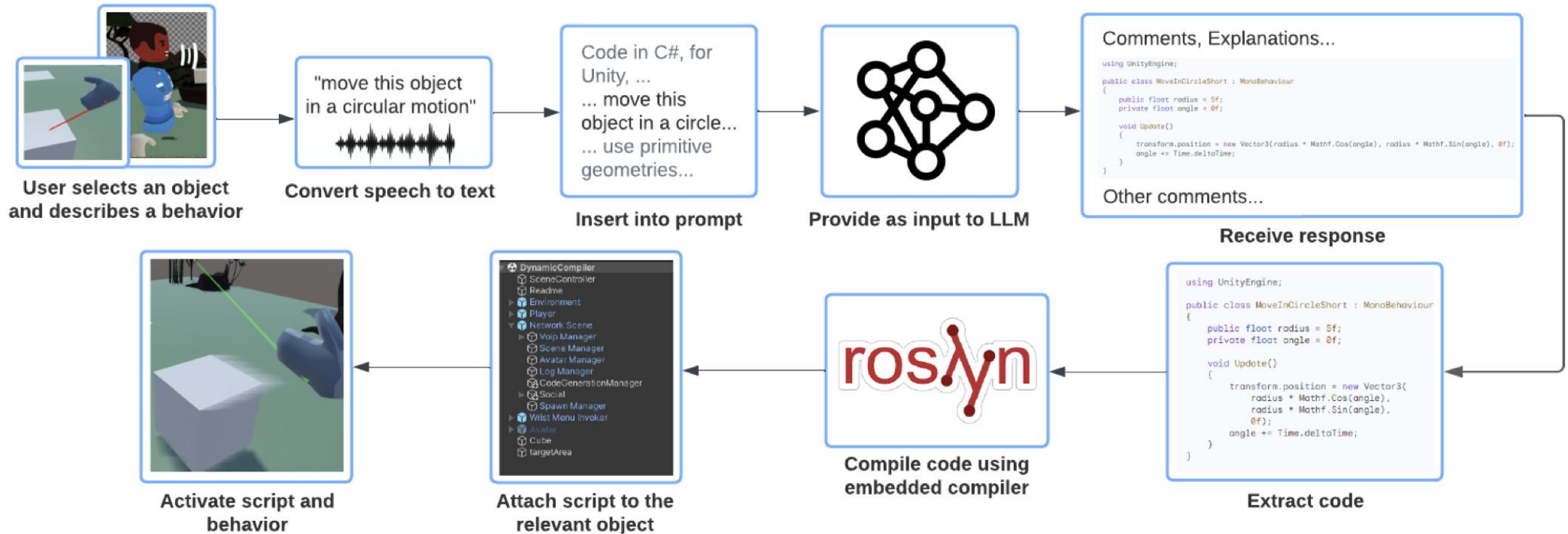
DreamCodeVR (IEEE VR 2024)

Daniele Giunchi, Nels Numan, Elia Gatti, Anthony Steed



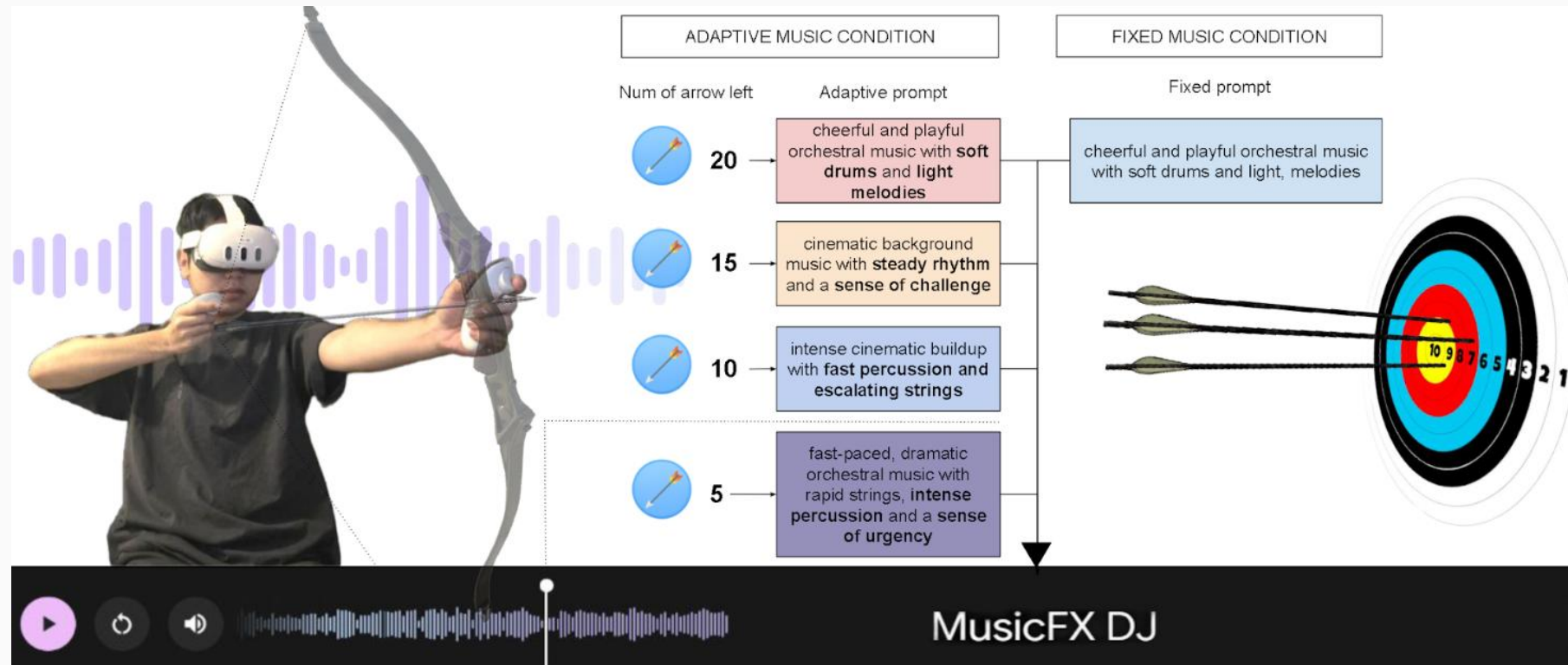
DreamCodeVR (IEEE VR 2024)

Daniele Giunchi, Nels Numan, Elia Gatti, Anthony Steed

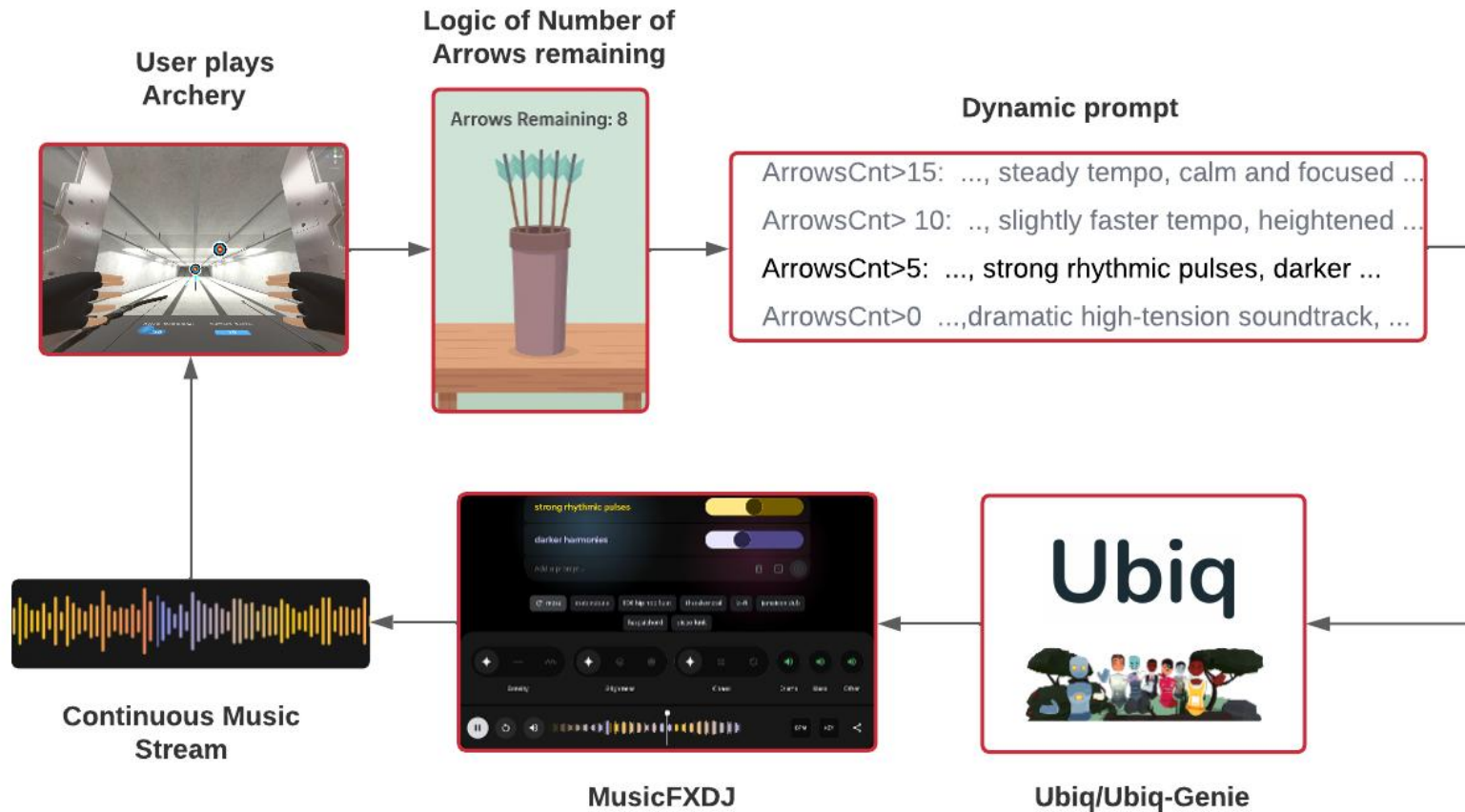


Tuning Immersion and Performance with Adaptive Generative Music in VR (IEEE VR 2026)

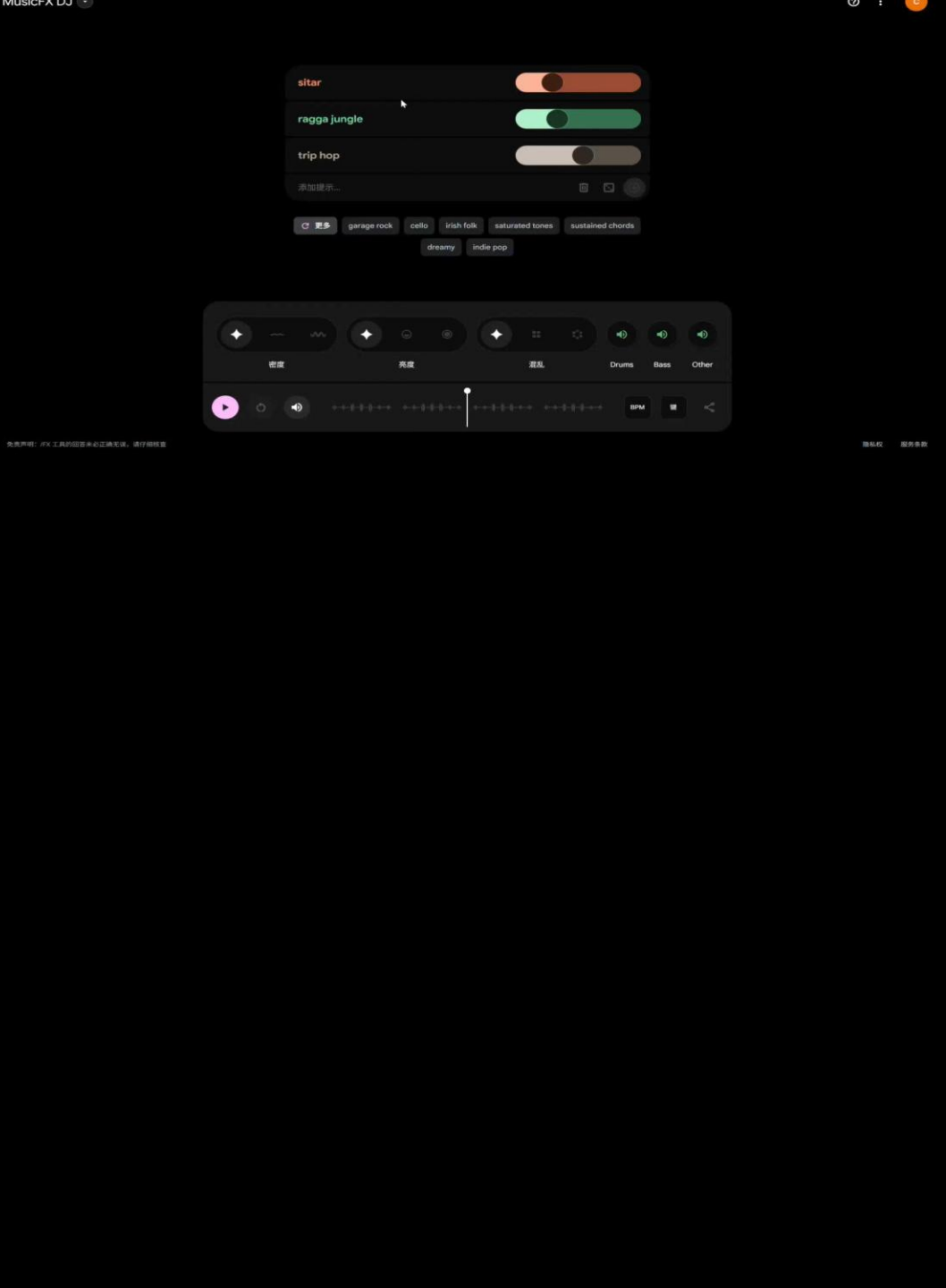
Jiayuan Wen, Daniele Giunchi, Pasquale Cascarano, Riccardo Bovo, Eyal Ofek, Anthony Steed



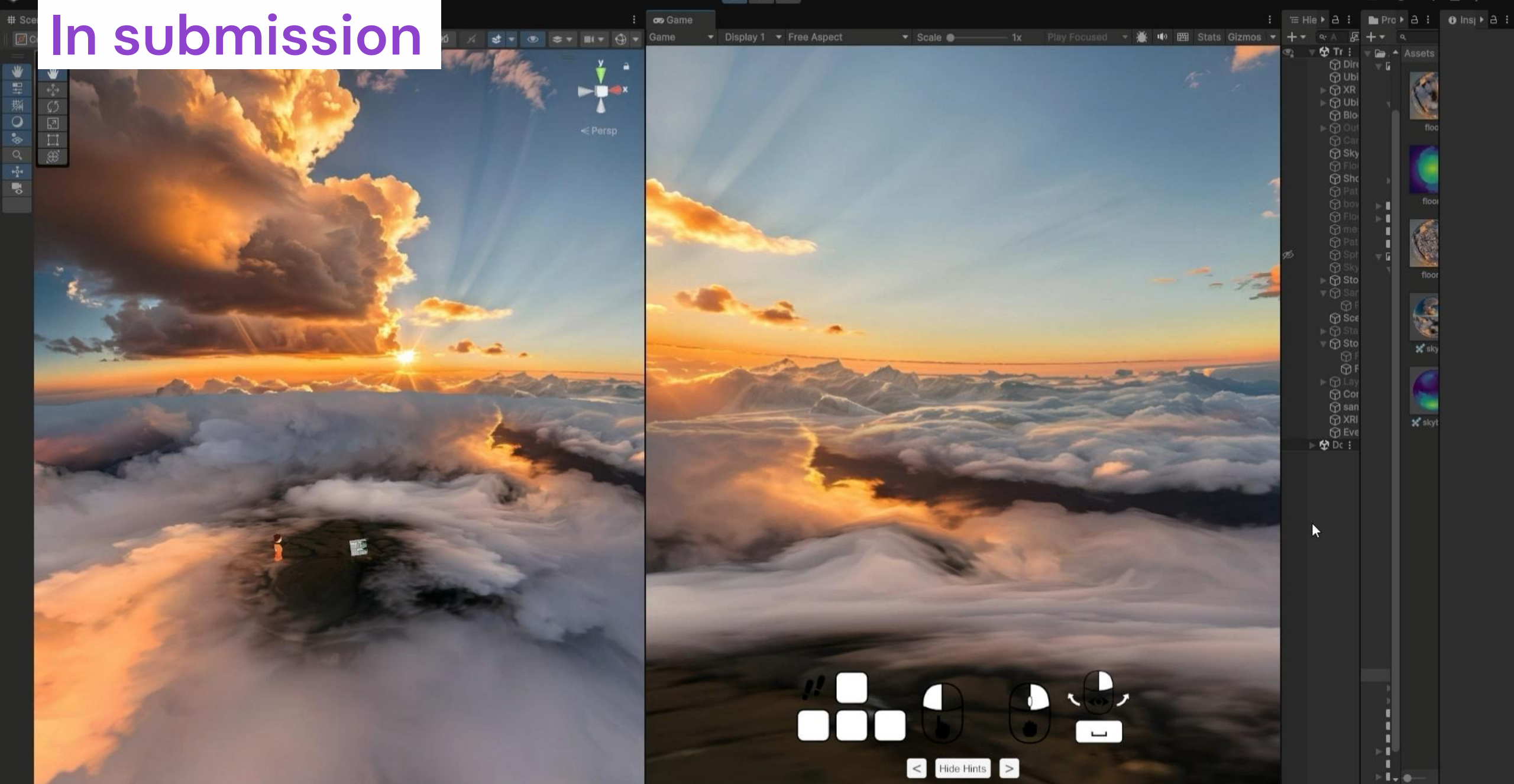
Tuning Immersion and Performance with Adaptive Generative Music in VR (IEEE VR 2026)



Demo



In submission



2026
IEEE VR
DAEGU, KOREA

MARCH 21-25, 2026



Do You See What I See? Bring Live Pedestrians into an Outdoor Collaborative Mixed Reality Experience

Jingyi Zhang*, Ziwen Lu*, Changrui Zhu, Simon Julier, Anthony Steed
University College London

The 33rd IEEE Conference on Virtual Reality and 3D User Interfaces

*Both authors contributed equally to this research.



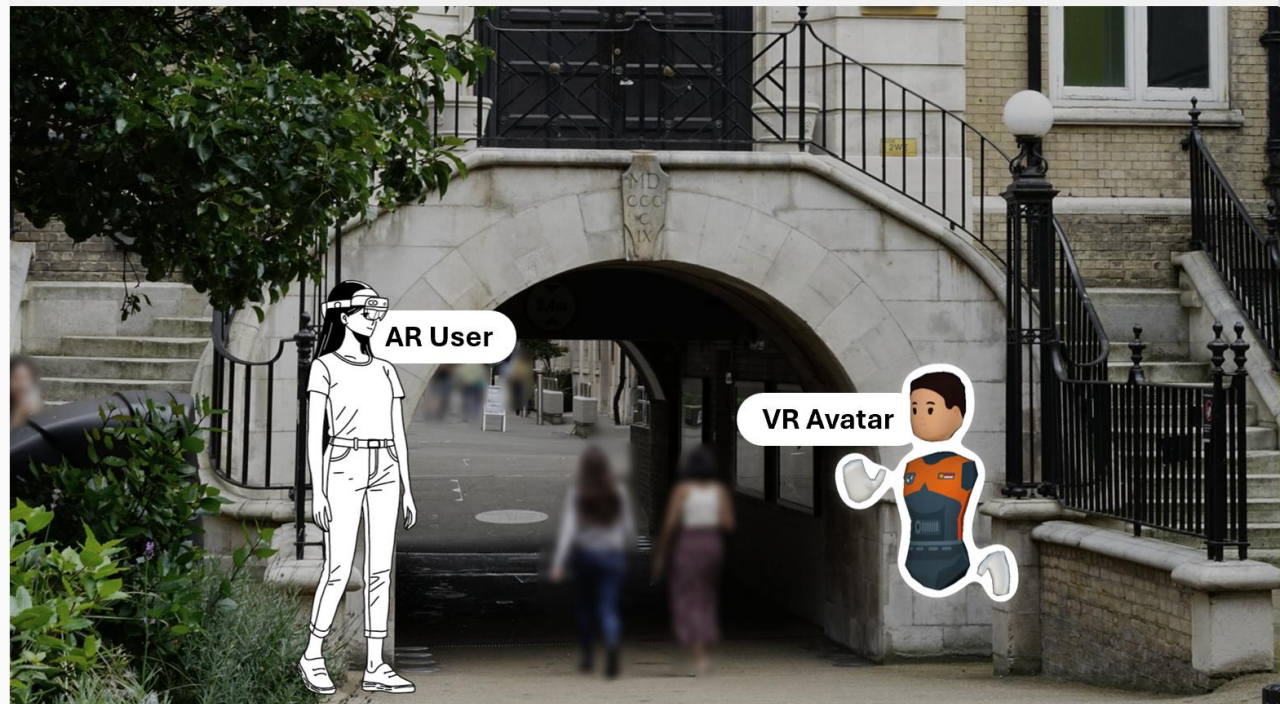
REALITY



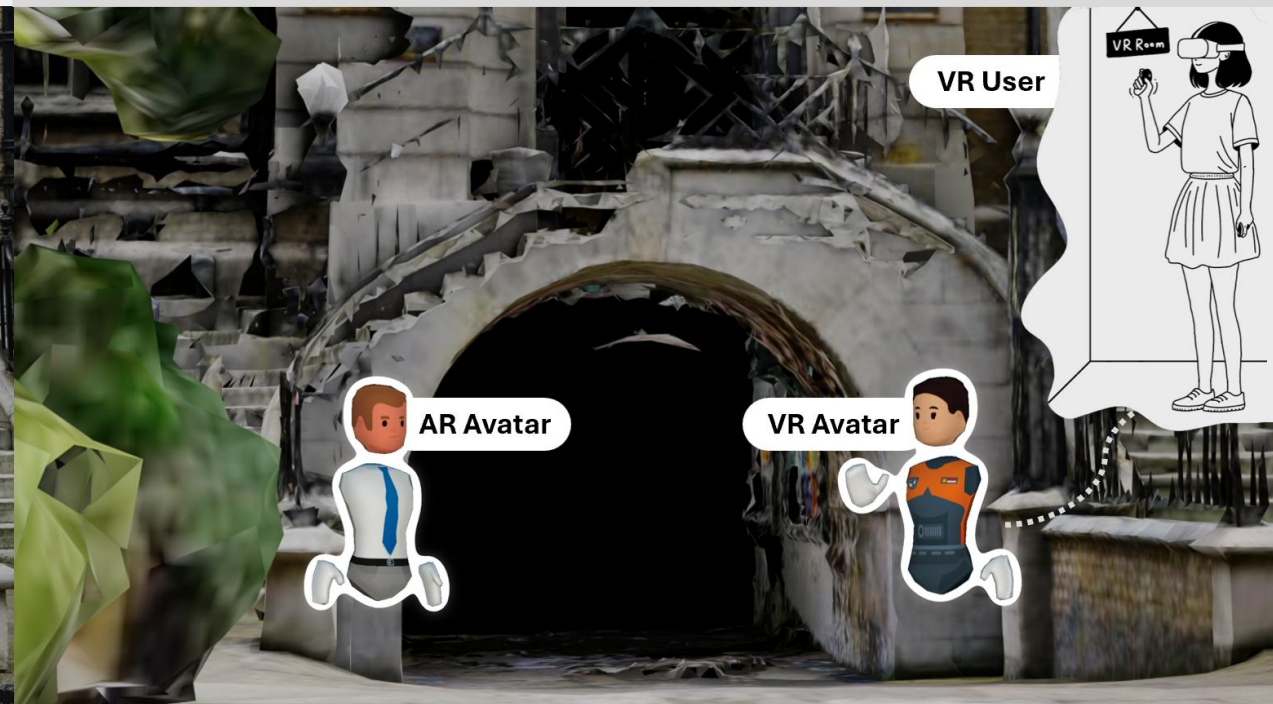
VIRTUAL REALITY



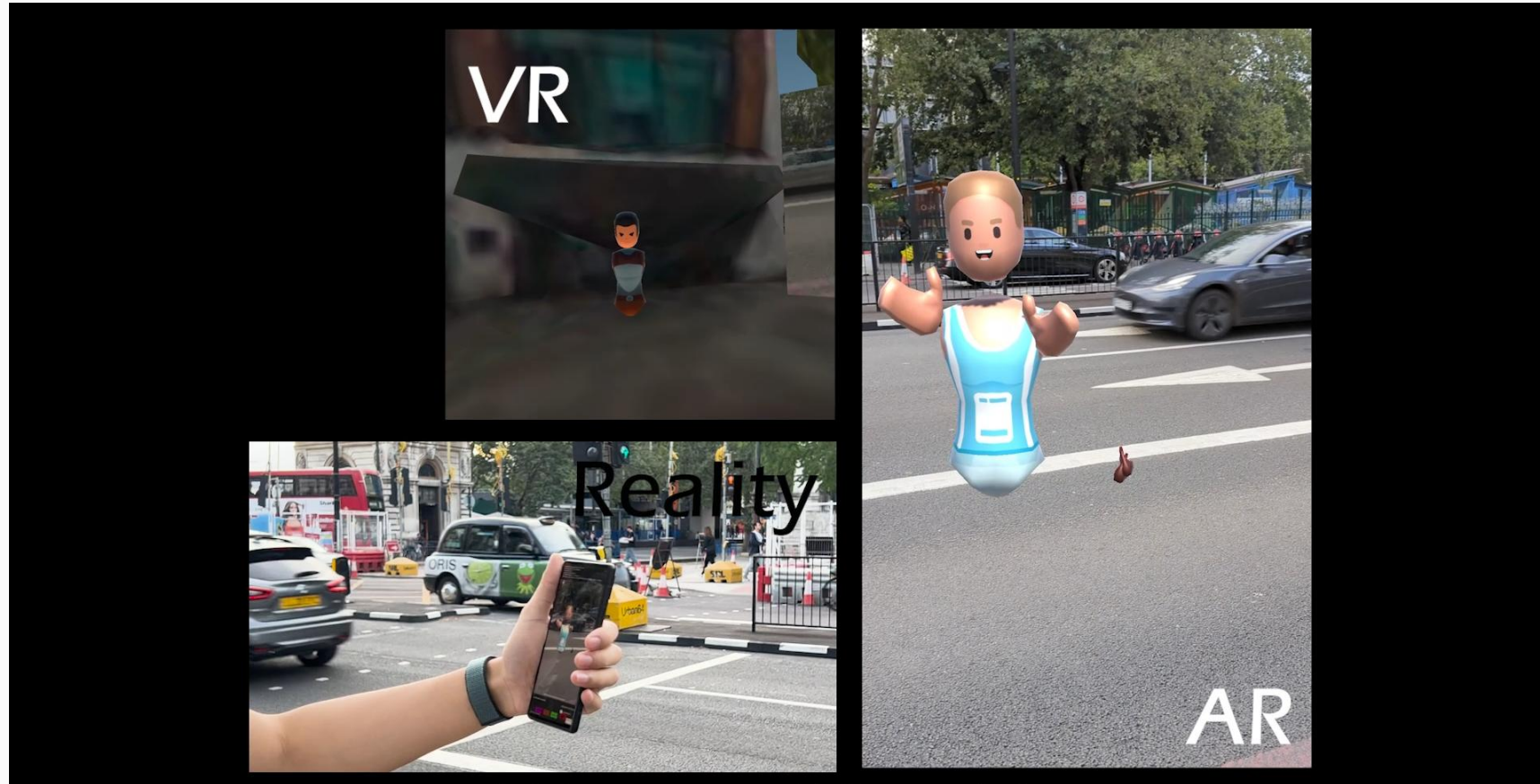
REALITY



VIRTUAL REALITY



Focus Group – Scenario



Reviving the Euston arch:

A mixed reality approach to cultural heritage tours [ISMAR 23]

Focus Group – Takeaway



Where are the dynamic elements?

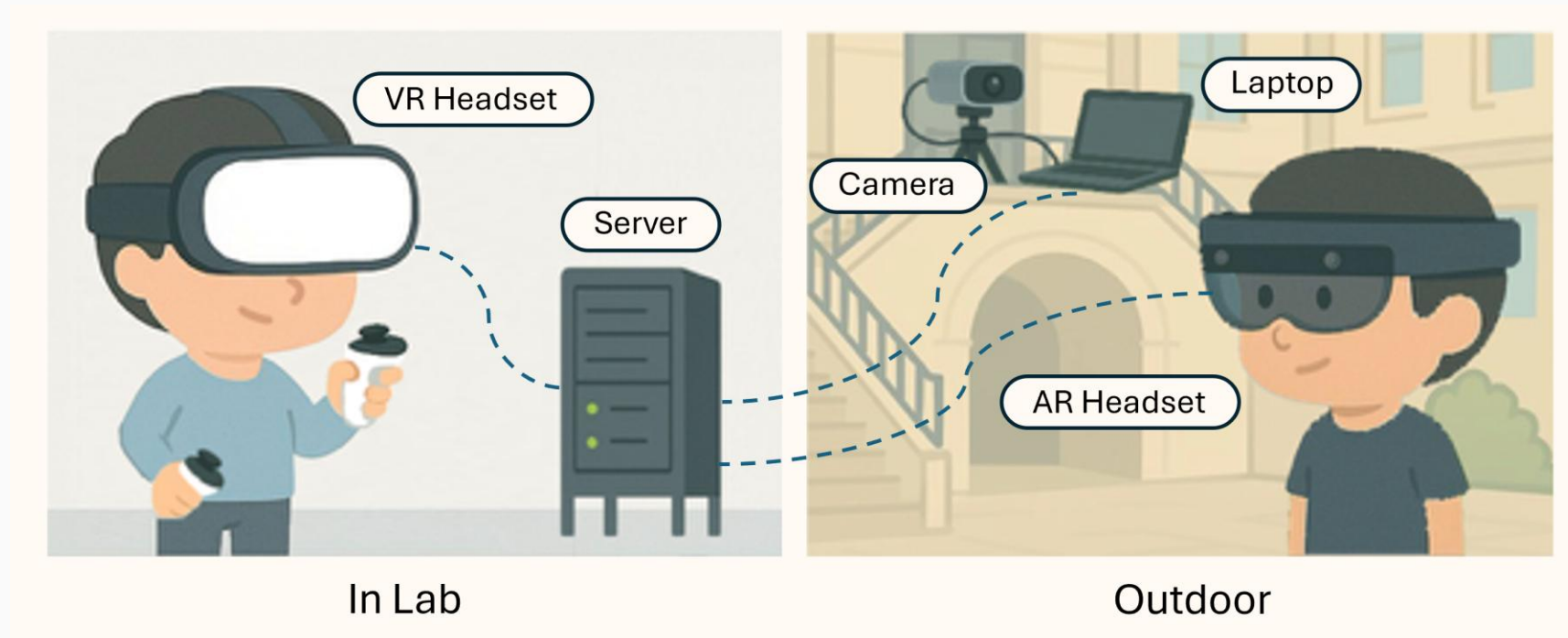
Raining?

Why do you stop? Red Traffic Light?

So Empty! Pedestrians?

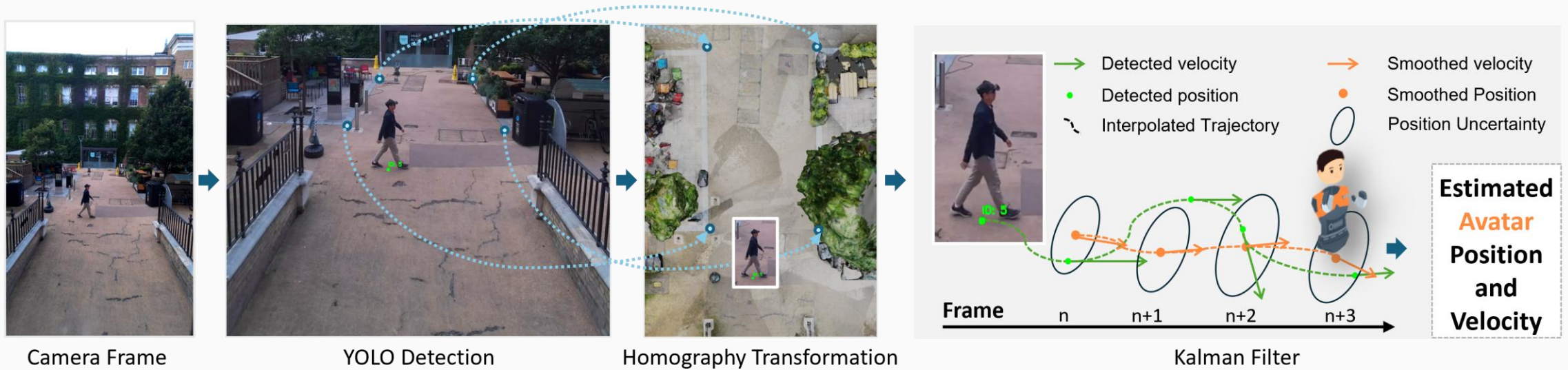
You are hit by a car!

System – High Level (Ubiq)



- **Reconstruction:** Bentley iTwin Capture Modeler Master
- **Apparatus:** Meta Quest 3 & HoloLens
- **AR and VR alignments:** World Locking Tools with QR markers

Ubiq-Genie Tracking Component



Reality Bird-eye



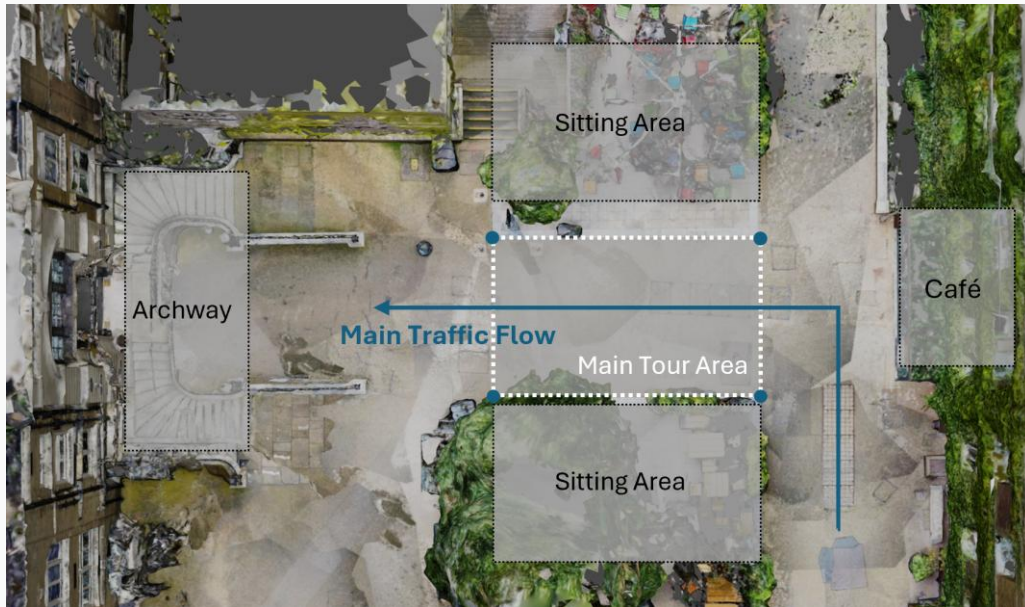
VR Bird-eye



Evaluation

- **RQ1:** whether the avatars perceived by the VR user were real-time virtual representations of people physically present at the AR user's location
- **RQ2:** whether participants preferred the presence of these pedestrian avatars, and whether this enhanced the sense of visiting the real-world location in real-time together with the AR guide
- Within Subject
- 21 participants

Evaluation – Scenario



Layout of the outdoor experiment area

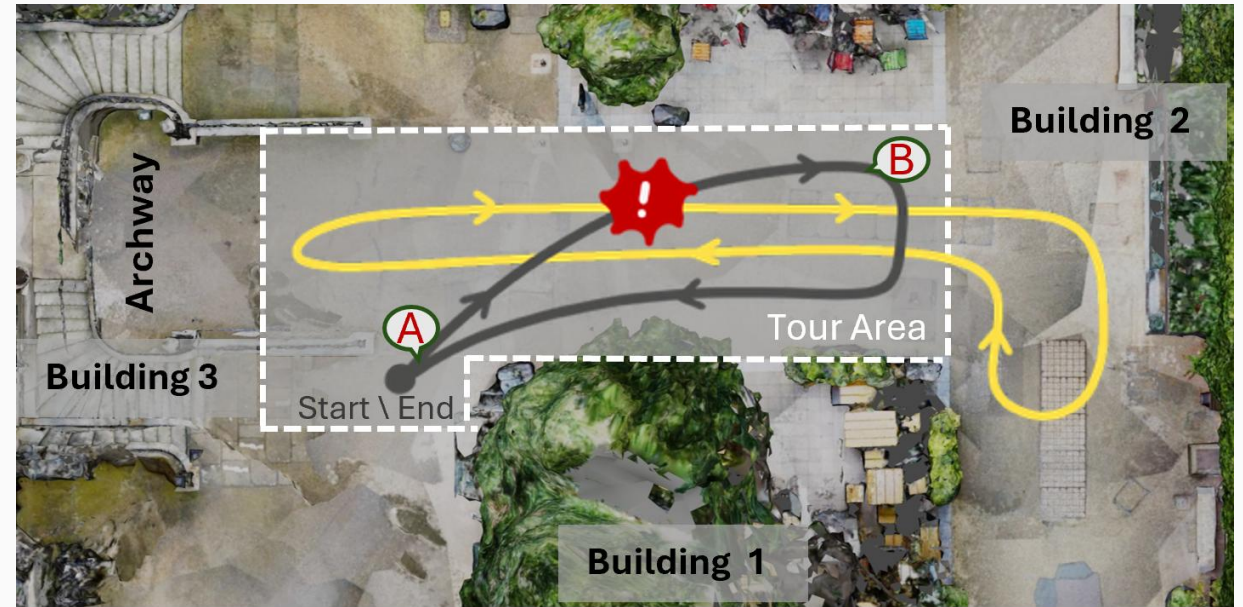


Illustration of the guided tour in our study.

Real-time Pedestrians

AR



VR Bird-eye



Reality



VR

