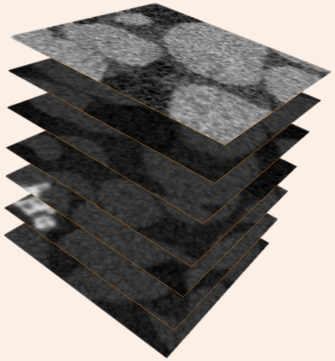
جامعة الملك عبدالله للعلوم والتقنية
King Abdullah University of Science and Technology
Core Labs

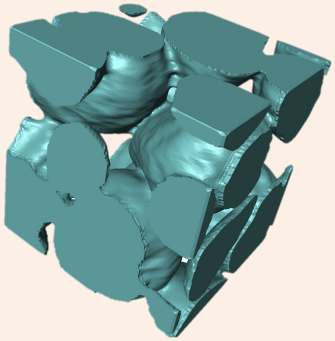
AR & VR for Data Visualization

How can
AR & VR
help you

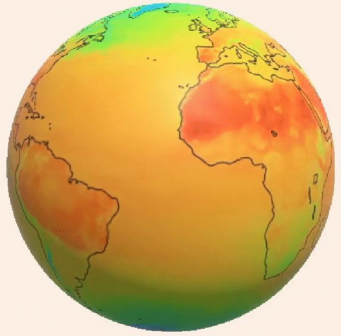
**visualize,
understand,
& explain**

your **data**
better?

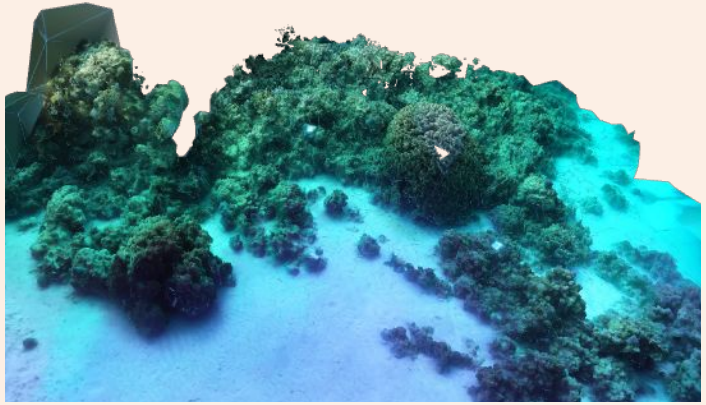




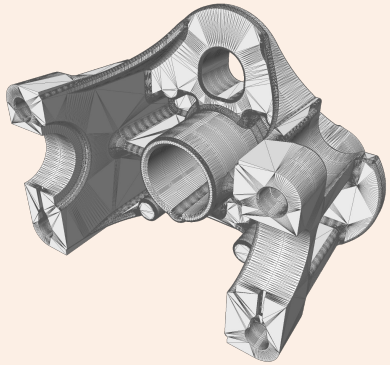
Microscopy



Simulation



Photogrammetry



3D Modeling


Click any icon below to learn more about each of the pillars of the Coral Probiotics Village:
Coral Probiotics Village

Overview

KVL Introduction

What is AR/VR?

AR/VR for Data Visualization

AR/VR Resources @ KVL

Live Demos

AR/VR Facilities Tour

KAUST Visualization Lab
Introduction

KVL provides expertise in **data visualization** & **data science**

Sohaib Ghani

- Visual Analytics
- Information Visualization
- Statistical Analysis

Ronell Sicat

- Scientific Visualization
- AR/VR Development
- Segmentation/3D Analysis

James Kress

- Scientific Visualization
- HPC In-situ Visualization
- Distributed Visualization

Didier Barradas

- Data Science
- Machine Learning
- Deep Learning

Abdelghafour Halimi

- Data Science
- Machine Learning
- Deep Learning

KVL provides state-of-the-art **visualization facilities**

wiki.vis.kaust.edu.sa
help@vis.kaust.edu.sa

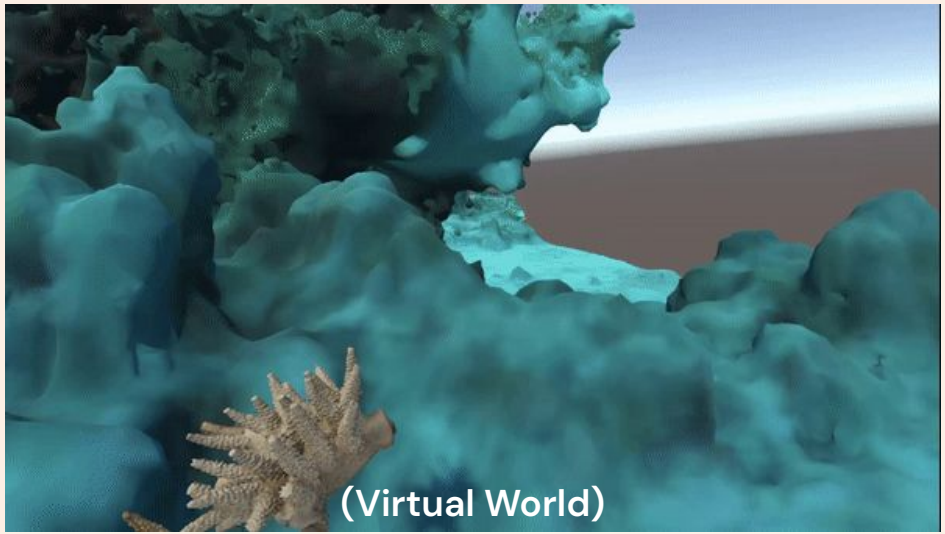
What is AR/VR?

Hardware and **software** systems that enable users to experience a blend of the **real** and **virtual** worlds.

VR

VR Device (Hardware)

Application / Game (Software)



input → **computer** → output

VR Examples

Riegler et al. 2019

Driving Simulator

auic.ajman.ac.ae

Virtual Travel

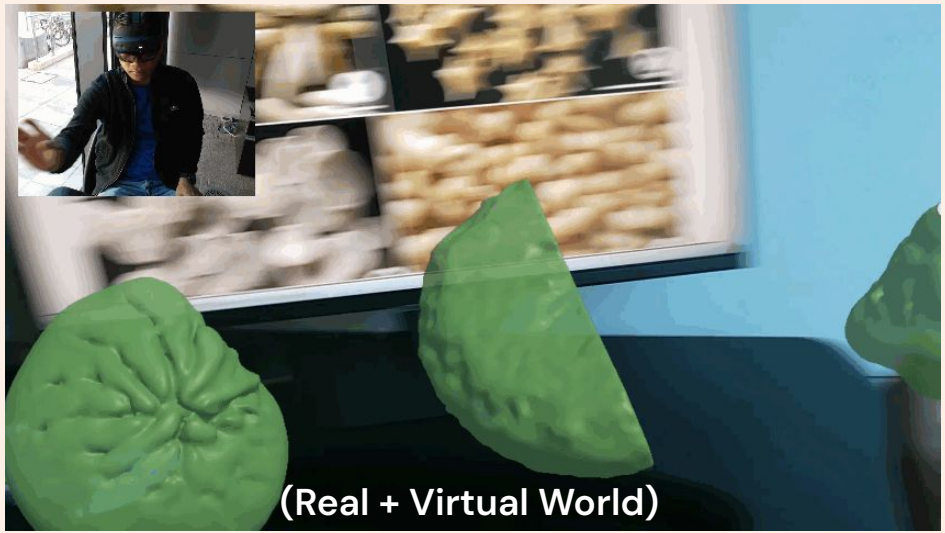
VR Demo

AR

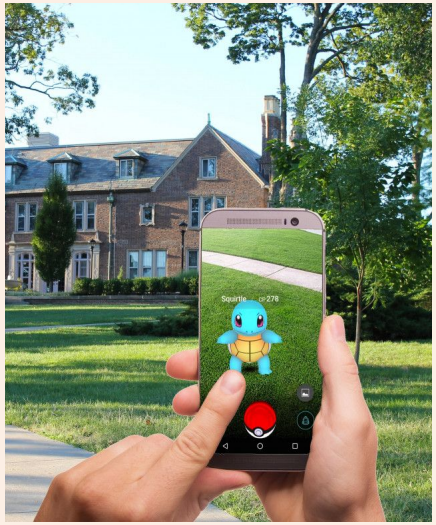
AR Device
(Hardware)

input → **computer** → output

Application / Game
(Software)



AR Examples



https://pxhere.com/en/photo/556168

AR Games

https://mashable.com/article/facebook-messenger-ar-effects

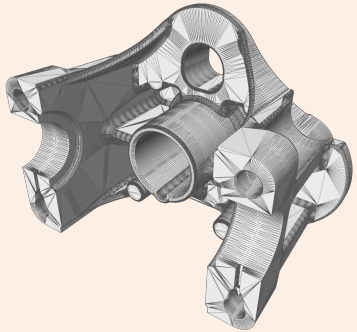
AR Effects

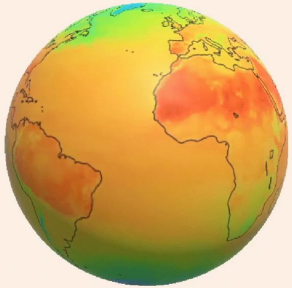
https://adsknews.autodesk.com/news/microsoft-hololens-autodesk-fusion-360-mixed-reality-for-product-design-and-engineering

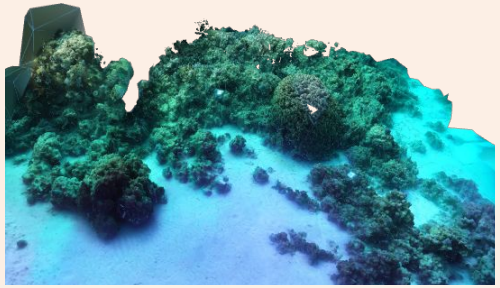
AR Planning

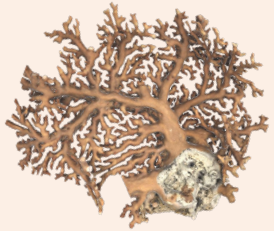
AR Demo

AR/VR for Data Visualization

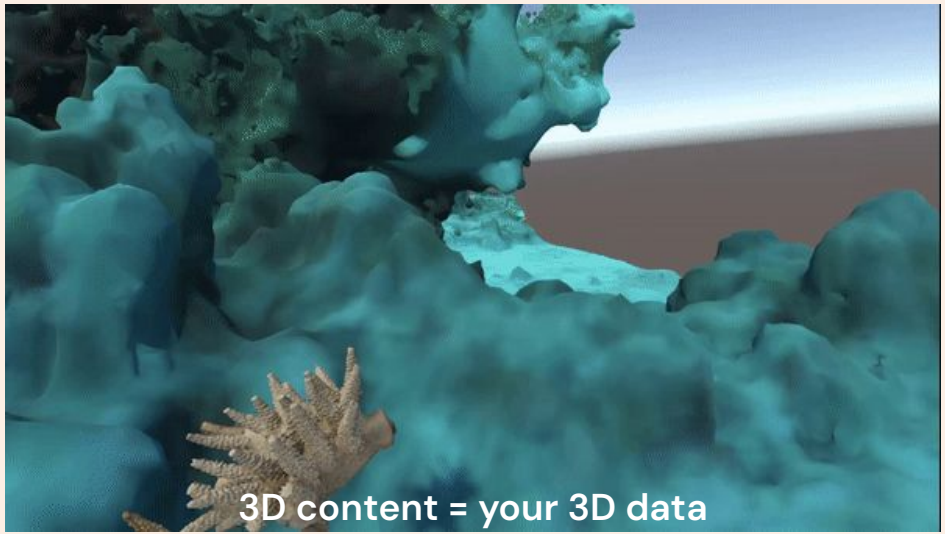




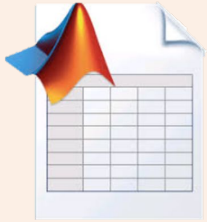




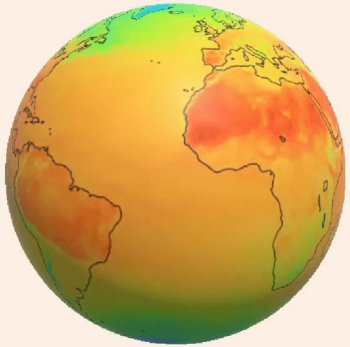
Application / Game (Software)

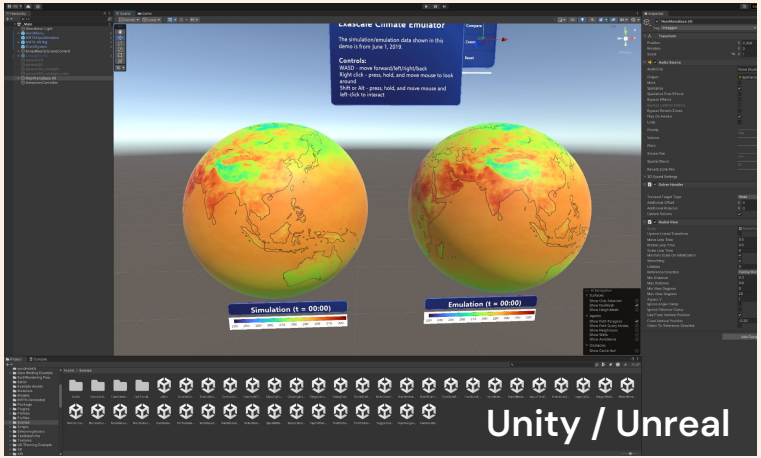


Workflow example

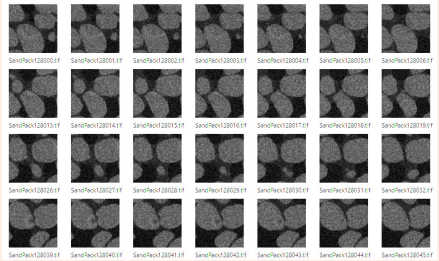


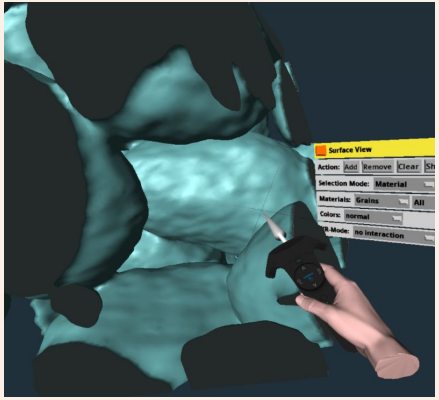
A	B	C	D	E	F	G	H
69	464	1483	801	1865	518	784	653
584	667	1727	21	1659	1318	842	947
744	947	1285	1200	1650	1466	733	1540
95	1803	1257	923	776	1846	1429	1747
1524	1874	377	1595	1642	13	472	1122
1791	840	1314	935	595	1210	839	506
877	511	1039	739	1469	230	488	315
1812	858	1379	1502	512	528	1074	1019
1094	1694	359	84	1709	1065	1016	1884
770	399	1394	1709	347	265	407	1279
184	1756	605	1744	1646	279	759	1748
410	1267	491	270	633	243	739	1505
1007	1751	1809	605	946	1821	1592	143
723	1896	288	1503	977	1020	712	183
1444	375	671	1554	415	1186	1795	1851
1624	71	1474	695	1574	1839	1368	1036
1297	1907	1493	783	1322	1365	113	1405

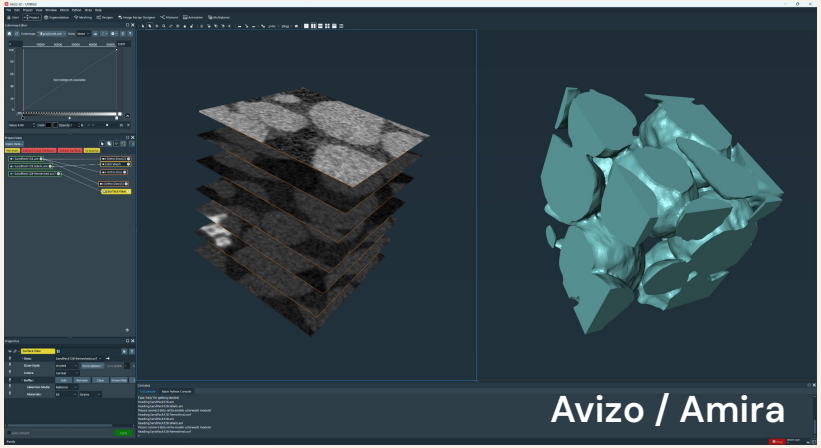


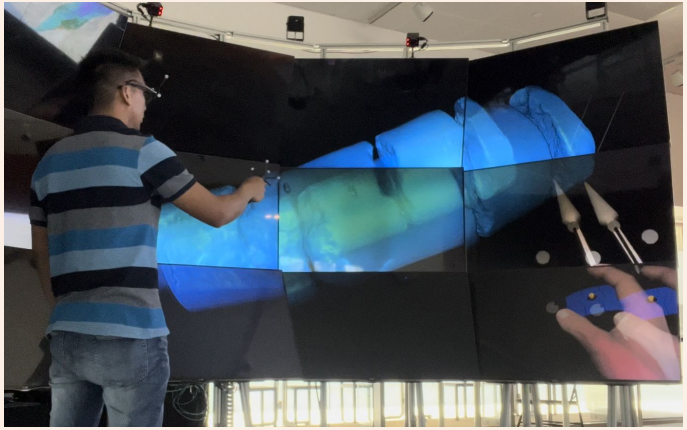


Workflow example



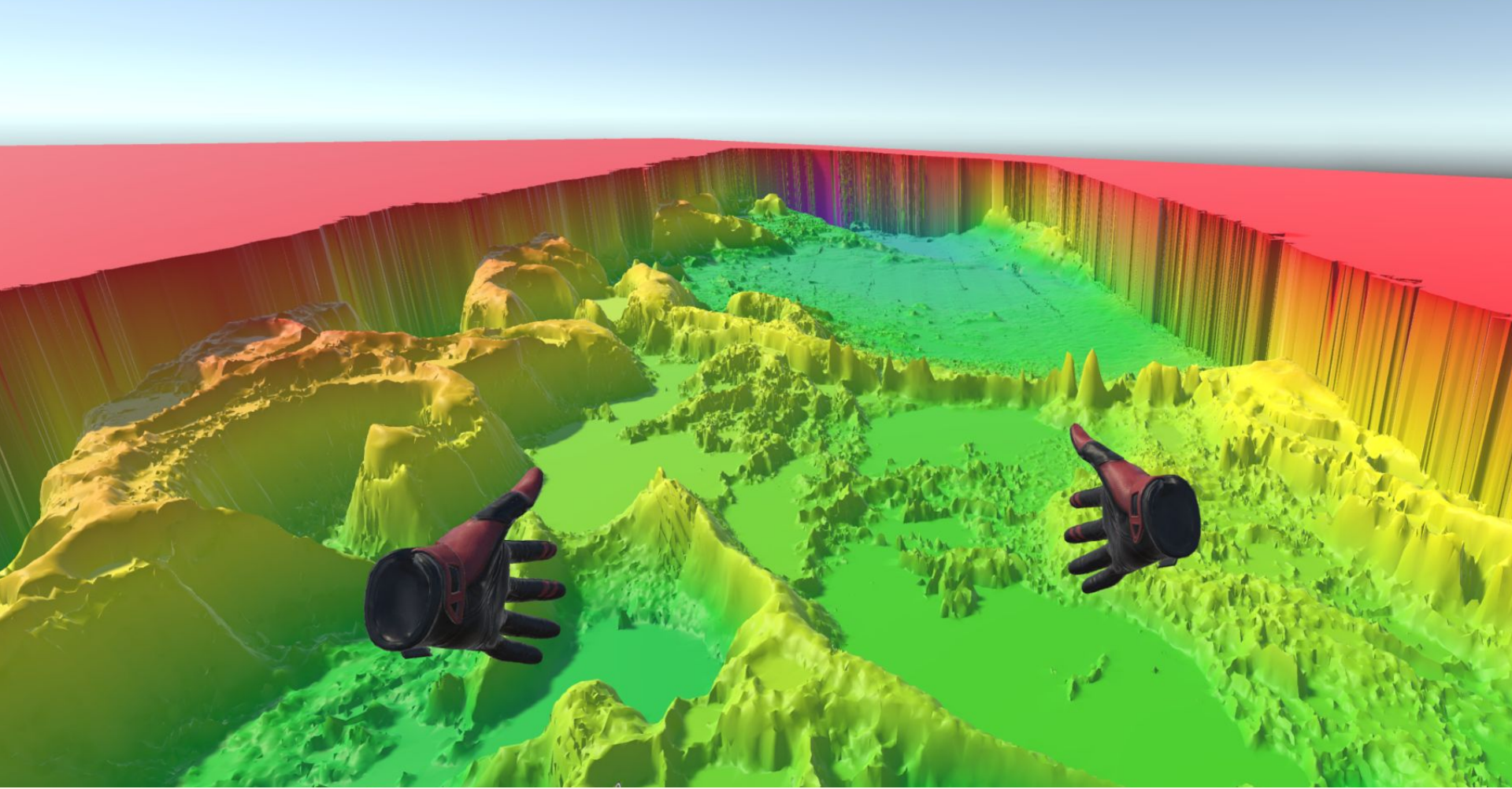




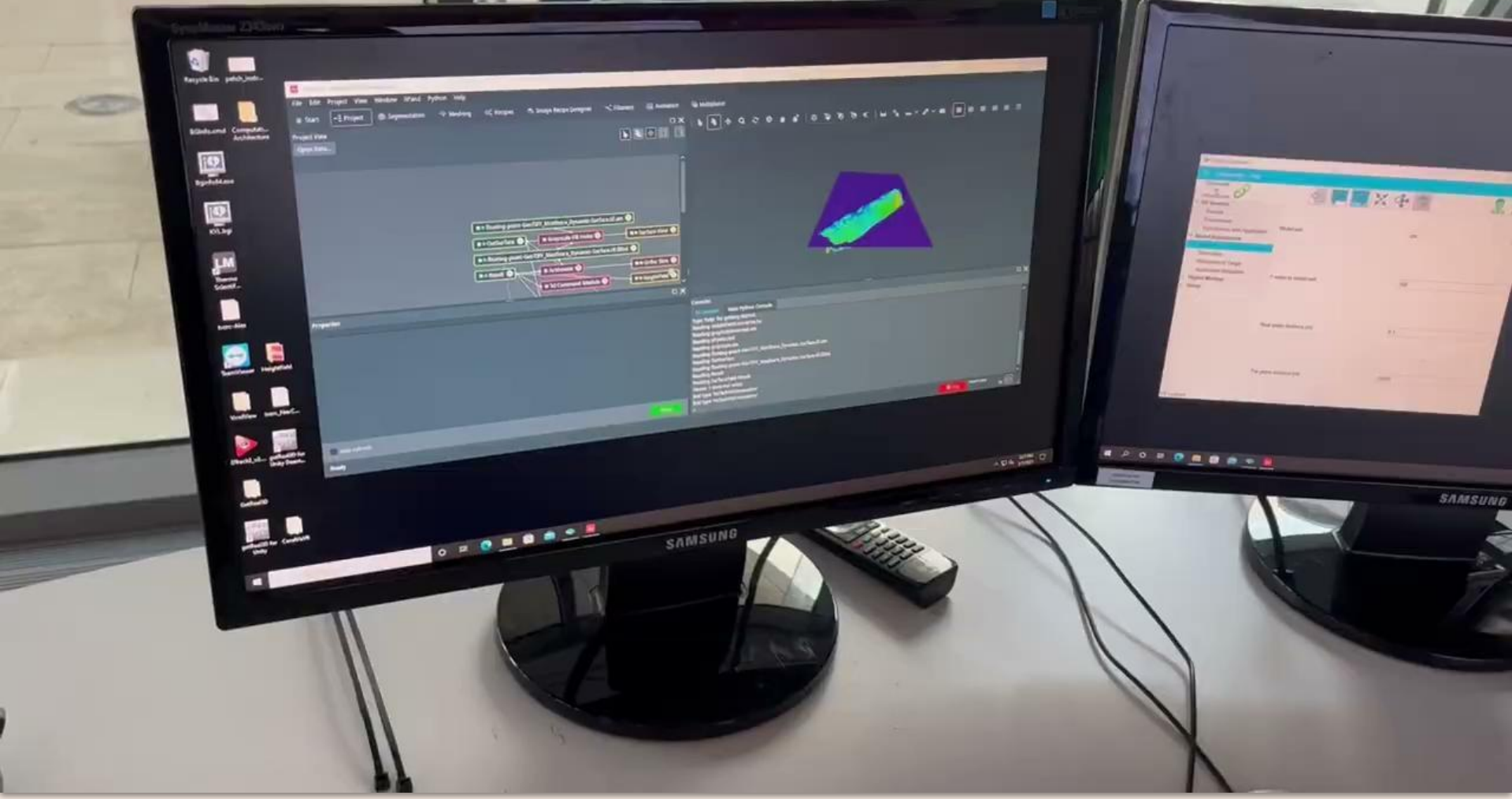


Potential **benefits** of using AR/VR for data visualization:

- understanding 3D spatial data,
- analyzing situated data,
- intuitive 3D interactions,
- immersive storytelling,
- and more!



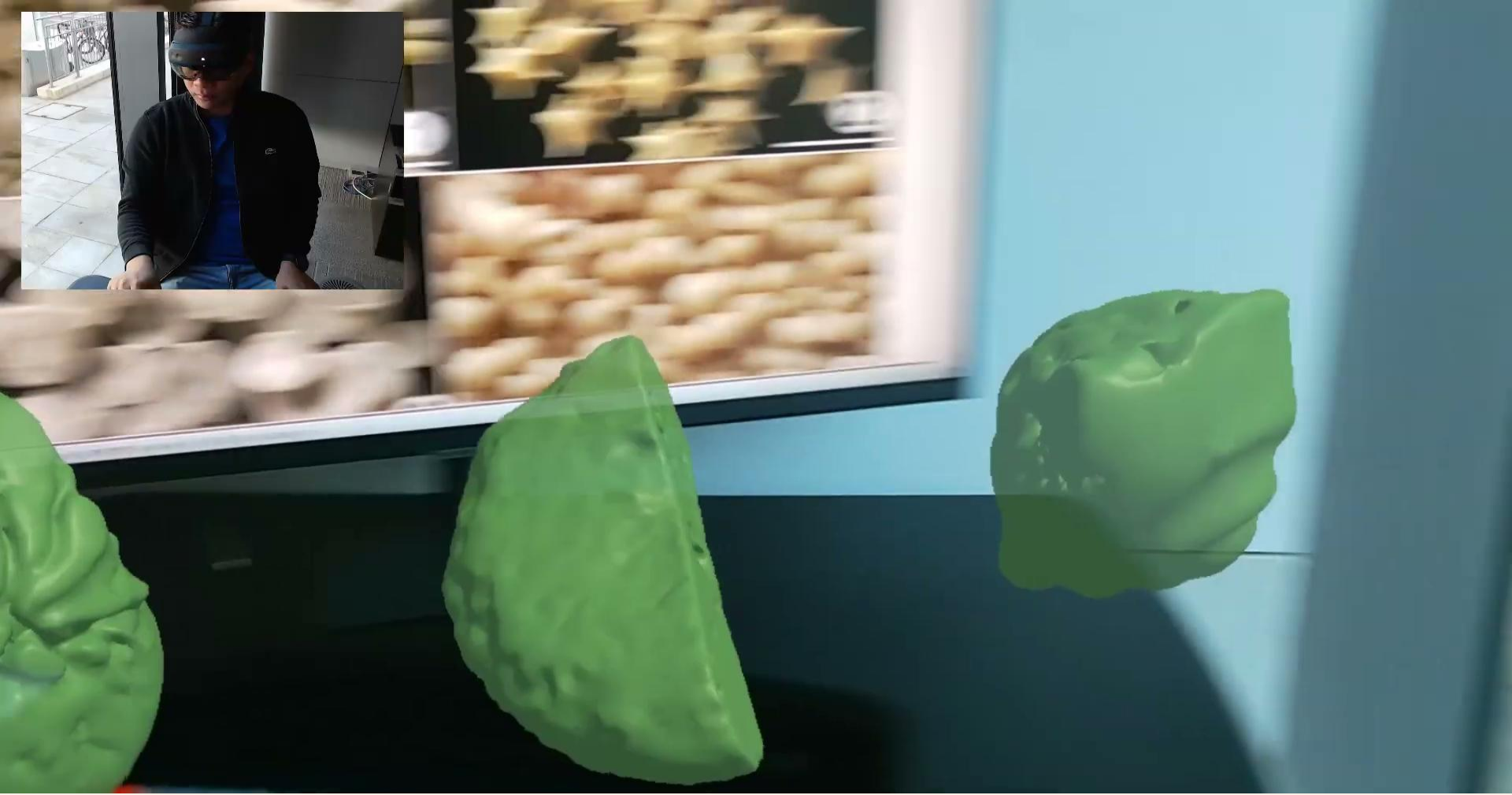
Credits: KVL + CMR



Credits: KVL + CMR

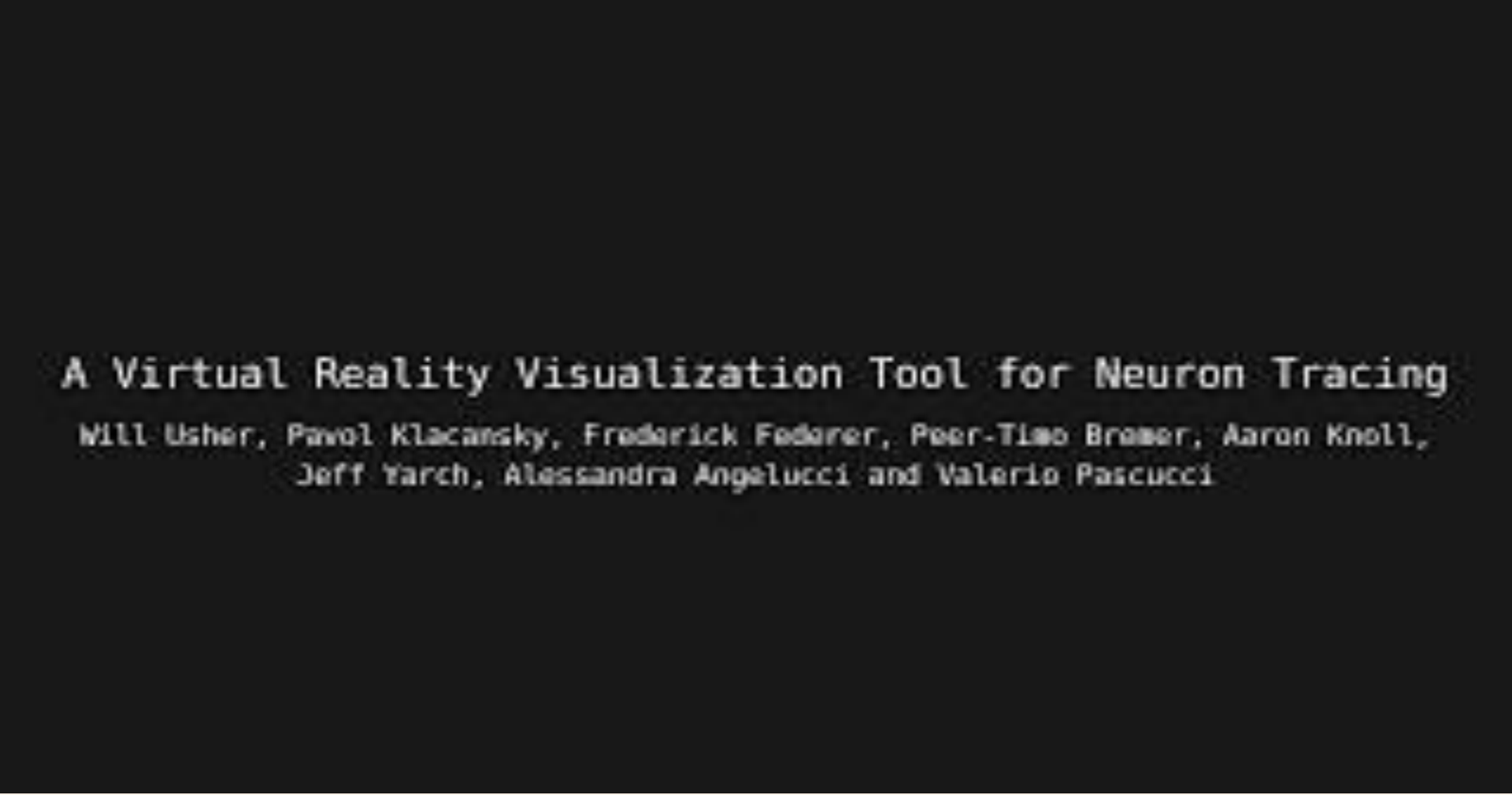
Credits: KVL + ANPERC

Understanding 3D Spatial Data



Credits: KVL + Ali Al Ibrahim

Intuitive 3D Interactions


A Virtual Reality Visualization Tool for Neuron Tracing
Will Usher, Pavol Klacansky, Frederick Federer, Peer-Timo Bremer, Aaron Knoll,
Jeff Yarch, Alessandra Angelucci and Valerio Pascucci

Credits: KVL + Prof. Peixoto Group

Immersive Storytelling

Credits: KVL + Prof. Peixoto Group

Immersive Storytelling

Credits: KVL + ECRC (Gordon Bell Prize for Climate Modeling)

Immersive Storytelling

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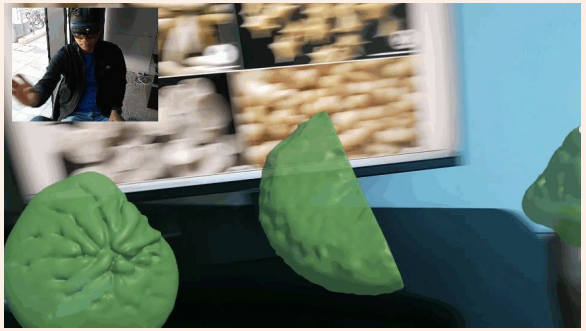
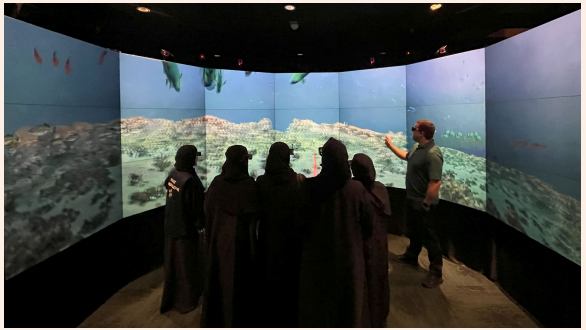
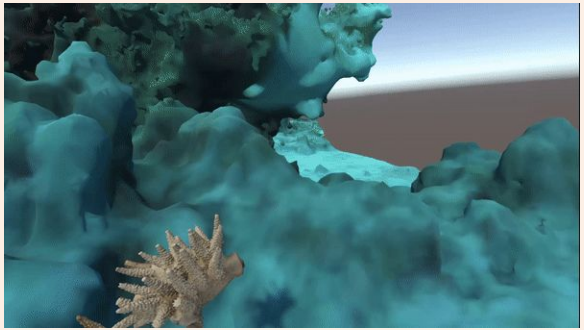






10-minute Break

AR/VR Resources @ KVL

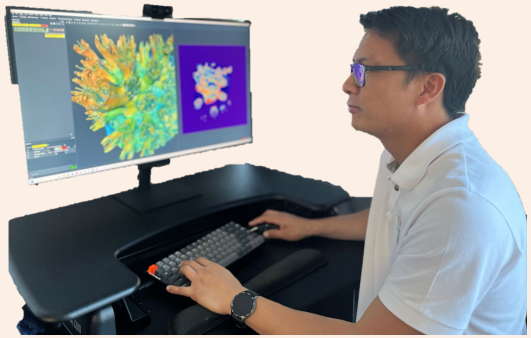
Hardware

Software

Avizo™ 3D

unity

Expertise



wiki.vis.kaust.edu.sa/arvr

Hardware: HMDs

Meta Quest 2/3/Pro

HTC Vive Pro 1/2

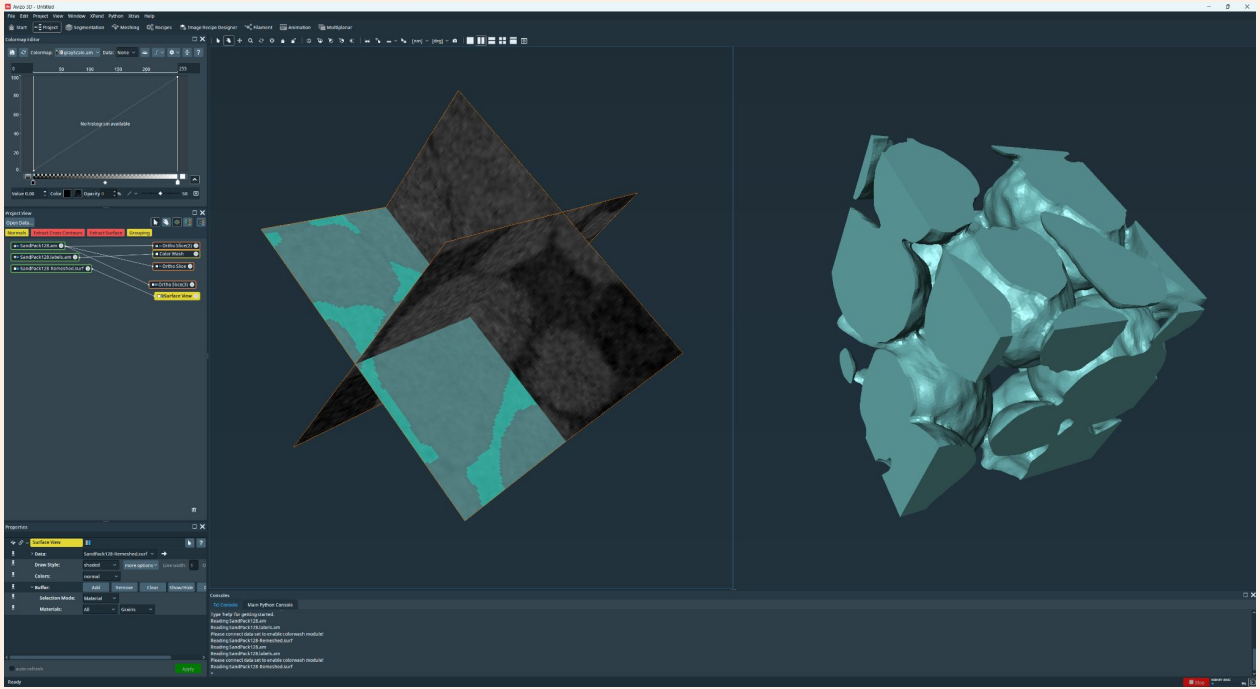
HoloLens 2

Apple Vision Pro

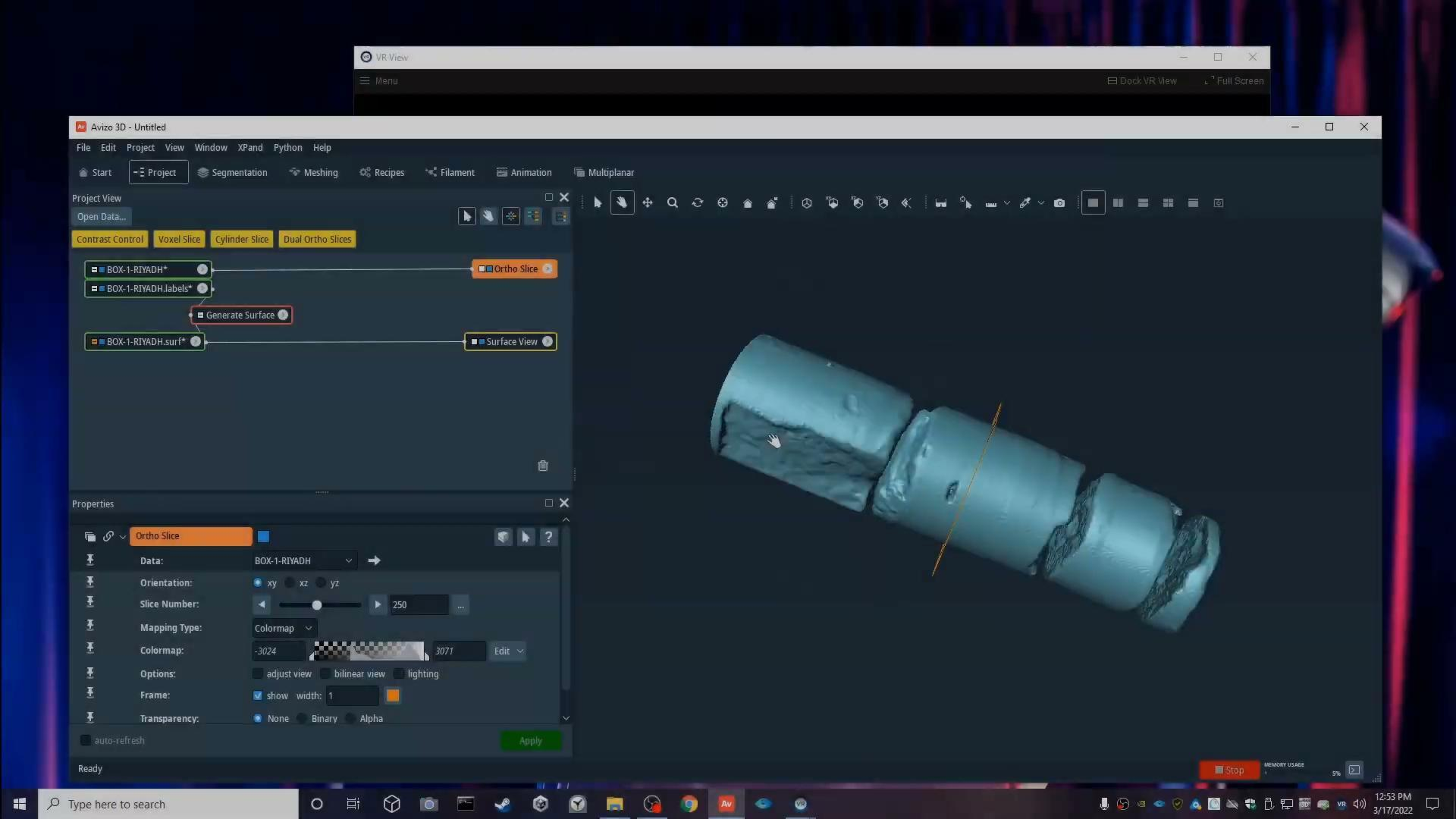
Laptops / Workstations

Hardware: VR Environments

Software: Avizo



it.kaust.edu.sa/software/avizo


VR View
Menu
Dock VR View
Full Screen
Avizo 3D - Untitled
File Edit Project View Window XPand Python Help
Start
Project
Segmentation
Meshing
Recipes
Filament
Animation
Multiplanar
Project View
Open Data...
Contrast Control
Voxel Slice
Cylinder Slice
Dual Ortho Slices
BOX-1-RIYADH*
BOX-1-RIYADH.labels*
Generate Surface
BOX-1-RIYADH.surf*
Ortho Slice
Surface View
Properties
Ortho Slice
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BOX-1-RIYADH
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xy
xz
yz
Slice Number:
250
Mapping Type:
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Colormap:
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Options:
adjust view
bilinear view
lighting
Frame:
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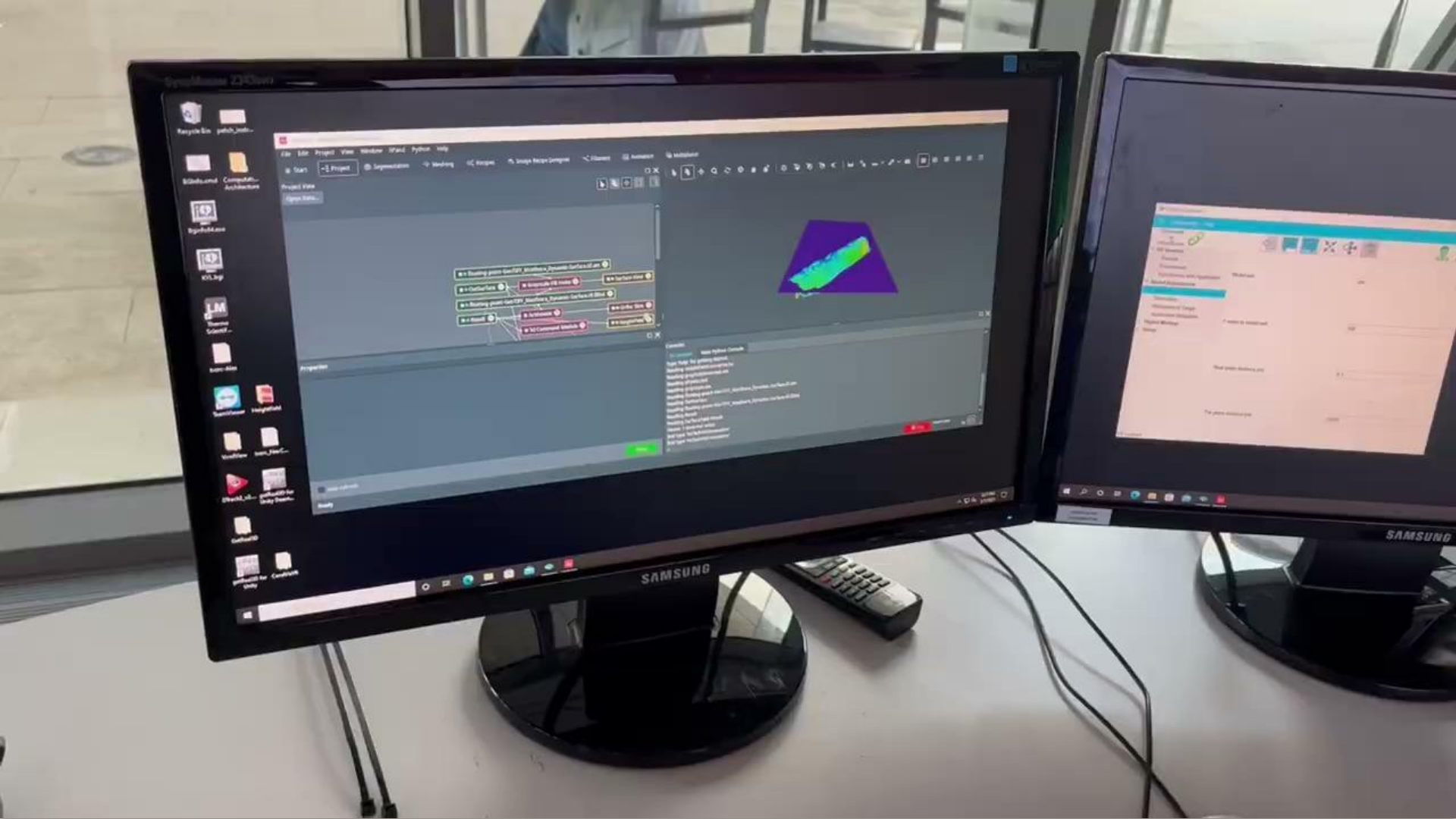
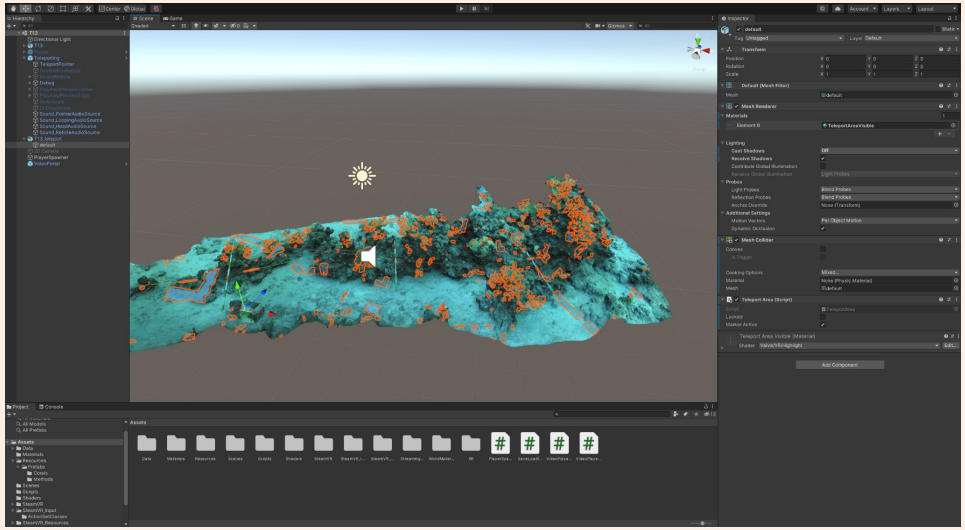
3/17/2022

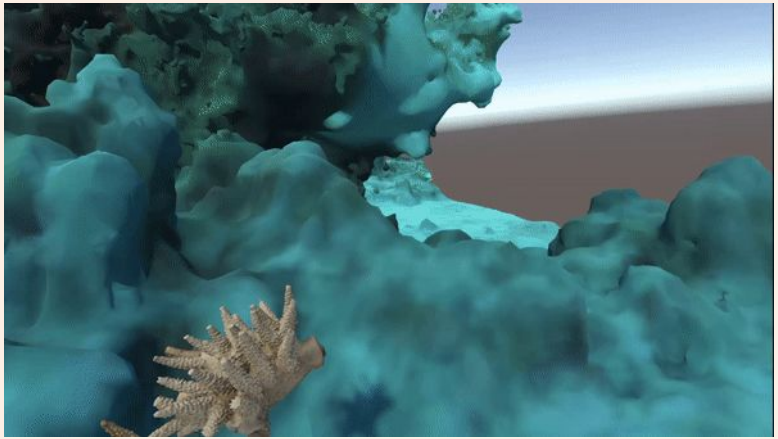

SAMSUNG
SAMSUNG

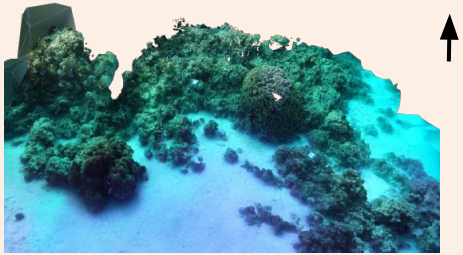
Software: Unity

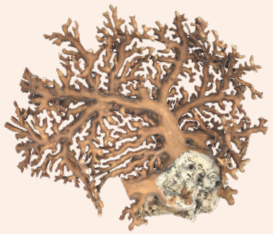
unity.com

Software: Unity

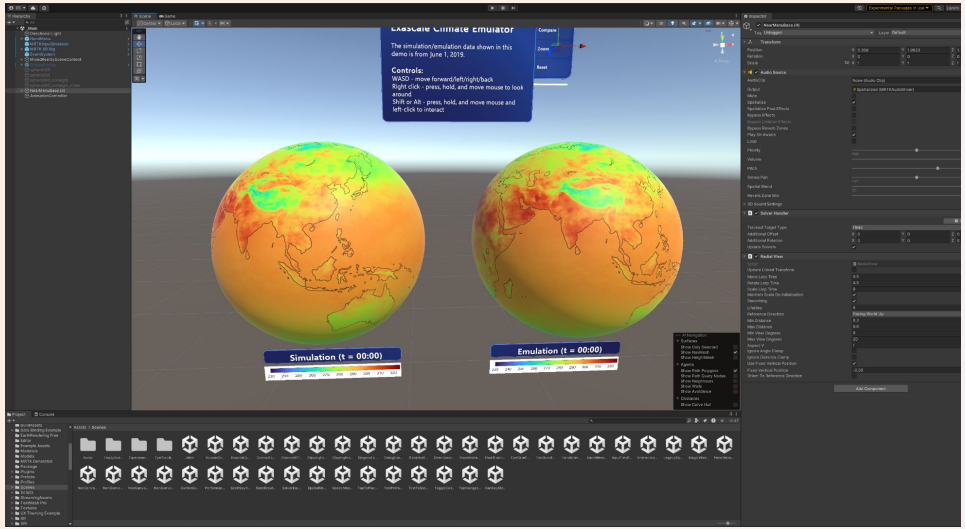


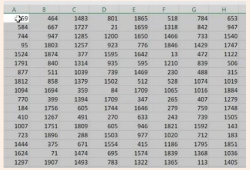


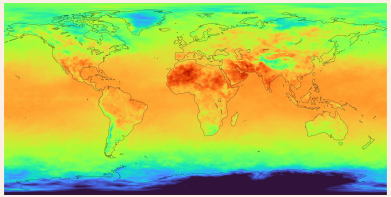




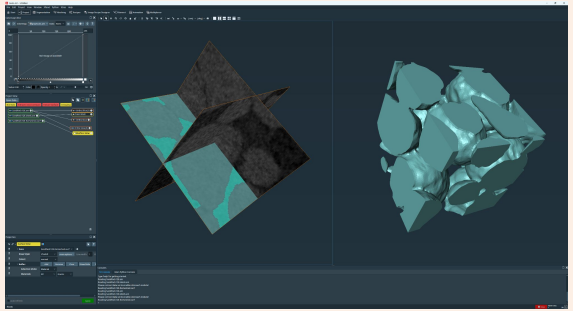
Software: Unity

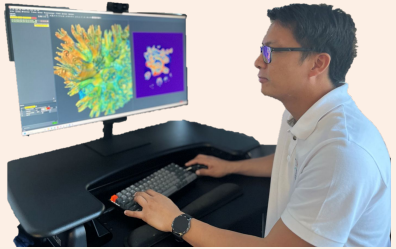


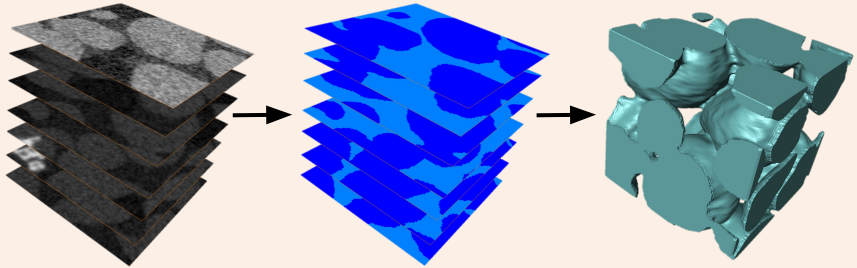


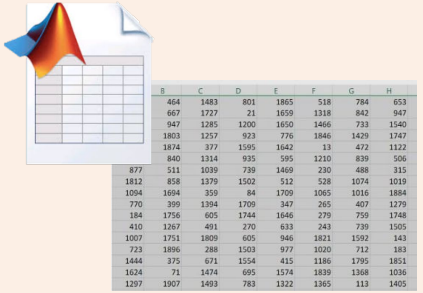


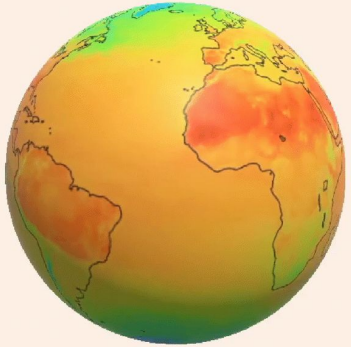
Expertise: Development



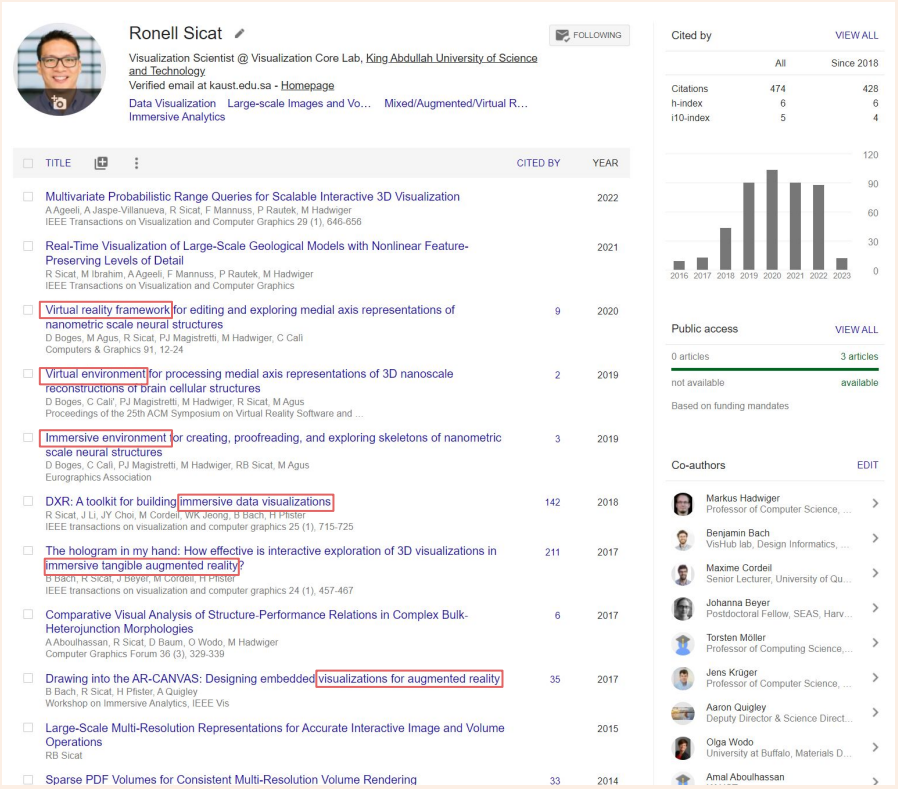








Expertise: Collaboration



Ronell Sicat

FOLLOWING

Visualization Scientist @ Visualization Core Lab, King Abdullah University of Science and Technology
Verified email at kaust.edu.sa - Homepage
Data Visualization Large-scale Images and Vo… Mixed/Augmented/Virtual R… Immersive Analytics

TITLE	CITED BY	YEAR
Multivariate Probabilistic Range Queries for Scalable Interactive 3D Visualization A Ageeli, A Jaspe-Villanueva, R Sicat, F Mannuss, P Rautek, M Hadwiger IEEE Transactions on Visualization and Computer Graphics 29 (1), 646-656		2022
Real-Time Visualization of Large-Scale Geological Models with Nonlinear Feature-Preserving Levels of Detail R Sicat, M Ibrahim, A Ageeli, F Mannuss, P Rautek, M Hadwiger IEEE Transactions on Visualization and Computer Graphics		2021
Virtual reality framework for editing and exploring medial axis representations of nanometric scale neural structures D Boges, M Agus, R Sicat, PJ Magistretti, M Hadwiger, C Calì Computers & Graphics 91, 12-24	9	2020
Virtual environment for processing medial axis representations of 3D nanoscale reconstructions of brain cellular structures D Boges, C Calì', PJ Magistretti, M Hadwiger, R Sicat, M Agus Proceedings of the 25th ACM Symposium on Virtual Reality Software and …	2	2019
Immersive environment for creating, proofreading, and exploring skeletons of nanometric scale neural structures D Boges, C Calì, PJ Magistretti, M Hadwiger, RB Sicat, M Agus Eurographics Association	3	2019
DXR: A toolkit for building immersive data visualizations R Sicat, J Li, JY Choi, M Cordeil, WK Jeong, B Bach, H Pfister IEEE transactions on visualization and computer graphics 25 (1), 715-725	142	2018
The hologram in my hand: How effective is interactive exploration of 3D visualizations in immersive tangible augmented reality? B Bach, R Sicat, J Beyer, M Cordeil, H Pfister IEEE transactions on visualization and computer graphics 24 (1), 457-467	211	2017
Comparative Visual Analysis of Structure-Performance Relations in Complex Bulk-Heterojunction Morphologies A Abouelhassan, R Sicat, D Baum, O Wodo, M Hadwiger Computer Graphics Forum 36 (3), 329-339	6	2017
Drawing into the AR-CANVAS: Designing embedded visualizations for augmented reality B Bach, R Sicat, H Pfister, A Quigley Workshop on Immersive Analytics, IEEE Vis	35	2017
Large-Scale Multi-Resolution Representations for Accurate Interactive Image and Volume Operations RB Sicat		2015
Sparse PDF Volumes for Consistent Multi-Resolution Volume Rendering	33	2014

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- Benjamin Bach, VisHub lab, Design Informatics, …
- Maxime Cordeil, Senior Lecturer, University of Qu…
- Johanna Beyer, Postdoctoral Fellow, SEAS, Harv…
- Torsten Möller, Professor of Computing Science,…
- Jens Krüger, Professor of Computer Science, …
- Aaron Quigley, Deputy Director & Science Direct…
- Olga Wodo, University at Buffalo, Materials D…
- Amal Abouelhassan

The Hologram in My Hand:
How Effective is Interactive Exploration of 3D Visualizations in Immersive Tangible Augmented Reality?

Benjamin Bach, Ronell Sicat, Johanna Beyer, Maxime Cordeil, Hanspeter Pfister

(a) Distance task (b) Cluster task (c) Selection task (d) Cutting plane task

Fig. 1. Monoscopic and low-resolution approximations of hologram visualizations of 3D scatterplots using immersive tangible augmented reality with the HoloLens. Actual perception through the HoloLens provides stereoscopic images and higher resolution.

Abstract—We report on a controlled user study comparing three visualization environments for common 3D exploration. Our

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DXR: A Toolkit for Building Immersive Data Visualizations

Ronell Sicat, Jiabao Li, JunYoung Choi, Maxime Cordeil, Won-Ki Jeong, Benjamin Bach, and Hanspeter Pfister

Fig. 1. DXR enables rapid prototyping of immersive data visualizations: (b,c) declarative specifications concisely represent visualizations; (a:right) DXR's graphical user interface (GUI) within the virtual world enables quick iteration over visualization parameters such as data sources, graphical marks, and visual encodings; (b) the GUI modifies the underlying design specifications; (c) specifications can be fine-tuned by the designer in a text editor; (d) the designer can add 3D models as custom graphical marks to achieve (e) novel immersive visualization designs. Example visualizations built using DXR: (f) a 3D vector field plot showing locations of photographs of an exhibit; (g) flames representing the remaining lifetime of real-world organic materials as they decay; (h) bar charts and scatter plots

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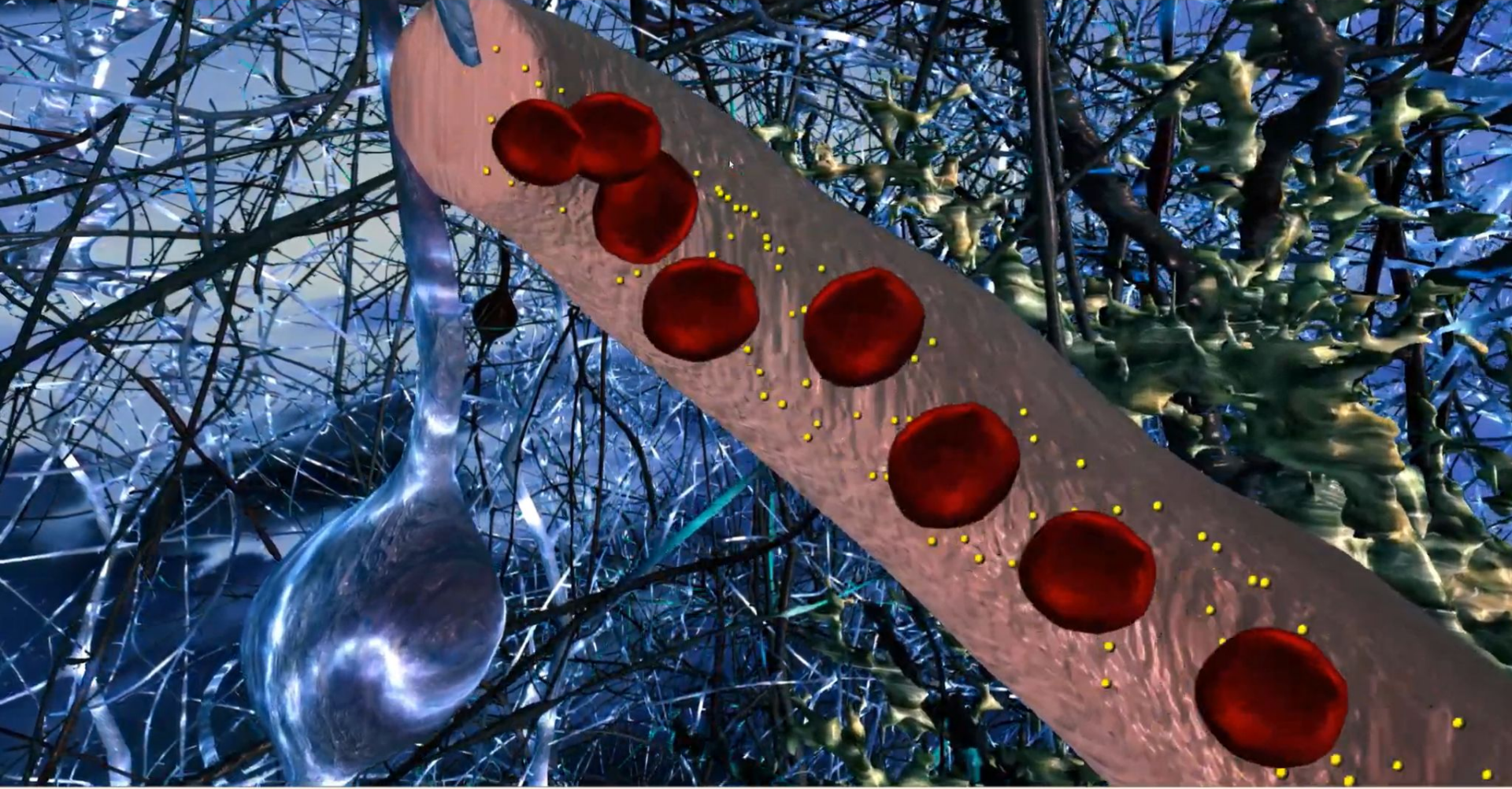
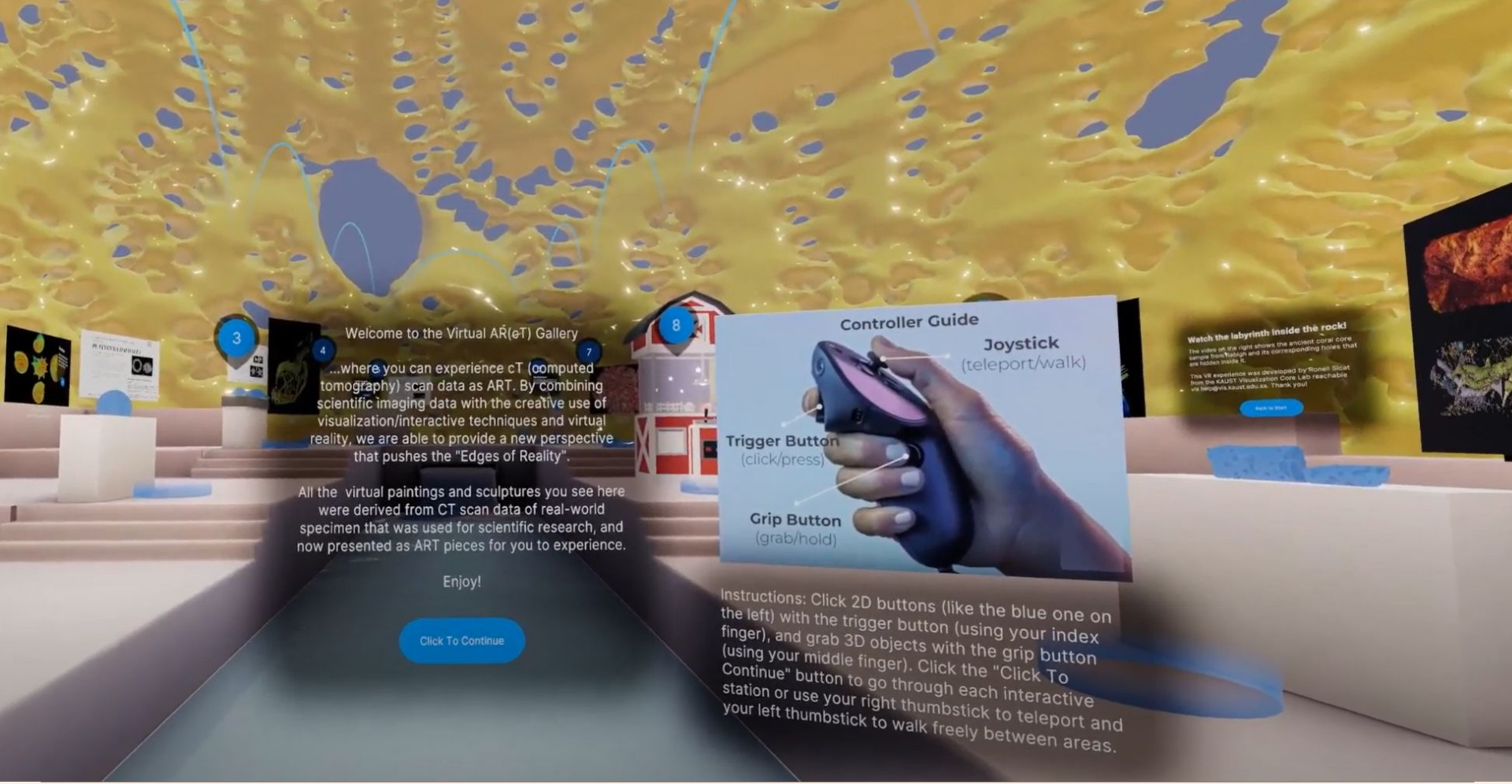
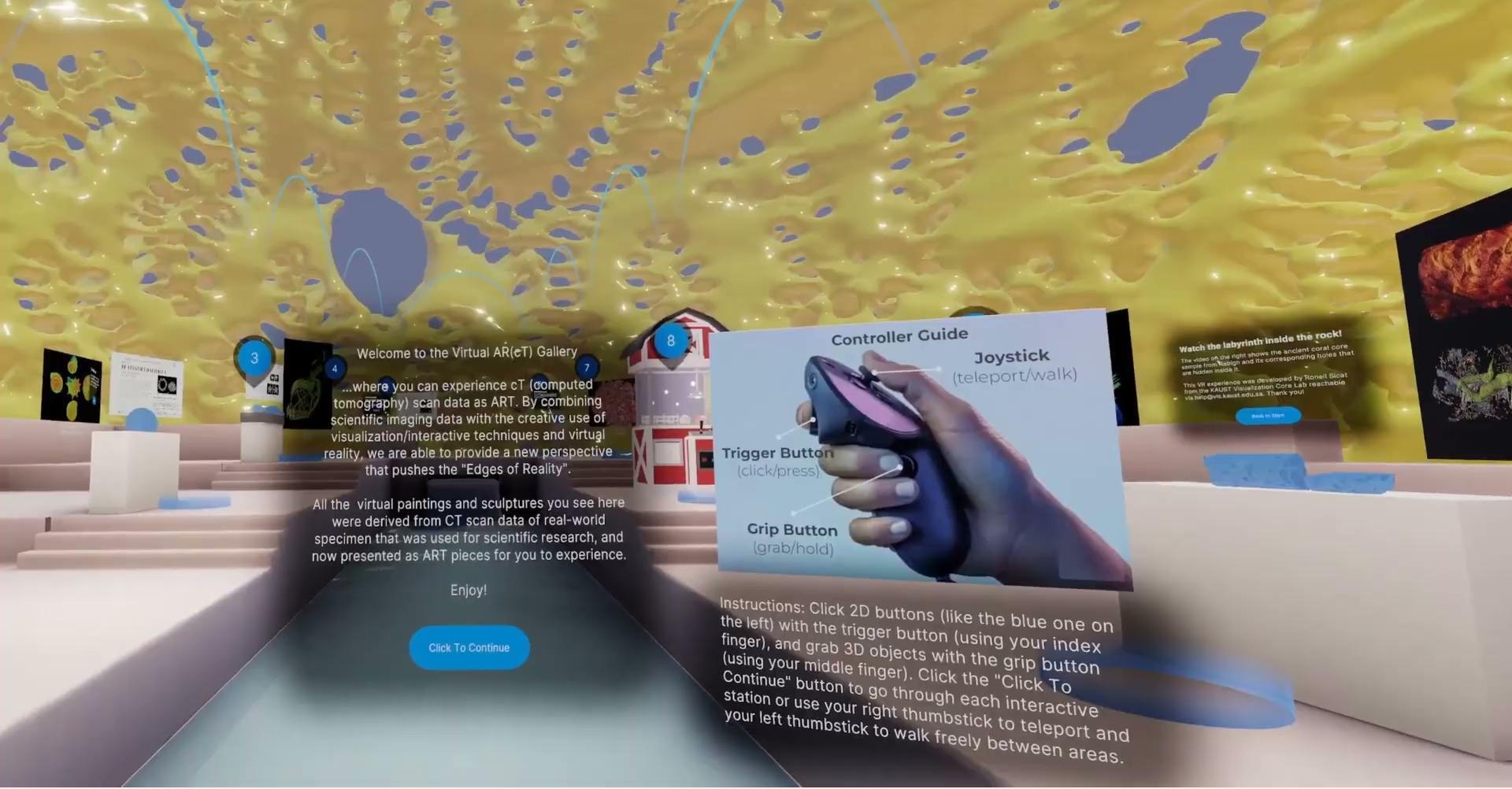
~~Live~~ Demos




Welcome to the Virtual AR(eT) Gallery
...where you can experience cT (computed tomography) scan data as ART. By combining scientific imaging data with the creative use of visualization/interactive techniques and virtual reality, we are able to provide a new perspective that pushes the "Edges of Reality".
All the virtual paintings and sculptures you see here were derived from CT scan data of real-world specimen that was used for scientific research, and now presented as ART pieces for you to experience.
Enjoy!
Click To Continue
Controller Guide
Joystick
(teleport/walk)
Trigger Button
(click/press)
Grip Button
(grab/hold)
Instructions: Click 2D buttons (like the blue one on the left) with the trigger button (using your index finger), and grab 3D objects with the grip button (using your middle finger). Click the "Click To Continue" button to go through each interactive station or use your right thumbstick to teleport and your left thumbstick to walk freely between areas.
Watch the labyrinth inside the rock!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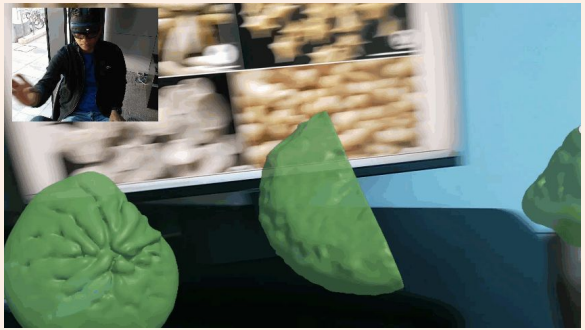
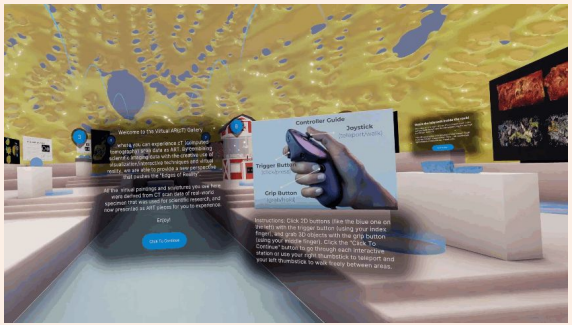
Live Demos

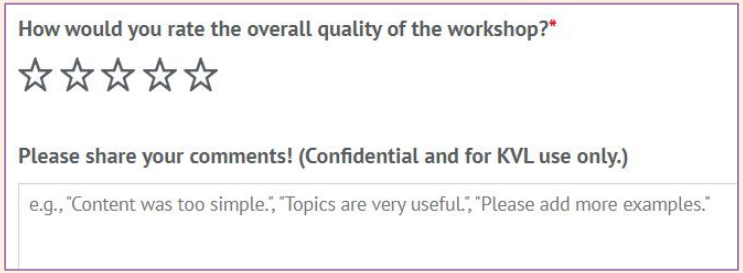




AR/VR Facilities Tour

Thank you!

Please share your feedback. →



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