



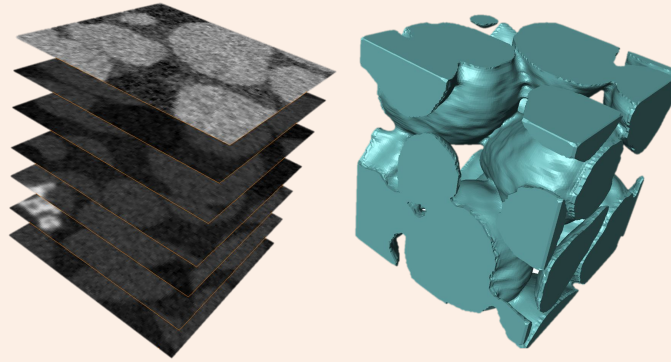
AR & VR for Data Visualization

Ronell Sicat & Ahmed Saleh @ KAUST Visualization Core Lab

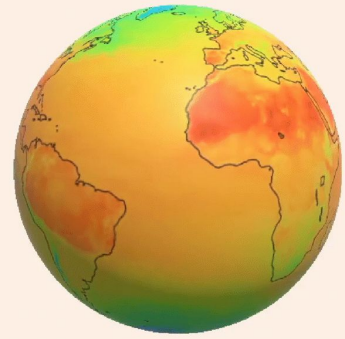
How can
AR & VR
help you

visualize,
understand,
& explain

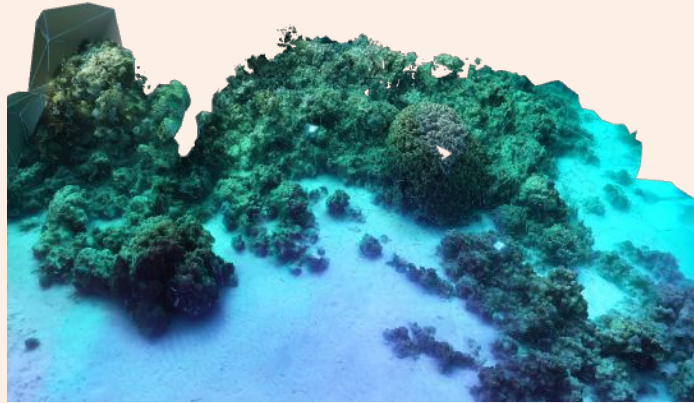
your data?



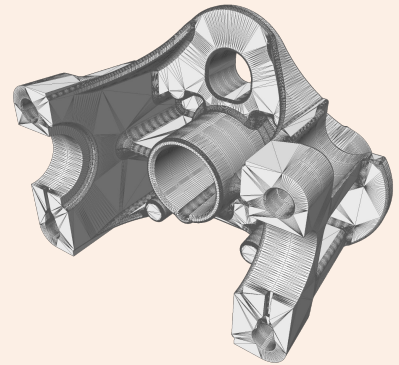
Microscopy



Simulation



Photogrammetry



3D Modeling



Click here to learn more about the importance of coral reefs.

Click here to learn more about the importance of coral reefs.

Click here to learn more about the importance of coral reefs.

Click here to learn more about the importance of coral reefs.

Click here to learn more about the importance of coral reefs.

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Overview

KVL Introduction

What is AR/VR?

Why AR/VR for Data Vis?

AR/VR Services @ KVL

Live Demos & Discussions

AR/VR Facilities Tour

KAUST Visualization Core Lab Introduction

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



Sohaib Ghani

- Visual Analytics
- Information Visualization
- Statistical 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



Ronell Sicat

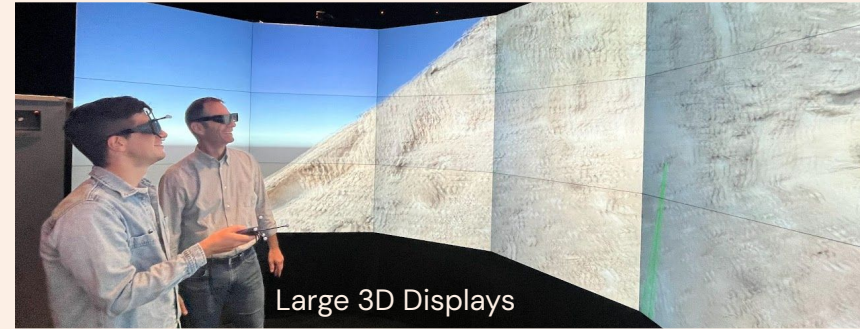
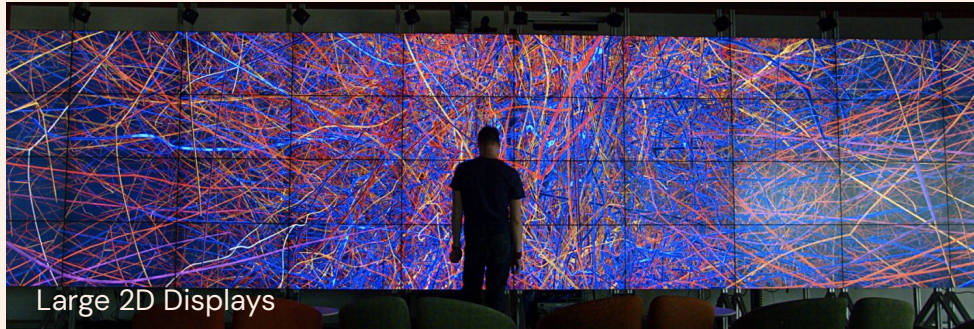
- Scientific Visualization
- Segmentation/3D Analysis
- AR/VR Development



Ahmed Saleh

- AR/VR Development
- Digital Twins
- Real-Time 3D

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



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



What is AR/VR?

AR/VR: hardware and **software** systems that enable users to experience a blend of the **real** and **virtual** worlds.

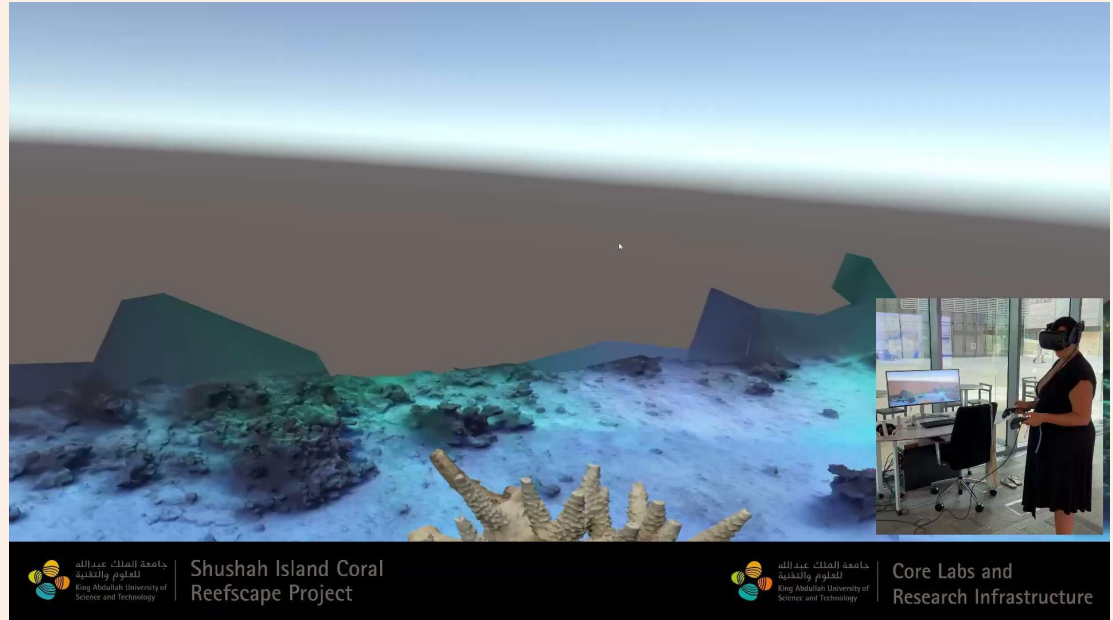
related terms: reality-virtuality continuum, **Mixed Reality**, **eXtended Reality**

Virtual Reality (VR)

VR Device
(Hardware)



Application / Game
(Software)



(Virtual World)

VR Examples



Riegler et al. 2019

Driving Simulator



auic.ajman.ac.ae

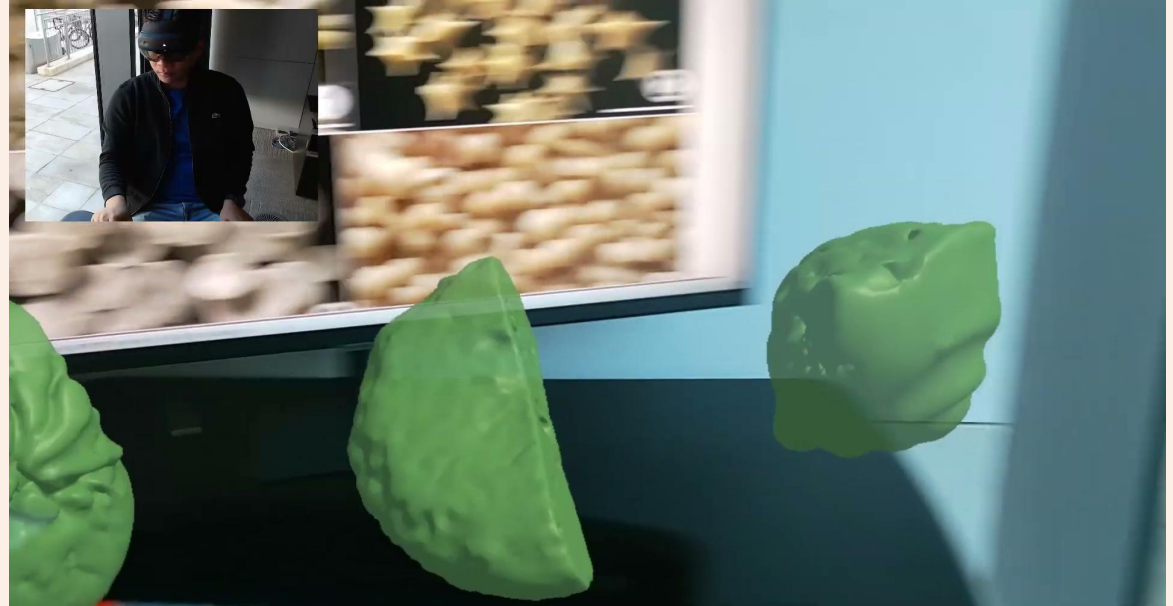
Virtual Travel

Augmented Reality (AR)

AR Device
(Hardware)



Application / Game
(Software)



(Real + Virtual World)

AR Examples



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

AR Games



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

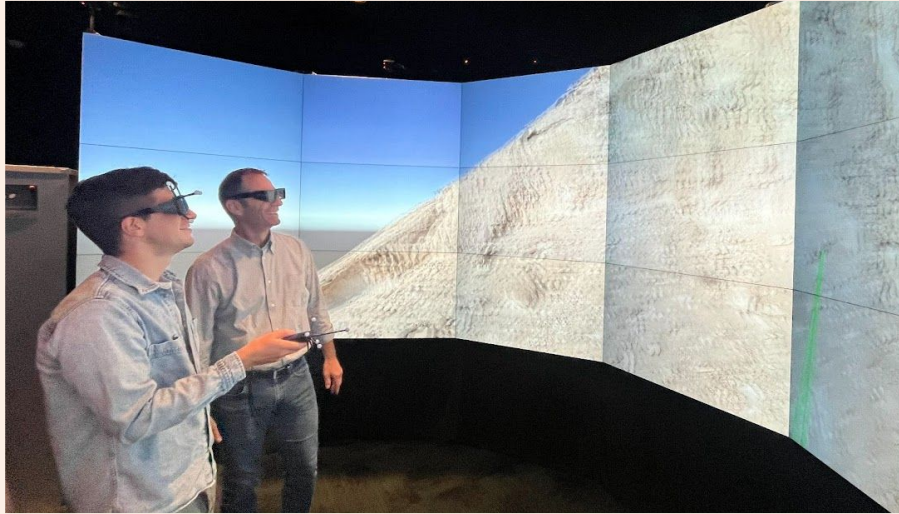
AR Effects



AI-generated using MS copilot

AR Cinema

CAVE VR



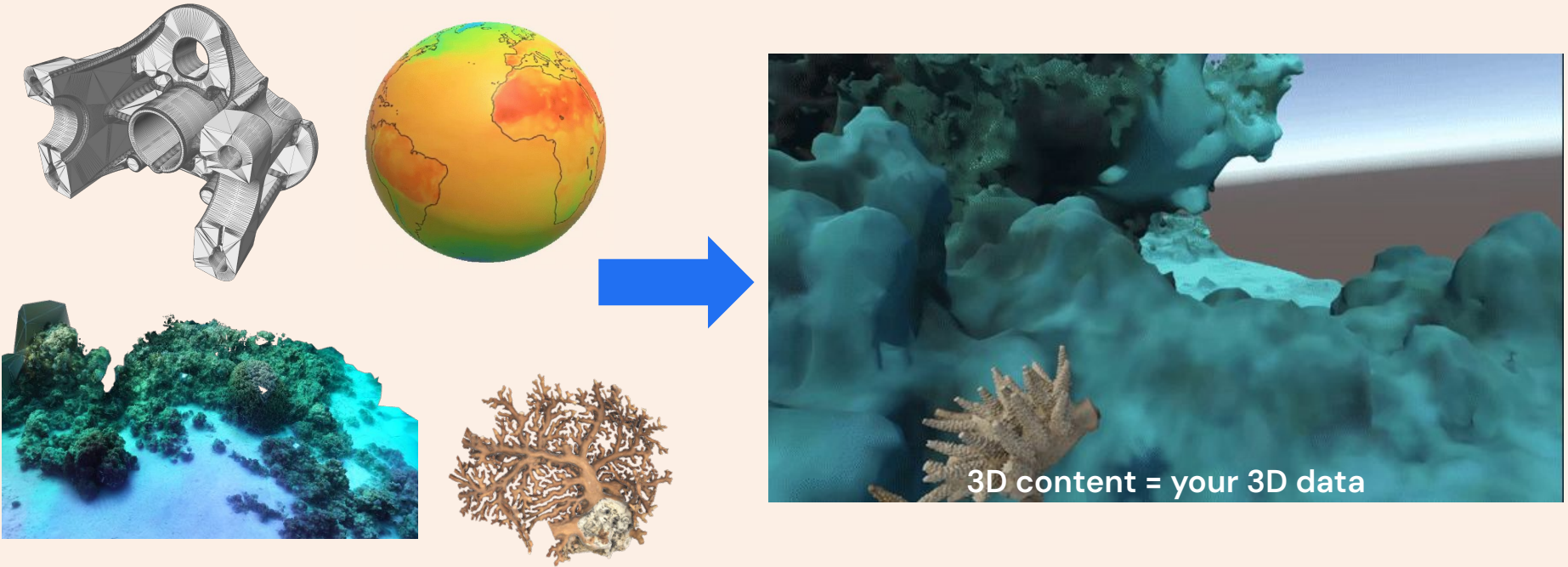
CUBES



(Real + Virtual World)

AR/VR for Data Vis?

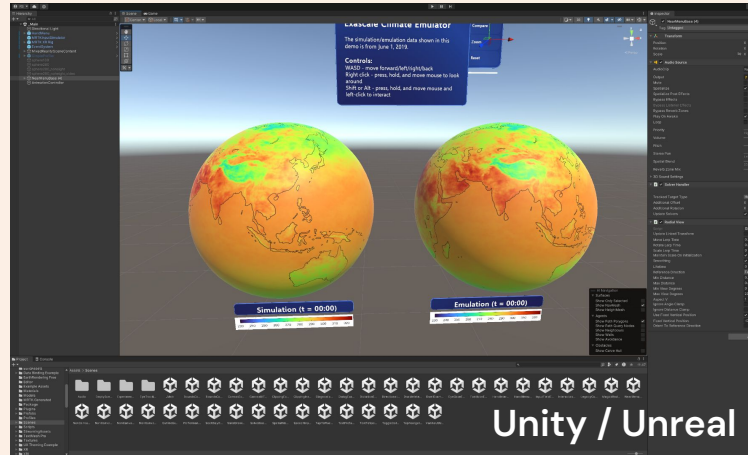
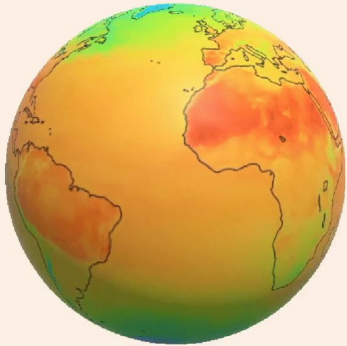
AR/VR for Data Vis: Data → AR/VR



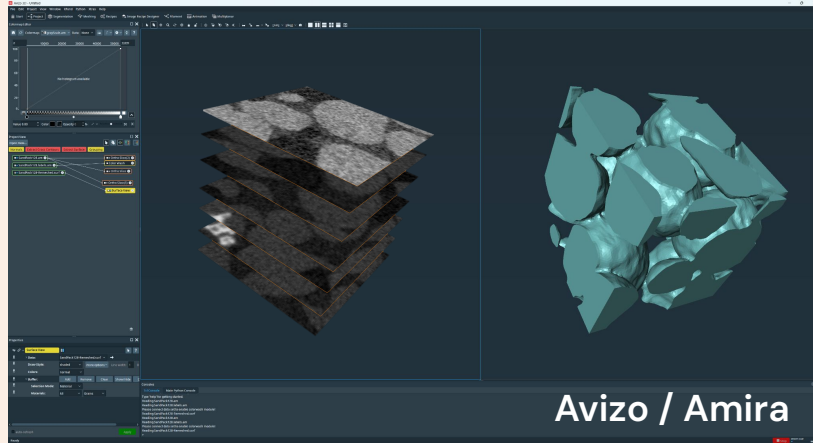
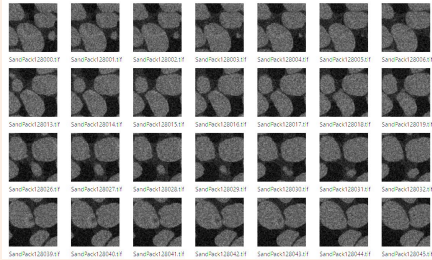
Data → AR/VR example



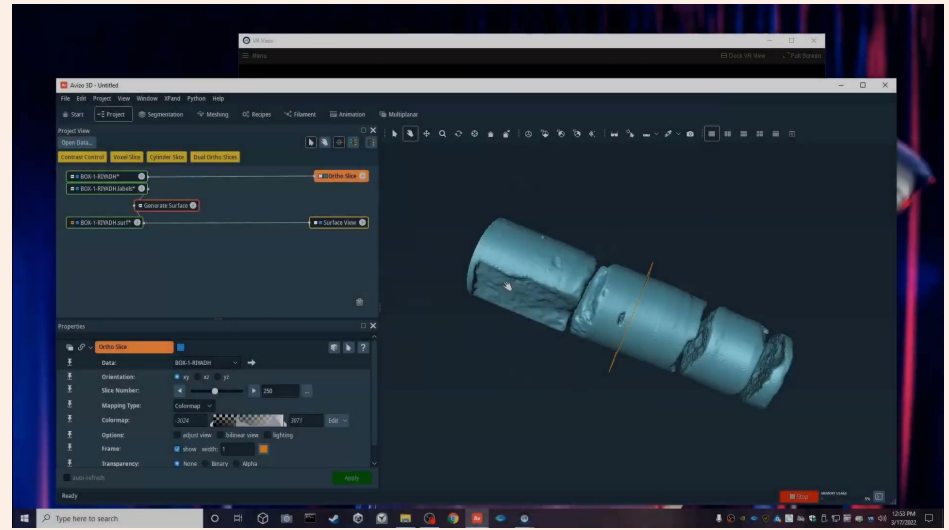
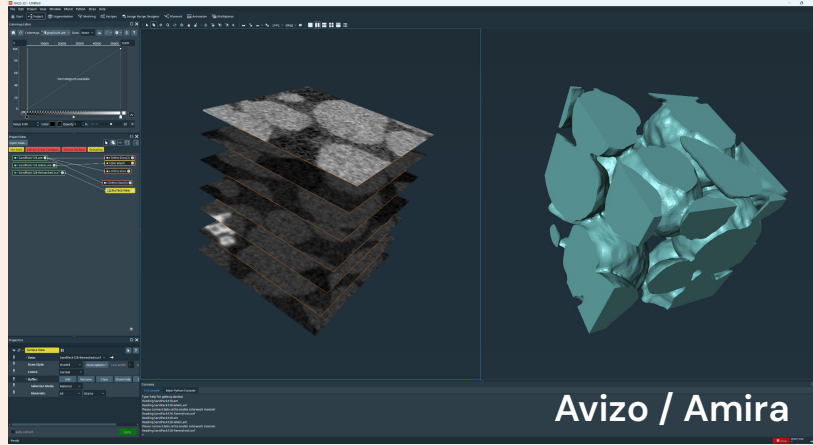
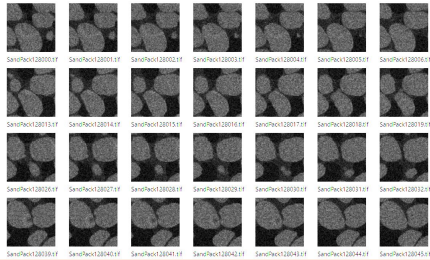
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Data → AR/VR example

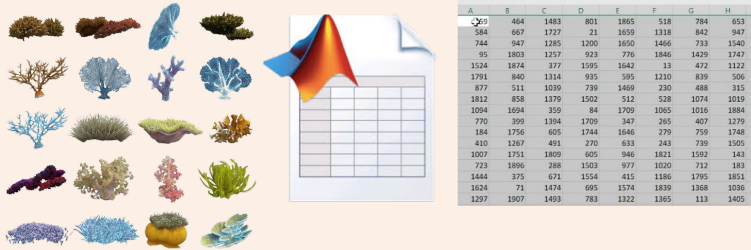


Data → AR/VR example



What is AR/VR?

Data → AR/VR example



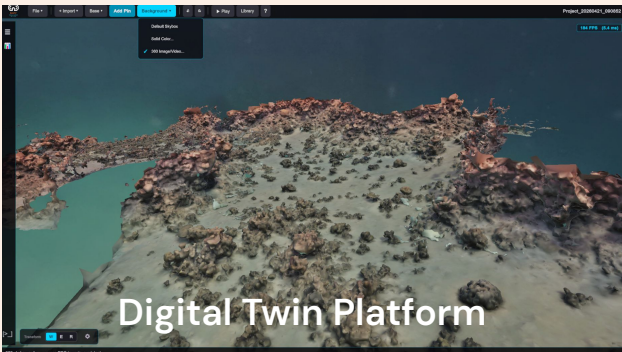
3D laptop (zSpace)



VR headsets



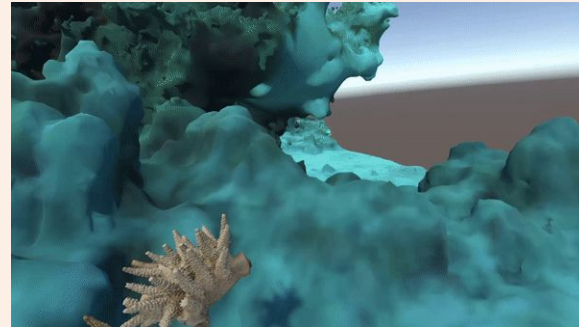
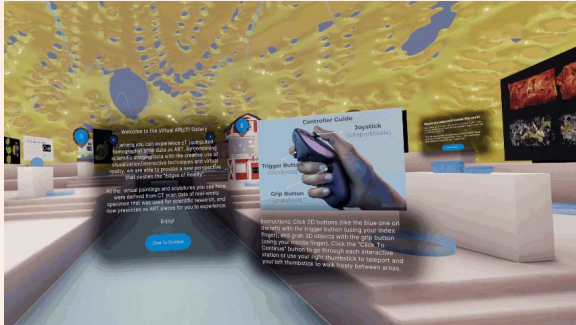
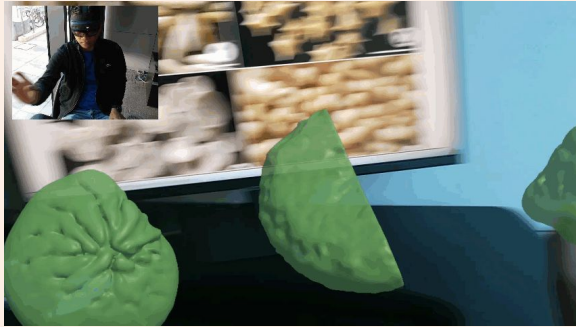
CAVE VR



Digital Twin Platform



AR/VR for Data Vis: Data → AR/VR



Why AR/VR for Data Vis?

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

- understanding 3D spatial data
- intuitive 3D interactions
- engaging immersive storytelling
- and more!

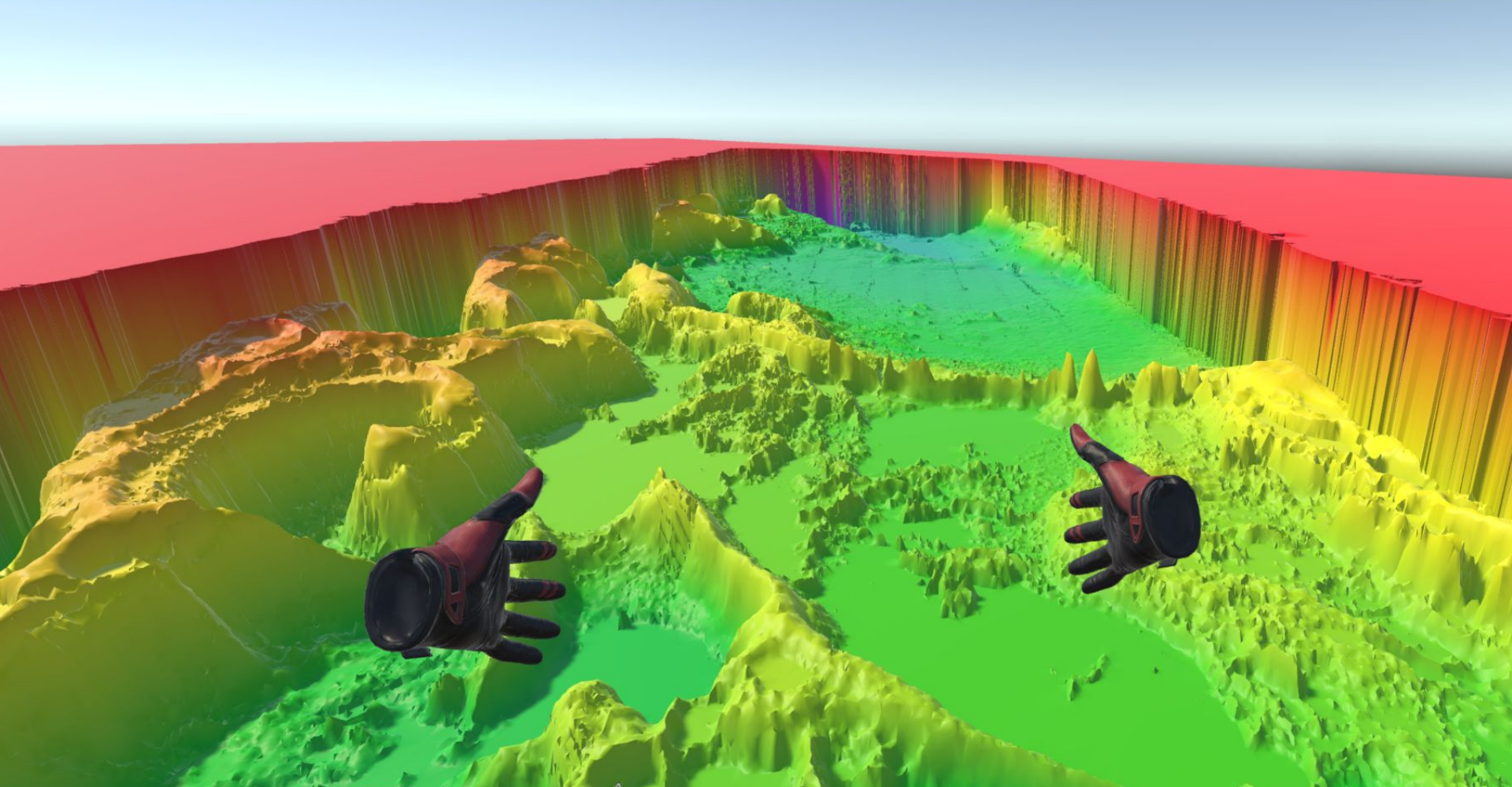
All following examples are developed by KVL.

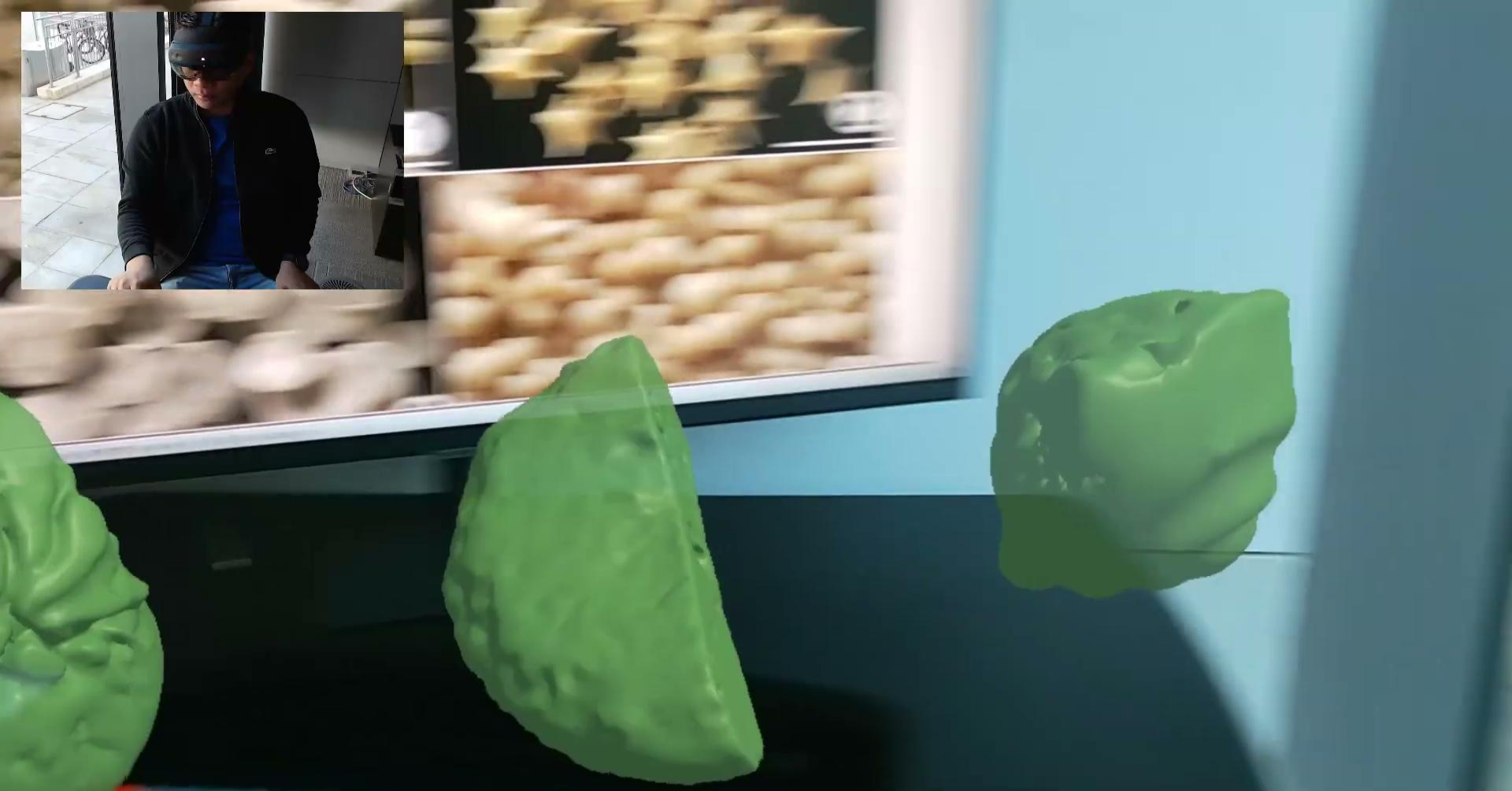


Credits: KVL + Prof. Finkbeiner's Group

Understanding 3D Spatial Data







Credits: KVL + Ali Al Ibrahim

Intuitive 3D Interactions



Credits: KVL + Prof. Peixoto's Group

Engaging Immersive Storytelling



Informational panel showing a close-up of a fish and associated data.

Informational panel showing a close-up of a fish and associated data.

Informational panel with text and images, likely describing the simulation or the user's role.

Informational panel showing a close-up of a fish and associated data.

Informational panel with logos and text, including the text: "Only you from before to learn more about each of the pillars of the Circular Production Village."





Electron Microscopy of Brain Tissue Fixed By Focused Beam Microwave To Preserve Glycogen

Introduction

Microscopy is an essential tool for the study of biological structures. However, the preparation of samples for electron microscopy (EM) is a complex and often time-consuming process. Glycogen, a polysaccharide of glucose, is a key energy storage molecule in cells. Preserving its structure and distribution in EM is a significant challenge. This study aims to develop a protocol for the fixation of brain tissue using a focused beam microwave (FBM) to preserve glycogen structure for subsequent EM analysis.

Objectives

1. To develop a protocol for the fixation of brain tissue using FBM.
2. To evaluate the effectiveness of FBM fixation in preserving glycogen structure.
3. To compare the results of FBM fixation with conventional fixation methods.
4. To determine the optimal parameters for FBM fixation.

Methodology

Microwave Fixation

1. Sample Preparation: Brain tissue was sectioned and fixed with a focused beam microwave (FBM) system.

2. Staining: The fixed tissue was stained with uranyl acetate and lead citrate for EM.

Sample Preparation

1. Brain Sectioning & Fixation

2. Staining & Embedding

3. Sectioning & Image Acquisition

Data Acquisition

1. Image Acquisition

2. Image Processing

Segmentation and 3D Reconstruction

1. Image Segmentation

2. 3D Reconstruction

Results

Comparison of Ultrastructure of Glycogen Segmentation in Fixed and Microwave Samples

1. Glycogen Segmentation

2. Glycogen Segmentation

Segmentation and Reconstruction of 3D Model

1. Glycogen Segmentation

2. Glycogen Segmentation

Future Directions

1. Glycogen Segmentation

2. Glycogen Segmentation

FinalPoster_3D SM in MW Bra



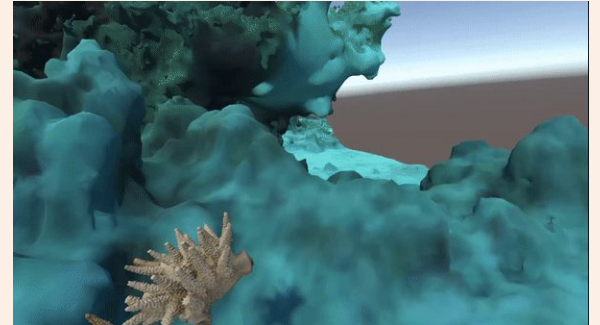
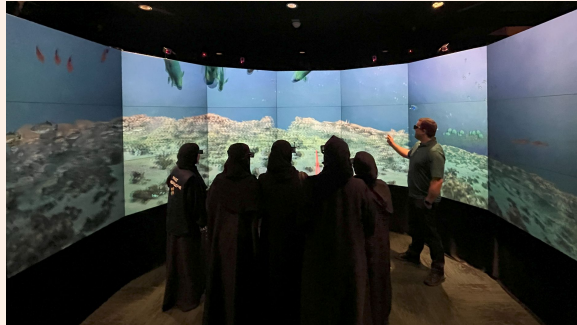
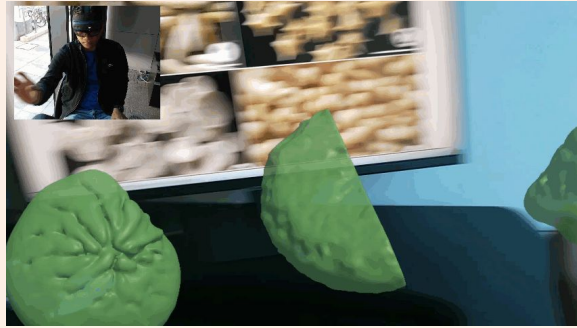
Omar David Sandoval Sida [CC BY-SA 4.0] Wikimedia Commons



How can
AR & VR
help you

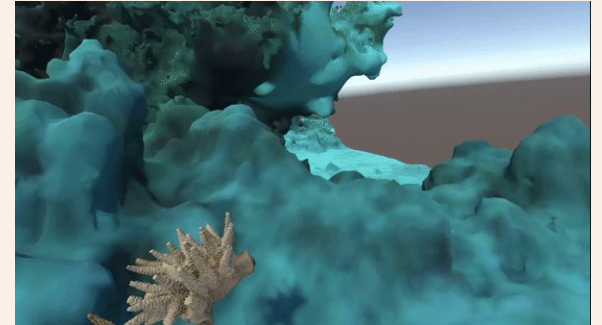
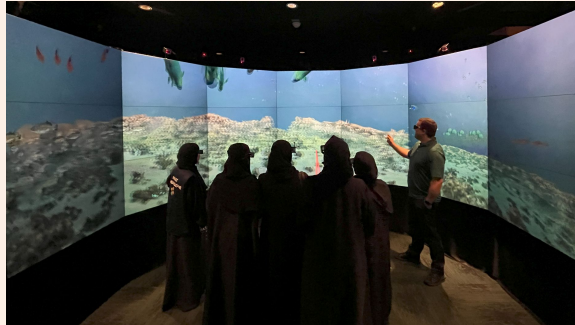
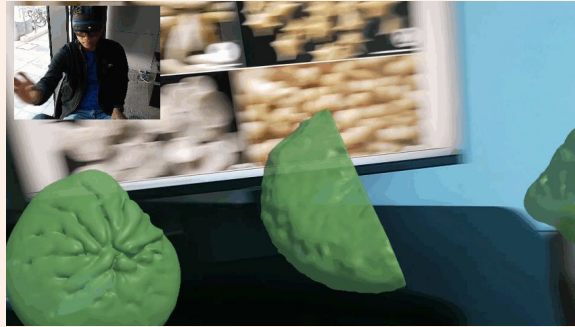
visualize,
understand,
& explain

your data?



How can
KVL
help you

visualize,
understand,
& explain
your data
using
AR/VR?



Up next: AR/VR Services @ KVL

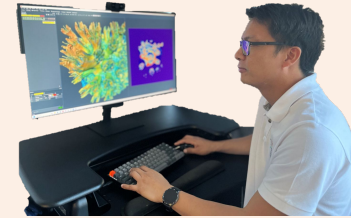
Hardware



Software



Expertise



Services

10-minute Break

AR/VR Services @ KVL

Four ways we can help

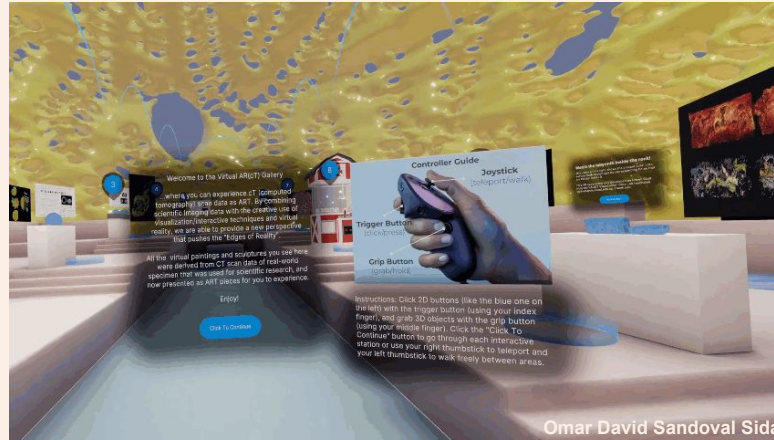
- **Consultation & Co-Design**
- **3D Showcasing**
- **Interactive 3D Tools.**
- **Digital Twins**

Start Here — Consultation & Co-Design

- **You bring:** a research question, dataset, or workflow you think might benefit from immersive viz
- **We deliver:** honest assessment (does AR/VR help?), recommended display + tool stack, scope, effort, milestones
- **No commitment.** Sometimes the answer is "use this off-the-shelf tool yourself" — that's still useful.
- **Book a 30-min scoping chat: help@vis.kaust.edu.sa**

Service 1 — 3D Showcasing

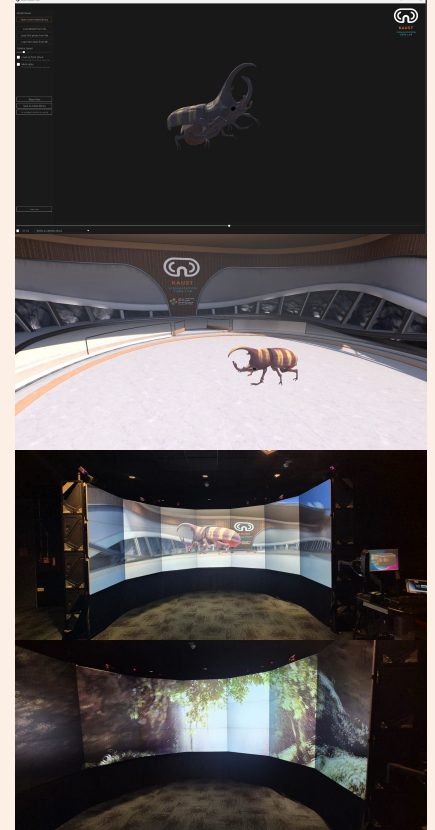
- **You bring:** microscopy, CT/MRI, simulations, point clouds, CAD, GIS — anything that is 3D or can be converted to 3D format
- **We deliver:** cleaned, real-time-ready 3D scene + publication-ready renders



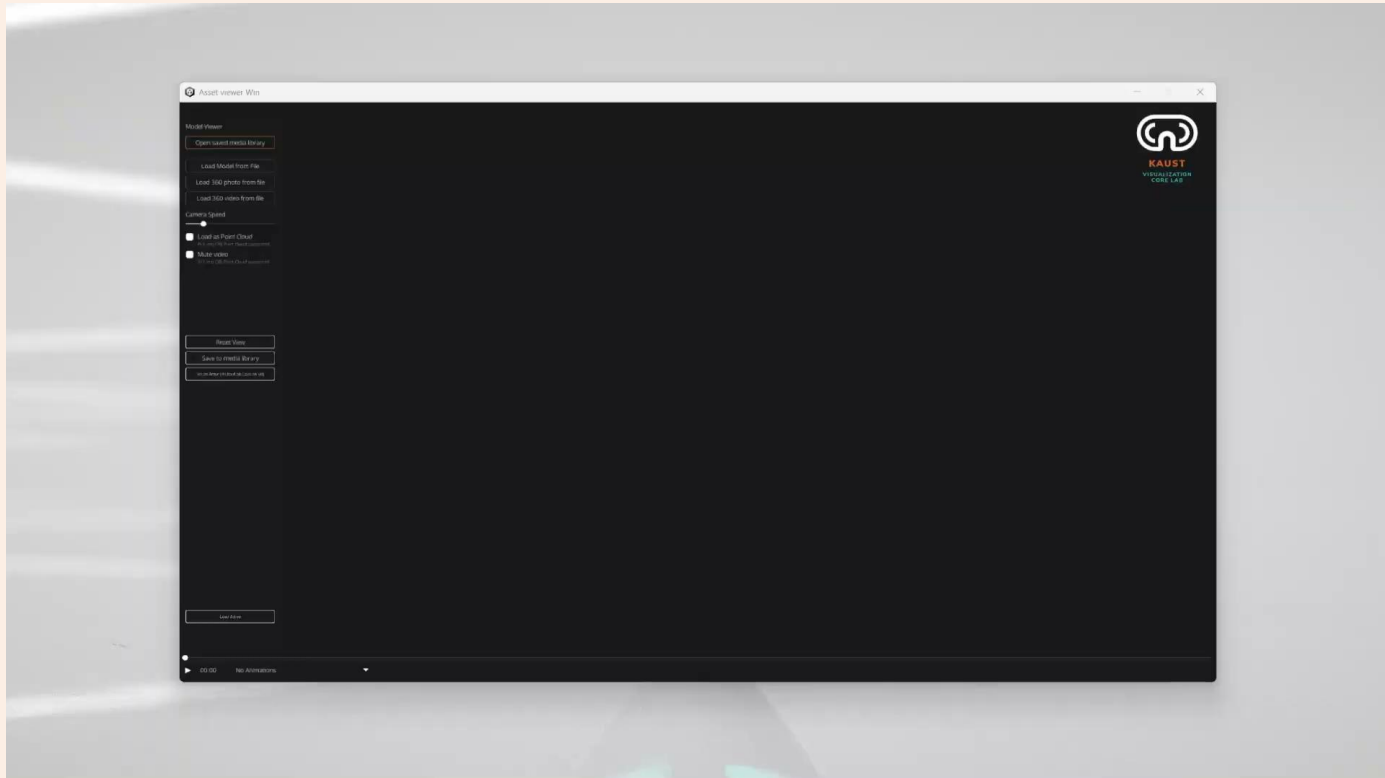
Or do it yourself — the KVL Viewer

Already have 3D data? Skip the build. Load it yourself.

- **Drag in your file.** Pick your screen. Walk into your data.
- **Supported out of the box:** FBX, OBJ, GLTF / GLB, STL, PLY, 3MF, DAE, or a GIS data
- **Runs on:** CUBES (CAVE), 3D desktop viewer, VR HMD
- **Best for:** quick checks, group reviews, datasets you've already cleaned in your own pipeline



KVL Viewer: Load your data



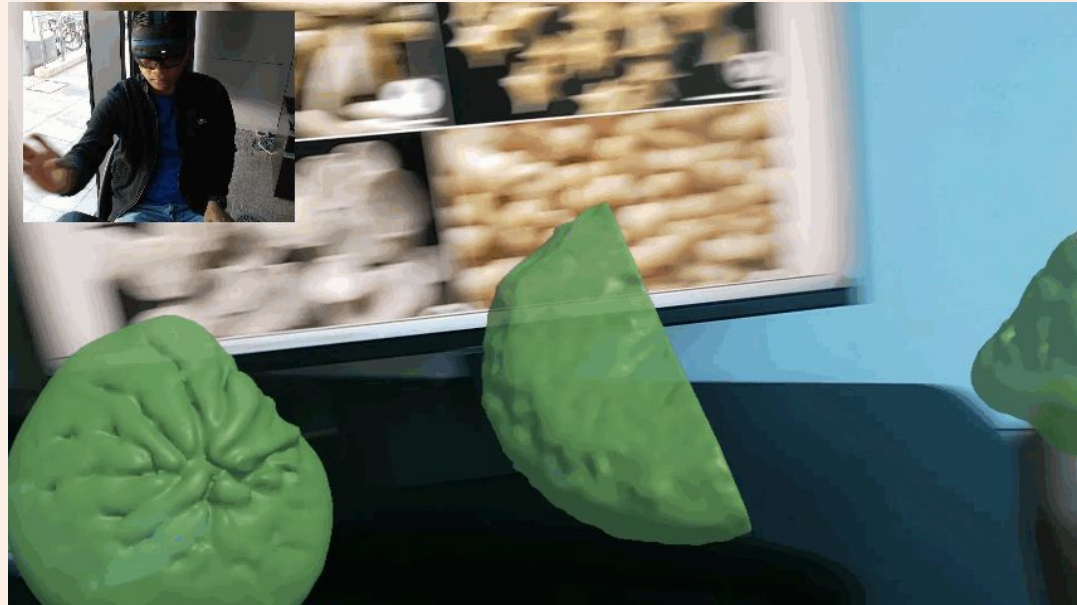
KVL Viewer: Experience your data



Service 2 — Interactive 3D Tools

When viewing isn't enough.

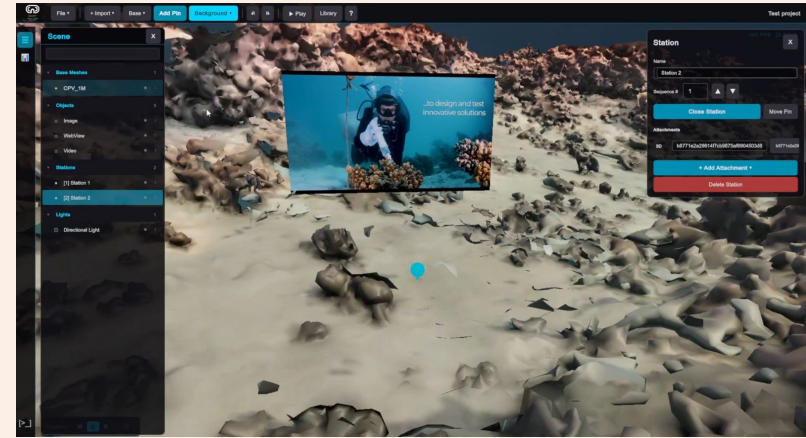
You bring the science problem. We build a single-purpose 3D tool that solves it — the kind of tool that doesn't exist off-the-shelf because nobody else has your data.



Service 3 — Digital Twins

What is a digital twin?

A digital twin is a live data-driven 3D copy of a real place, system, or object that updates as the real thing changes — so you can see, explore, and test it from anywhere.



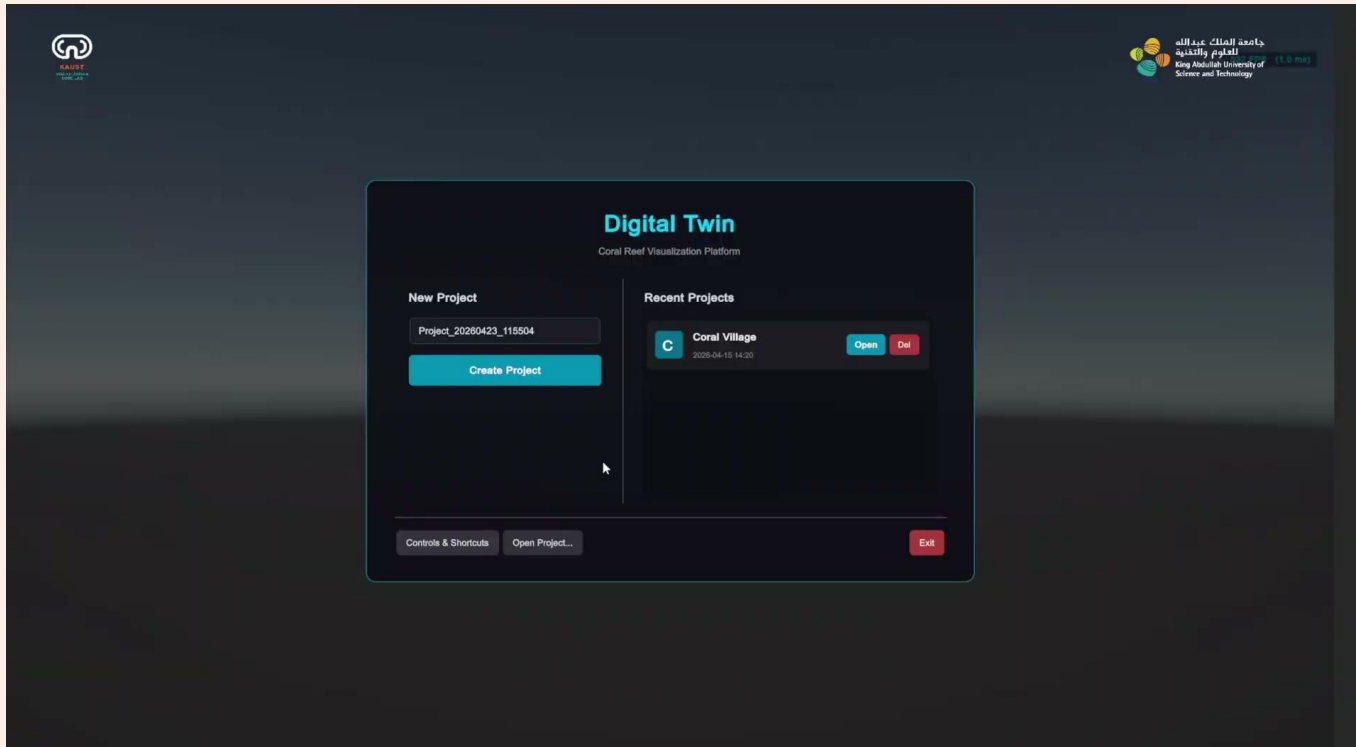
Service 3 — Digital Twins

- **You bring:** a real-world place, system, or facility — plus the data you have on it (live feeds, simulations, 3D scans, or static datasets, photos or videos, etc.)
- **We deliver:** a 3D environment that mirrors your system in real time, viewable on desktop, VR, or CUBES — your data, alive in 3D.

Or do it yourself — KVL Digital Twin Platform



Or do it yourself — KVL Digital Twin Platform



What powers our services

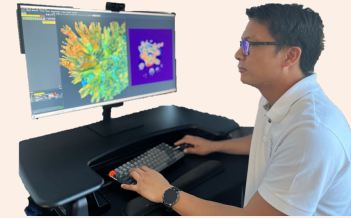
Hardware



Software



Expertise



Hardware: HMDs



Meta Quest 2/3/Pro



HTC Vive Pro 1/2



HoloLens 2



Laptops / Workstations

Hardware: 3D Laptop (zSpace)



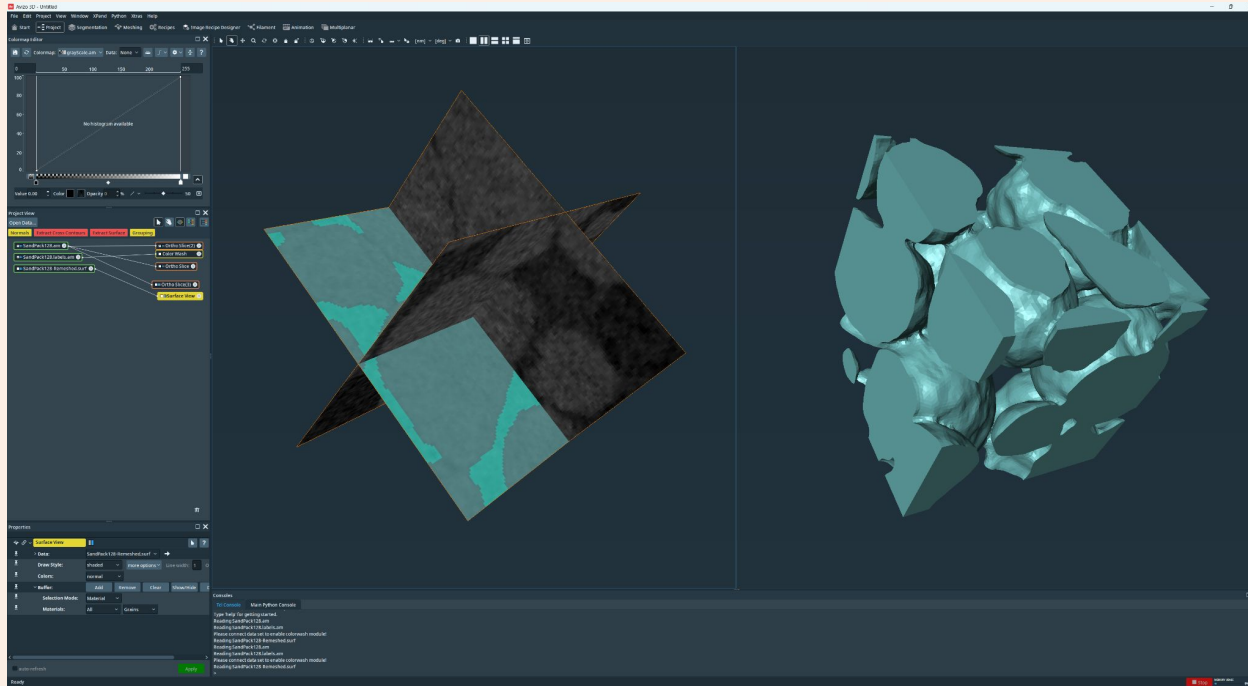
Hardware: CAVE VR (CUBES)



Pick the right platform for your audience

If your goal is...	Best fit
Max reach (talks, web, anyone with a laptop)	3D Desktop / WebGPU Apps
Bring your data into the real world	AR - Mobile or XR headset
Reach in and manipulate with your hands	VR or AR with hand tracking
Deepest immersion	VR Headset
One person Stereo 3D at your desk, no headset	zSpace, Light Field Display
Multiple people inside the data at once	CUBES (CAVE)

Software: Avizo



it.kaust.edu.sa/software/avizo



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* Ortho Slice

BOX-1-RIYADH.labels* Generate Surface

BOX-1-RIYADH.surf* Surface View

Properties

Ortho Slice

Data: BOX-1-RIYADH

Orientation: xy xz yz

Slice Number: 250

Mapping Type: Colormap

Colormap: -3024 3071 Edit

Options: adjust view bilinear view lighting

Frame: show width: 1

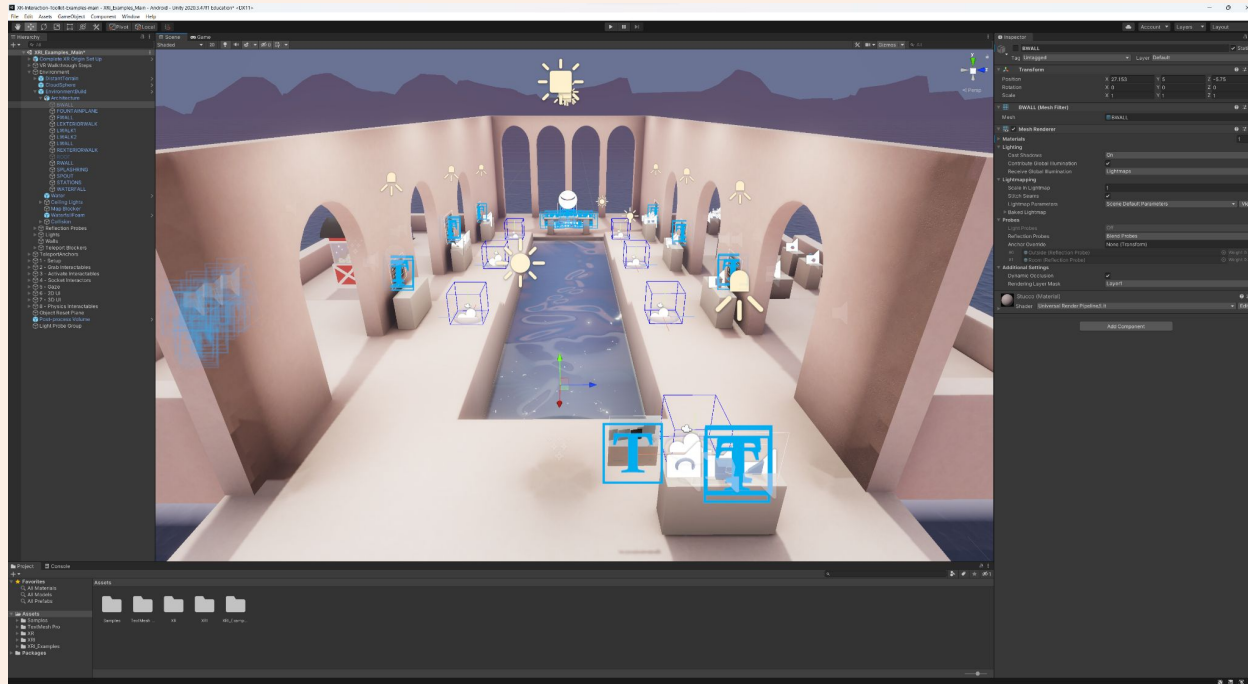
Transparency: None Binary Alpha

auto-refresh Apply

Ready

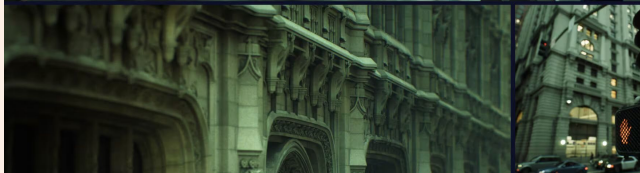
A 3D visualization of a segmented cylindrical object, possibly a biological specimen, rendered in a light blue color. The object is composed of several segments joined together. A vertical orange line indicates the position of an ortho slice. The background is dark with a grid pattern.

Software: Unity



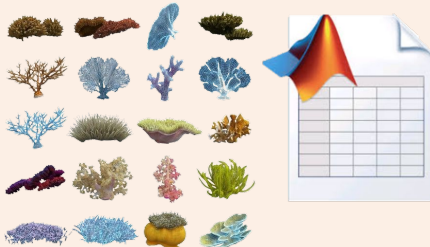
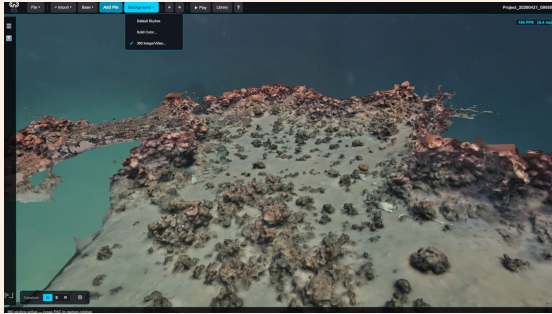
unity.com

Software: Unreal Engine



unrealengine.com

Software: KVL Digital Twin Platform



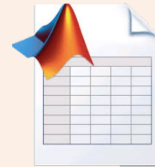
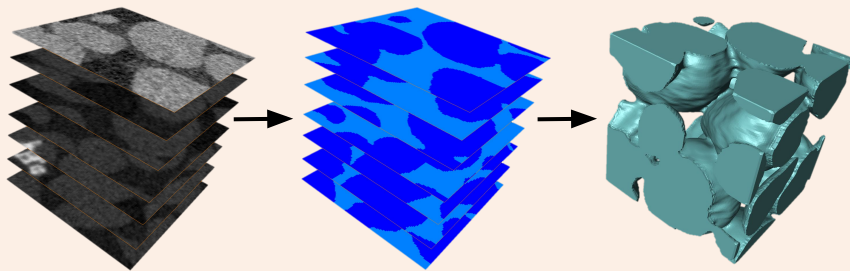
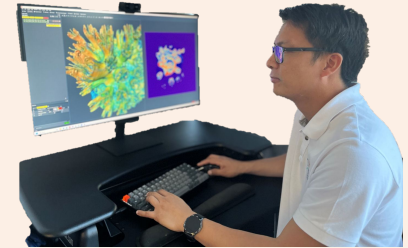
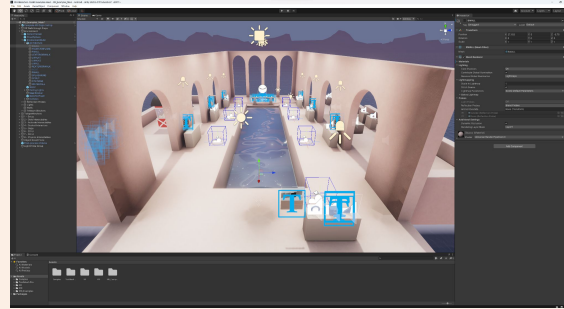
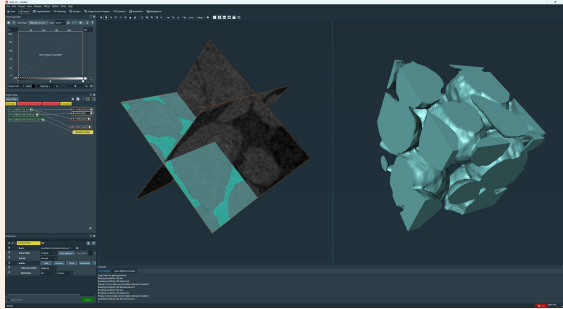
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1024	71	1474	695	1574	1839	1368	1036	
1207	1907	1403	783	1322	1365	113	3460	

AR/VR Hub

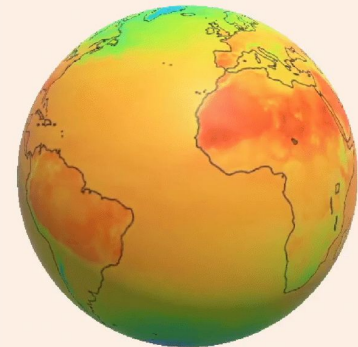


wiki.vis.kaust.edu.sa/arvr

Expertise: Design & Development



	B	C	D	E	F	G	H
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	667	1727	21	1659	1318	842	947
	947	1285	1200	1650	1466	733	1540
	1803	1257	923	776	1840	1429	1147
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1624	71	1474	695	1574	1839	1368	1036
1297	1907	1493	783	1322	1365	113	1405



Expertise: Collaboration



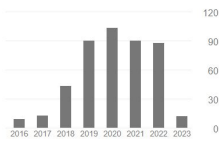
Ronell Sicat

Visualization Scientist @ Visualization Core Lab, King Abdullah University of Science and Technology
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- Oiga Wodo
University at Buffalo, Materials D...
- Amal Aboulhassan

TITLE CITED BY YEAR

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R Sicat, M Ibrahim, A Ageeli, F Mannuss, P Rautek, M Hadwiger
IEEE Transactions on Visualization and Computer Graphics
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D Boges, M Agus, R Sicat, P J Magistretti, M Hadwiger, C Call
Computers & Graphics 91, 12-24
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RB Sicat
- Sparse PDF Volumes for Consistent Multi-Resolution Volume Rendering
33 2014

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 Cordell, Hanspeter Pfister

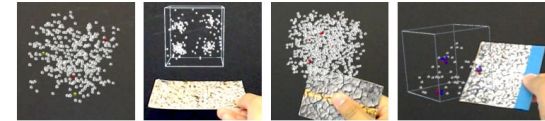


Fig. 1. Monoscopic and low-resolution approximations of hologram visualizations of 3D scatterplots using Immersive Tangible Augmented reality with the HoloLens. Actual perception through the HoloLens provides stereoscopic images and higher resolution.

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

IEEE TRANSACTIONS ON VISUALIZATION AND COMPUTER GRAPHICS, VOL. 25, NO. 1, JANUARY 2019

DXR: A Toolkit for Building Immersive Data Visualizations

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

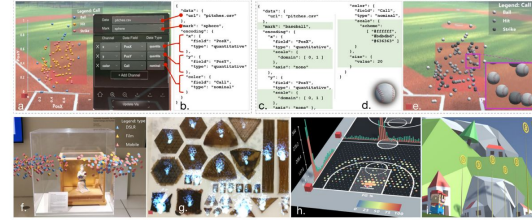


Fig. 1. DXR enables rapid prototyping of immersive data visualizations: (b,c) declarative specifications concisely represent visualizations; (a) right) DXR's graphical user interface (GUI) within the virtual world enables quick iteration over visualization parameters such as data sources, graphical marks, 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

hologram in my hand: How effective is interactive exploration of 3D visualizations in immersive tangible augmented reality with the HoloLens. Actual perception through the HoloLens provides stereoscopic images and higher resolution. We compare an augmented-reality

3-dimensional (3D) content [50], spatial and abstract data can be actions and representations fall). Consequently, research in augmented HCI has contributed a variety of visualization and interaction techniques in the respective conditions, technologies (e.g., [10, 34, 63]), it remains how efficient is direct holograms in the real world? as they for such? zation environments composed ented-reality combined with tanner tracking, called tangible displays, such as Meta [3] or the

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10-minute Break

~~Live~~ Demos

All following examples are developed by KVL.

The mobile AR application allows users to scan the environment and place a virtual version of a giant Red Sea coral in augmented reality.



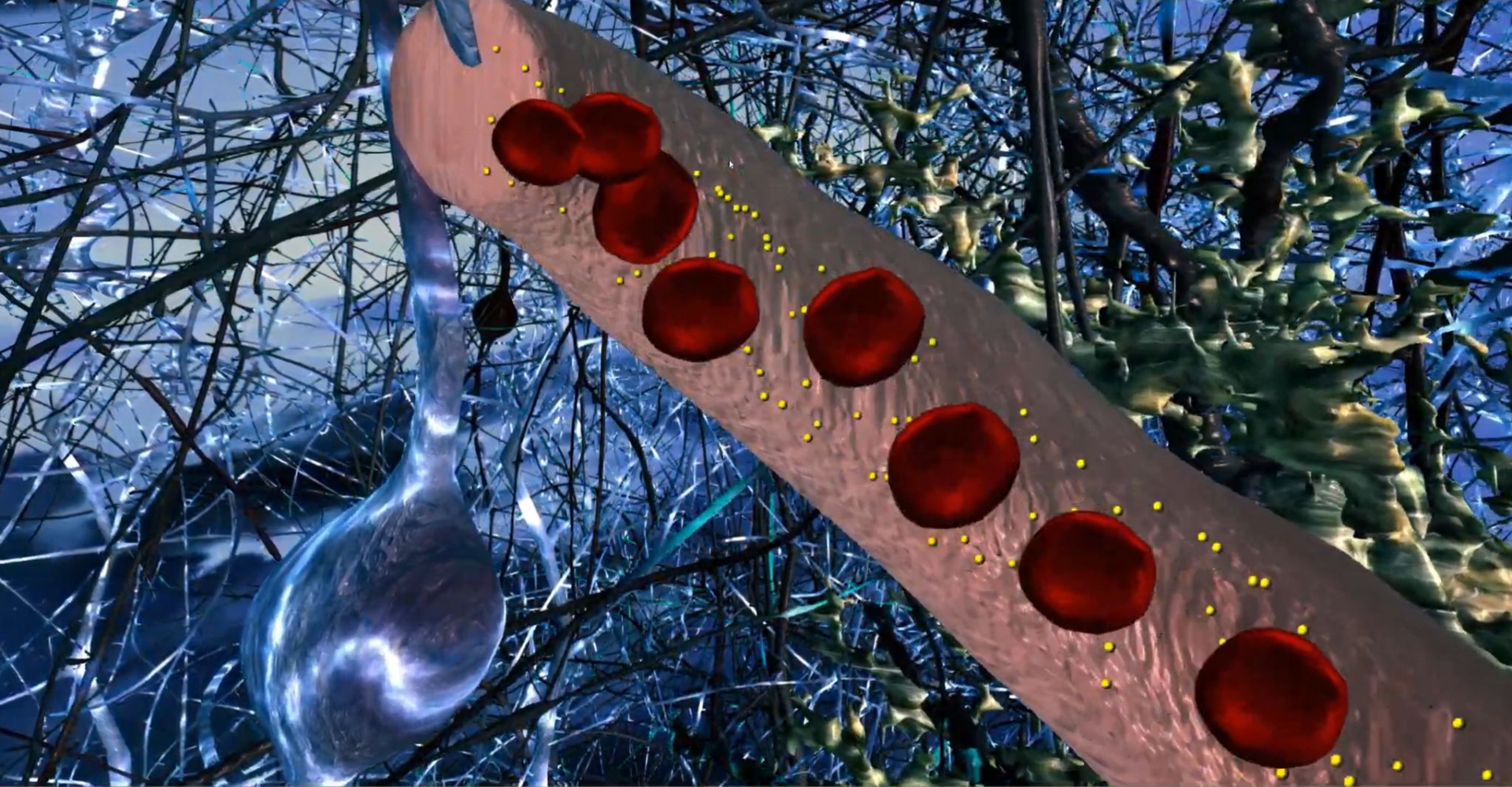
Welcome to the SHAMS AR App.
Let's get started!

Continue



recorded demo from phone

The app was exhibited in the 2025 Saudi Environment week in Riyadh.





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

The video on the right shows the ancient coral core sample from Baffin and its corresponding holes that are hidden inside it.

The VR experience was developed by Ronell Sicat from the KAUST Visualization Core Lab reachable via ronell@kaust.edu.sa. Thank you!

[Back to Start](#)

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".

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Enjoy!

[Click To Continue](#)

8

Controller Guide

Joystick
(teleport/walk)

Trigger Button
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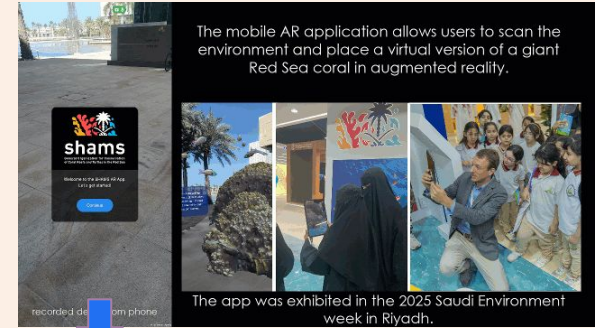
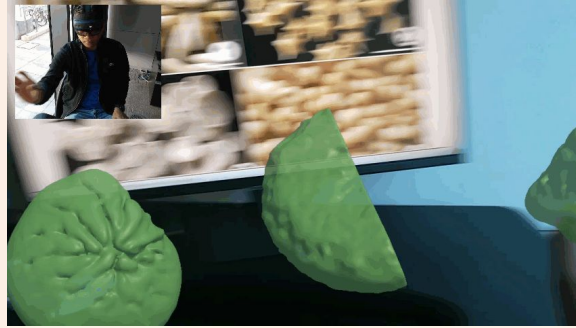
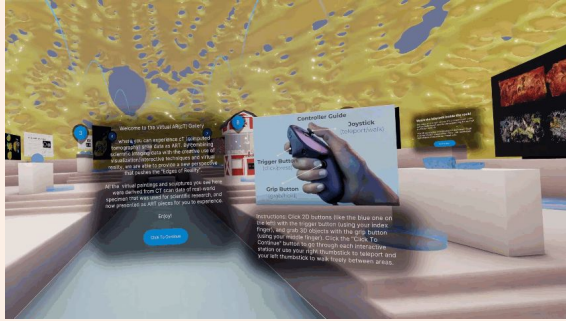
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Watch the labyrinth inside the rock!
The video on the right shows the ancient coral core sample from Nantou and the corresponding holes that are hidden inside it.

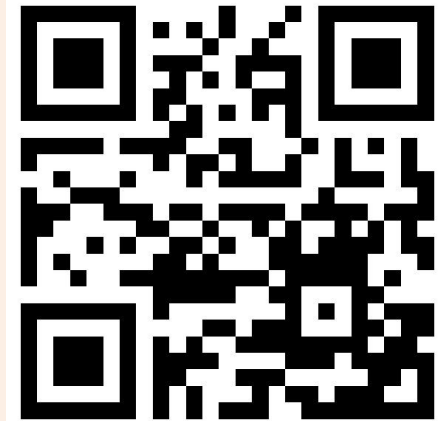
This VR experience was developed by Roneri Sicat from the KALIST Visualization Core Lab reachable via roneri@kallist.edu.ph. Thank you!

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Live Demos & Discussion



AR/VR Facilities Tour



Thank you!

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How would you rate the overall quality of the workshop?*



Please share your comments! (Confidential and for KVL use only.)

e.g., "Content was too simple.," "Topics are very useful.," "Please add more examples."

End