Virtual Reality Application

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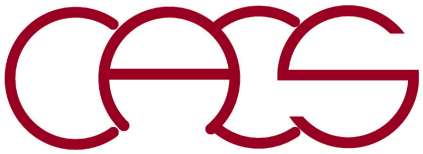
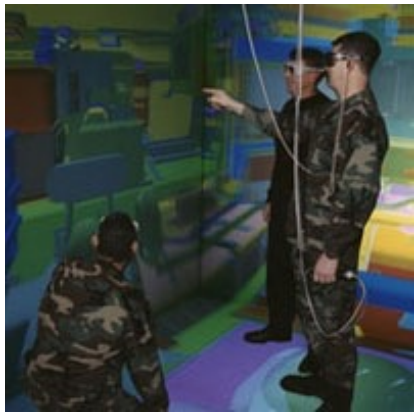
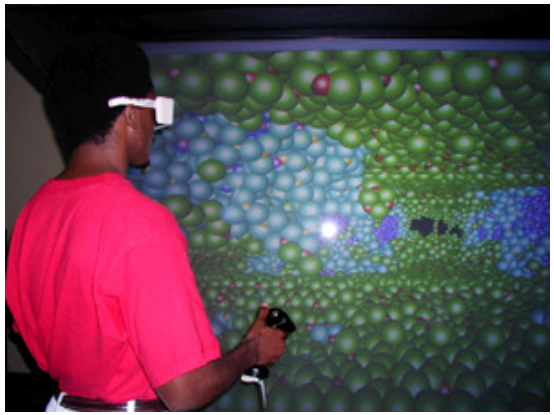
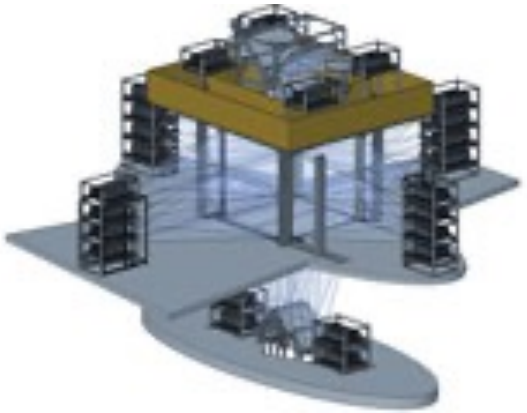


CAVE Visualization System

- **CAVE (CAVE Automatic Virtual Environment): A fully immersive & interactive $10'^3$ virtual environment (VE)**
- **ImmersaDesk: A semi-immersive with a 4'×5' display**







CAVE

C6 at Iowa-State VRAC

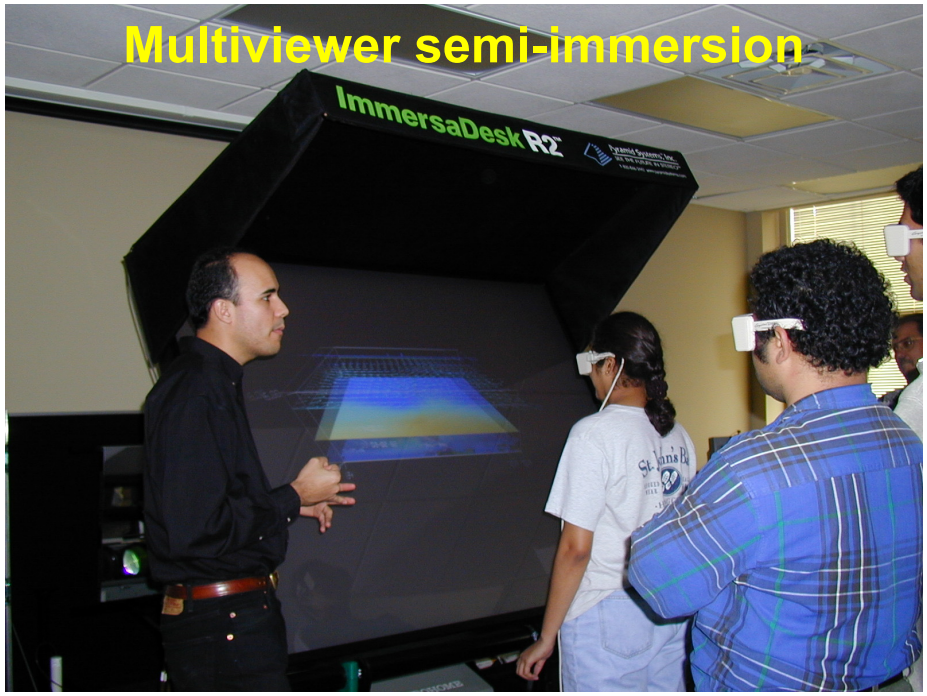
ImmersaDesk

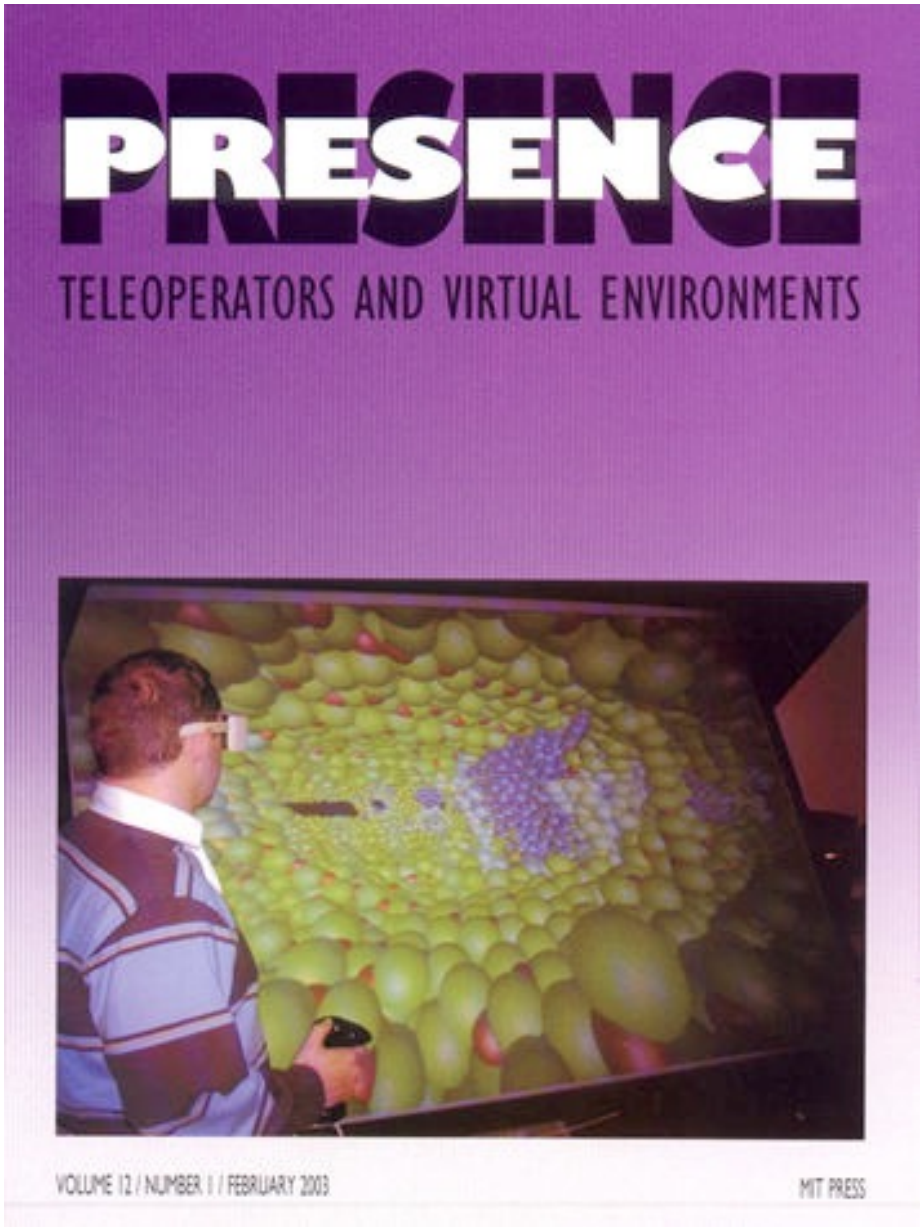
http://www.vrac.iastate.edu

http://www.mechdyne.com

Billion-Atom Walkthrough

- **Achieved real-time walkthrough for a billion atoms in ImmersaDesk**



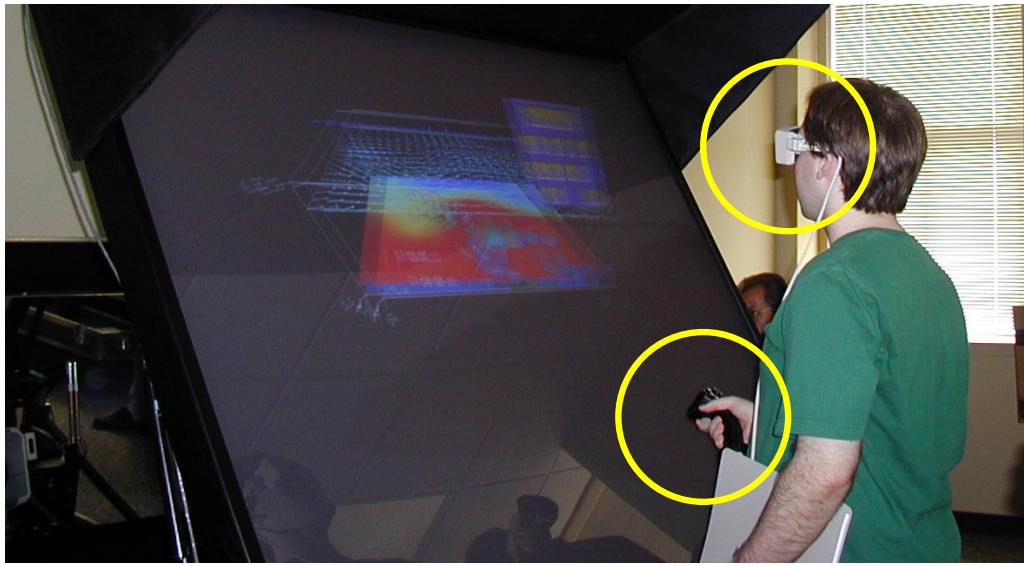


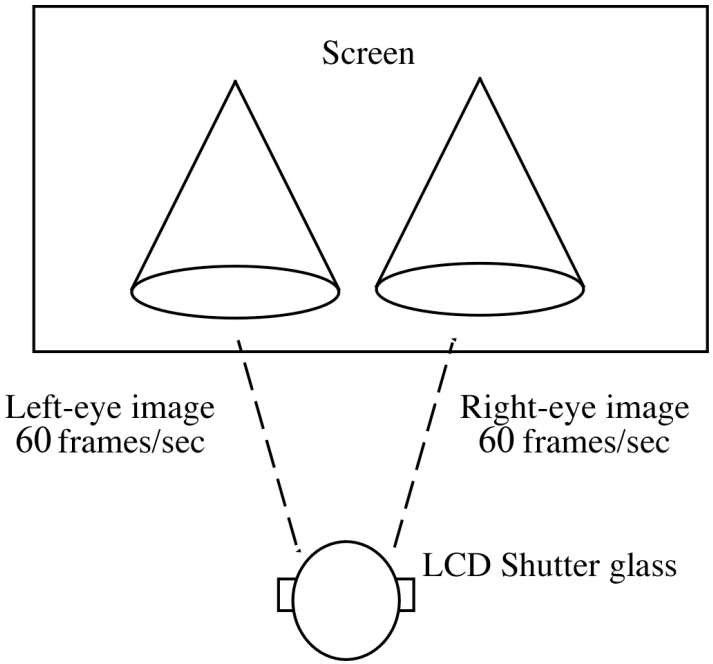
IEEE Virtual Reality Best Paper

https://aiichironakano.github.io/cs596/Sharma-Viz-Presence03.pdf

CAVE Components

- **Stereographics:** The projector interleaves images for left & right eyes at a rate of 120 frame/s synchronized with an LCD shutter glass *via* an infrared emitter; 3D perception is created by showing the two eyes slightly rotated objects
- **Wand:** A 3D mouse with buttons; the position & angle of the wand as well as button press are user inputs (*cf.* Wii)
- **Magnetic tracking system:** A sensor is attached to a user's head so that the scene can be changed according to the user's position (*cf.* `gluLookat()`)



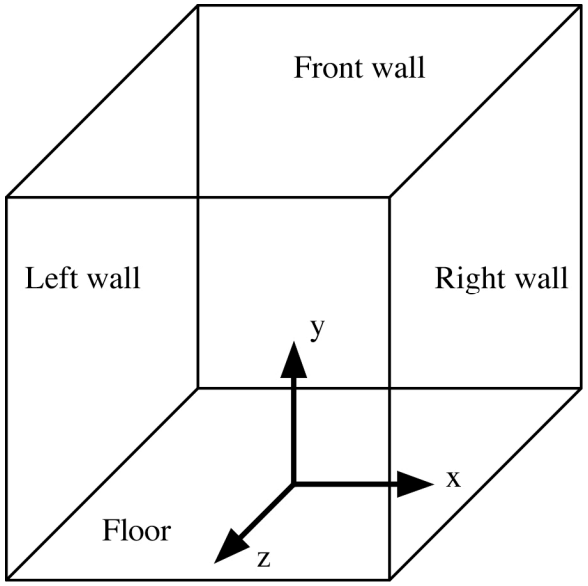


CAVE Programming

- **CAVE library: A library of C functions & macros to control the operation of the CAVE: keep all the devices synchronized; produce the correct perspective for each wall; & provide the applications with the current state of all the CAVE elements**
- **Compiling a CAVE application:**

```
LIBS = -L/usr/local/CAVE/lib32 -lcave_ogl -lGLU -lGL -lXi -lX11 -lm
cc -O -o ball ball.o $(LIBS)
```

- **CAVE coordinate system: $10'^3$ with the origin at the central floor**



http://www.evl.uic.edu/pape/CAVE/prog

Example: ball.c

```
#include <cave_ogl.h>
#include <GL/glu.h>

void main(int argc,char **argv) {
  CAVEConfigure(&argc,argv,NULL); CAVEInit(); // Initialize the CAVE
  CAVEInitApplication(init_gl,0);  // Pointer to GL initialization function
  CAVEDisplay(draw_ball,0);  // Pointer to drawing function
  while (!CAVEgetbutton(CAVE_ESCKEY)) sginap(10);  // Continue until ESC hit
  CAVEExit();}

void init_gl(void) {
 float redMaterial[] = { 1, 0, 0, 1 };
 glEnable(GL_LIGHT0);
 glMaterialfv(GL_FRONT_AND_BACK, GL_AMBIENT_AND_DIFFUSE, redMaterial);
 sphereObj = gluNewQuadric();}

void draw_ball(void) {
 glClearColor(0., 0., 0., 0.);
 glClear(GL_DEPTH_BUFFER_BIT|GL_COLOR_BUFFER_BIT);
 glEnable(GL_LIGHTING);
 glPushMatrix();
 glTranslatef(0.0, 4.0, -4.0);
 gluSphere(sphereObj, 1.0, 8, 8);
 glPopMatrix();
 glDisable(GL_LIGHTING);}
```

http://www.evl.uic.edu/pape/CAVE/prog

VR on Web: X3D

- **X3D is an open standards XML (extensible markup language)-enabled 3D file format for real-time communication of 3D data across applications over network**
- **With X3D browsers and plug-ins, X3D becomes immersive allowing a user to walk through the 3D scene**
- **An X3D file is publishable directly on the World Wide Web; an X3D browser acts as a helper application at the client side**

- **X3D homepage**

  `http://www.web3d.org`

- **X3D plug-ins for Windows, Macintosh, and Linux**

  `http://www.web3d.org/x3d/content/examples/X3dResources.html`

See also Qucktime VR: https://en.wikipedia.org/wiki/QuickTime_VR

Ttsunami on Web (Zili Zhou & Patrick Lynett, USC)

Metaverse Is Coming?

The New York Times

October 28, 2021

Facebook Renames Itself Meta

The social network, under fire for spreading misinformation and other issues, said the change was part of its bet on a next digital frontier called the metaverse.

Metaverse is a speculative future iteration of the Internet, made up of persistent, shared, 3D virtual spaces linked into a perceived virtual universe.

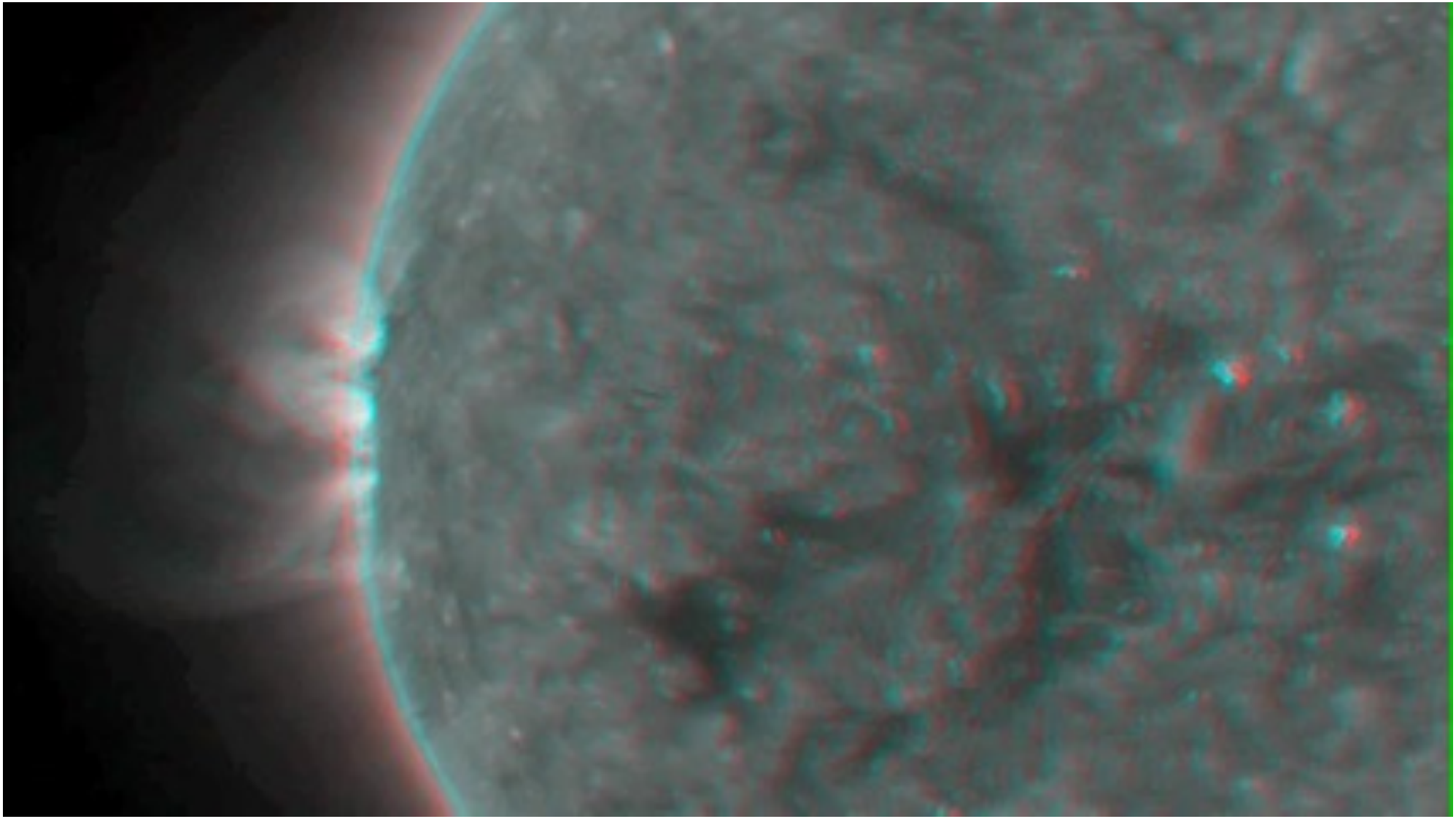
https://en.wikipedia.org/wiki/Metaverse

3D in Hollywood

http://www.youtube.com/watch?v=avecKPWqYqM

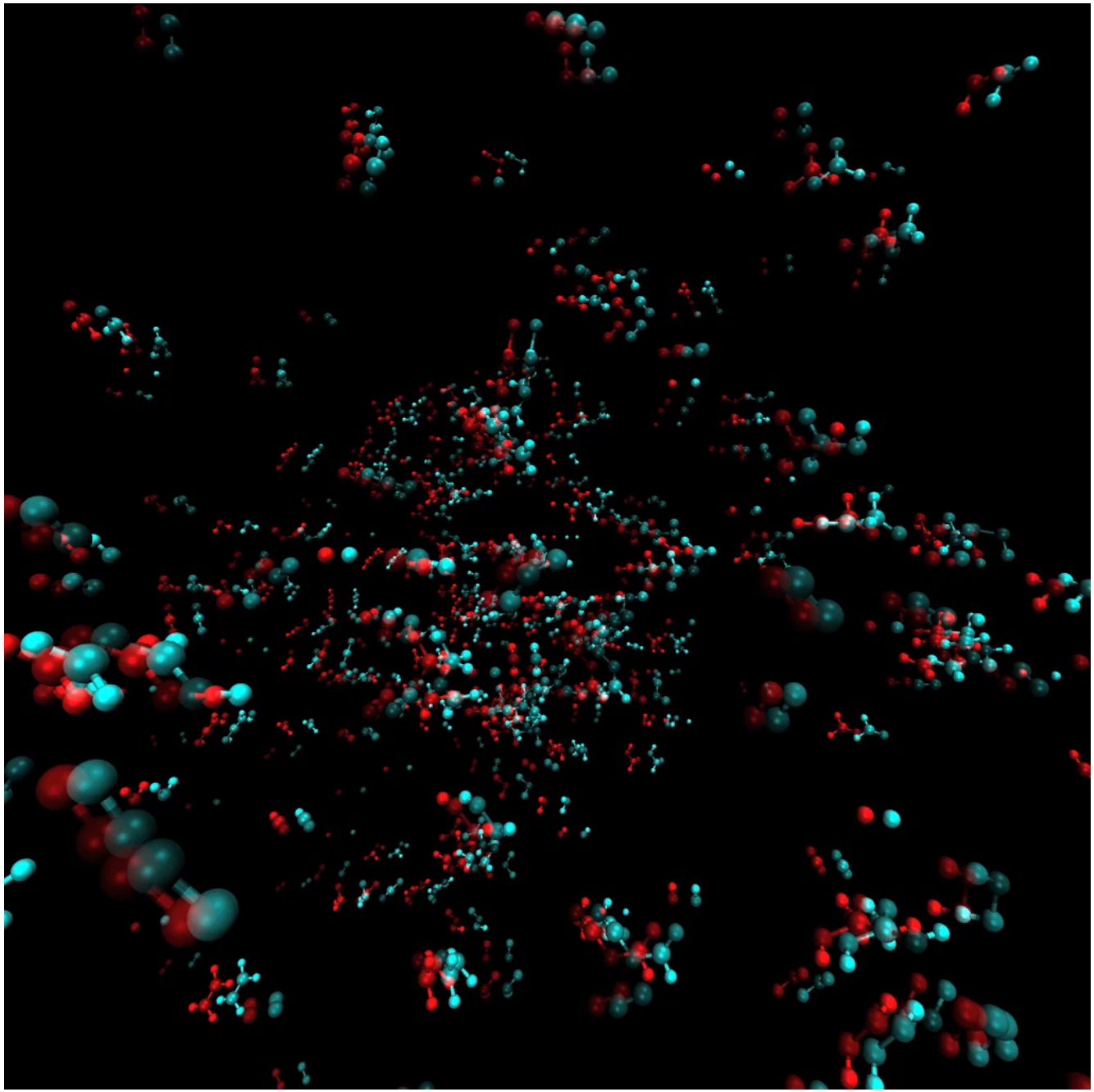
3D in Science

- **Anaglyph: Stereoscopic 3D effect by means of encoding each eye's image using filters of different colors (typically red & cyan).**



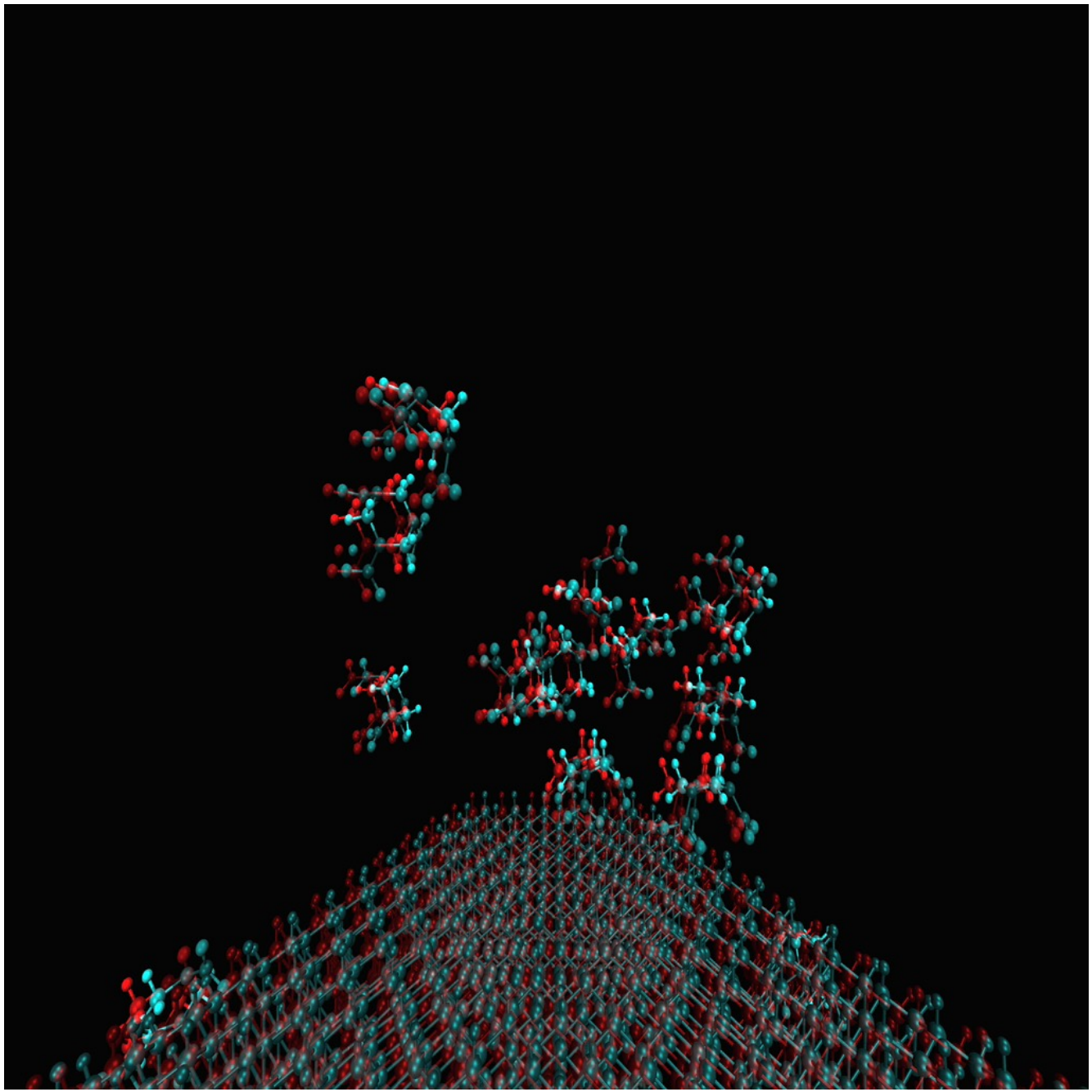
http://www.nasa.gov/mission_pages/stereo/news/stereo3D_press.html

3D in Molecular Dynamics (1)



K. Nomura *et al*., *Phys. Rev. Lett*. **99,** 148303 ('07)

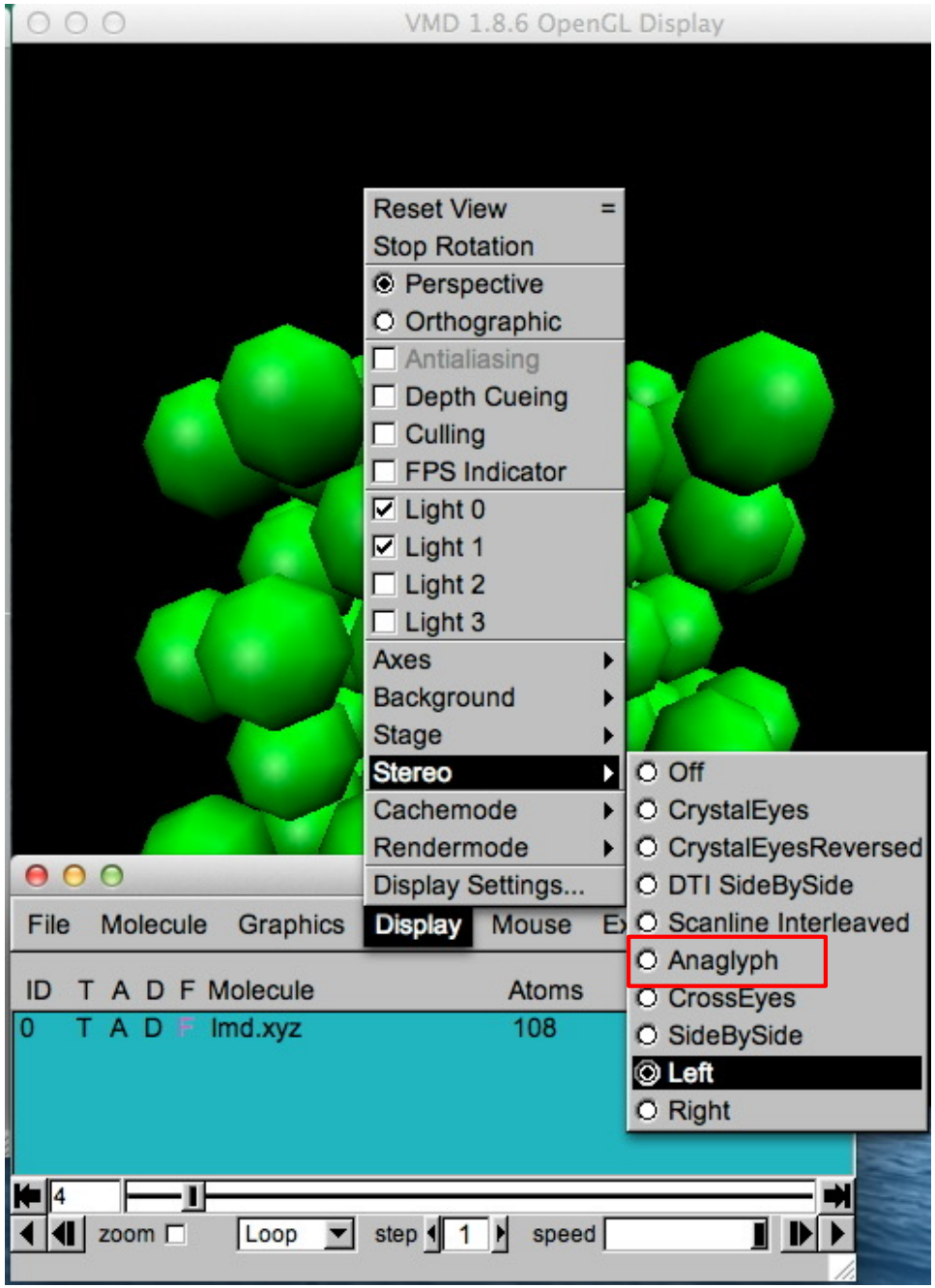
3D in Molecular Dynamics (2)



Y. Chen *et al*.,
Appl. Phys. Lett.
93, 171908 (’08)

How to Make Anaglyph Stereo

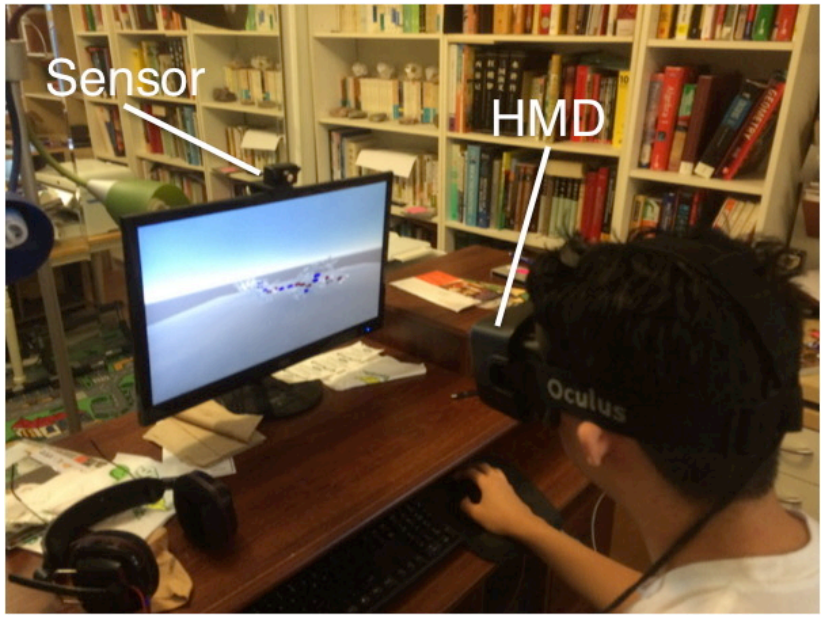
- In the main window of the VMD software, go to the Display menu, then the Stereo submenu
- Select the Left view & save the image as an image file
- Next select the Right view & save the image as another image file
- Use software such as Photoshop to make an anaglyph by image processing
- Or, simply select Anaglyph option

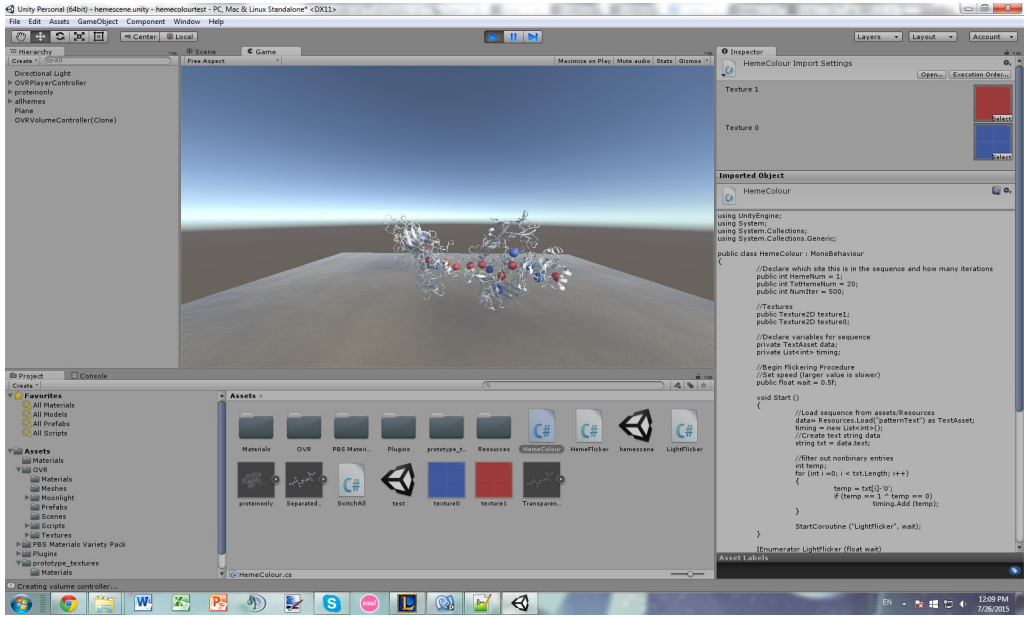


http://www.ks.uiuc.edu/Research/vmd/

Commodity Virtual Reality

- **Immersive visualization to every scientist's desktop: Exported VMD animation to a VR platform — Oculus Rift head mounted display (HMD) — using Unity game engine to increase the perceptive depth**





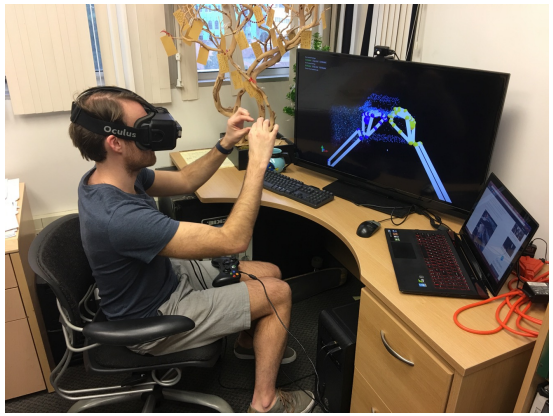
- **In VMD, File → Render as wavefront object & material (texture) files; then, use Blender (3D editor software, https://www.blender.org) to make it compatible with Unity**

https://en.wikipedia.org/wiki/Alex_McDowell

C. M. Nakano, E. Moen, H. Byun, H. Ma, B. Newman, A. McDowell, T. Wei, & M. Y. El-Naggar, iBET: Immersive visualization of biological electron-transfer dynamics, *Journal of Molecular Graphics & Modelling* **65**, 94 ('16)

GEARS: VR to Every Scientist's Desktop

GEARS (Game-engine-assisted research platform for scientific computing) allows scientists to develop & perform immersive & interactive simulations within commodity virtual reality (VR) platforms

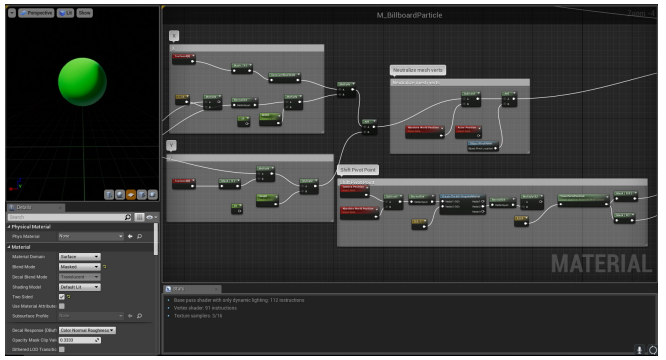


Oculus Rift + Leap Motion

HTC Vive

Exfoliation of MoS_2

- **Implemented simulation workflows in VR-capable Unity & Unreal game engines**
- **Enhanced interaction utilities, *e.g.*, virtual confocal microscopy**
- **Developed an interface with community MD software, LAMMPS, & demonstrated immersive & interactive 250K-atom simulations on desktop**

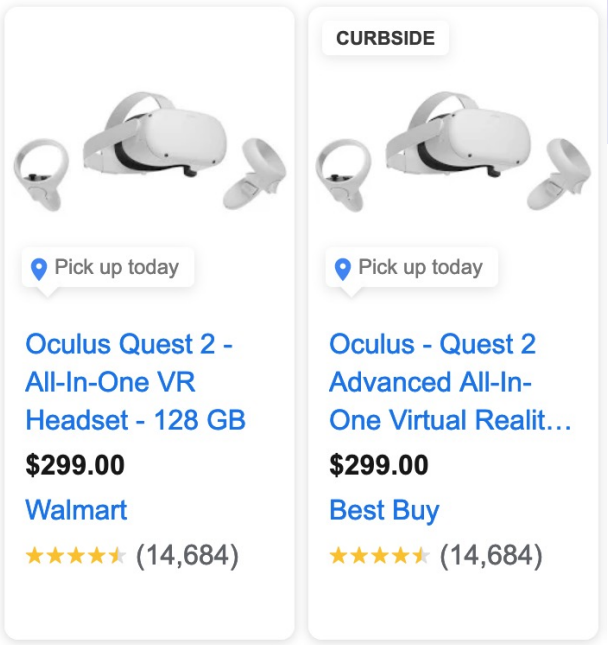


LammpsVR editor

https://github.com/USCCACS/GEARS

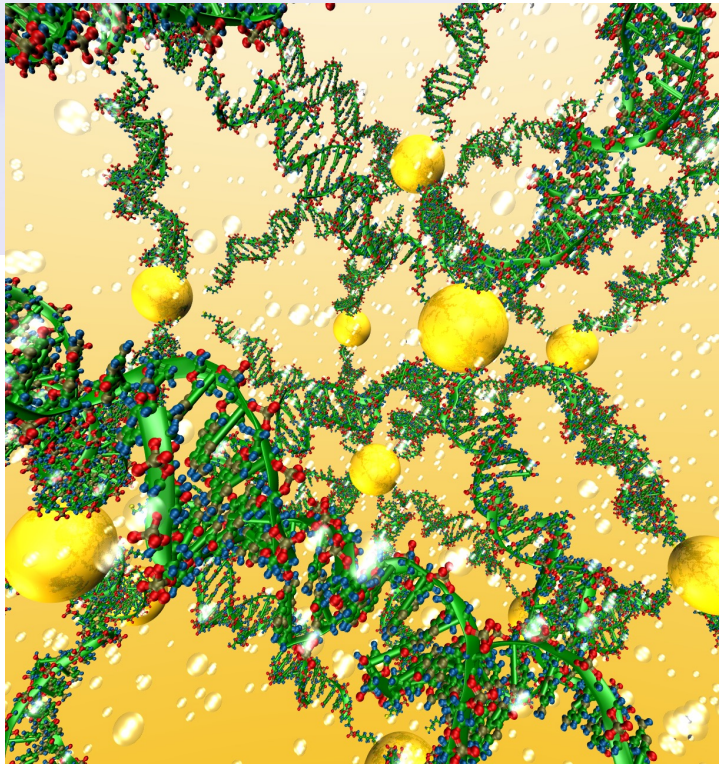
B. Horton, E. Moen, K. Nomura *et al.*, *SoftwareX* **9**, 112 ('19)

New Model

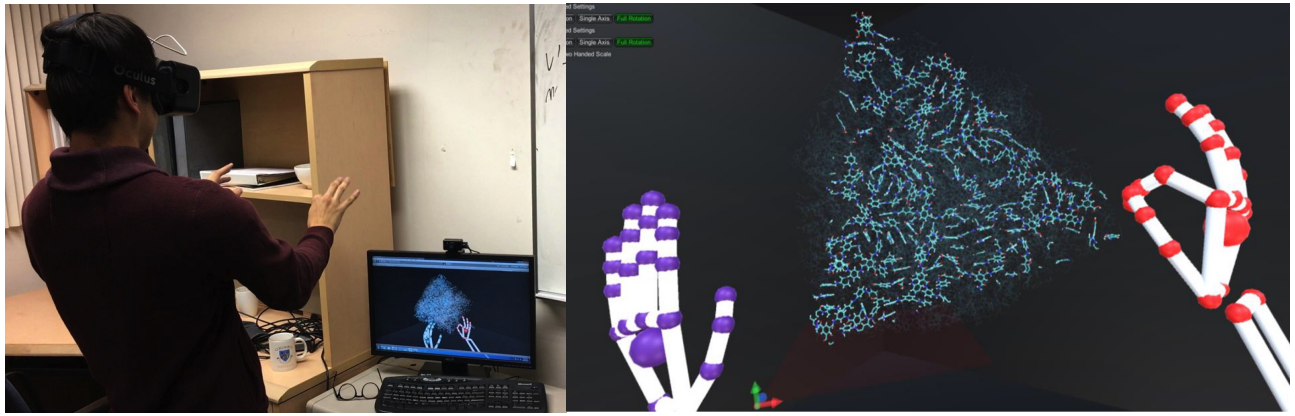


JPCC **116**, 19579 ('12)

Render a Christmas gift?



Scientific Augmented Reality?



VR

MR

Order summary | 3 items Edit

Meta Quest 3 Carrying Case $69.99
Est. delivery: Tue, Oct 31 Quantity: 1

Meta Quest 3 512GB $649.99
Est. delivery: Tue, Oct 31 Quantity: 1

Meta Quest 3 Elite Strap with Battery $129.99
Est. delivery: Thu, Nov 2 Quantity: 1

Subtotal $849.97
Add promo code
Shipping Free
Est. taxes and fees Calculated at payment

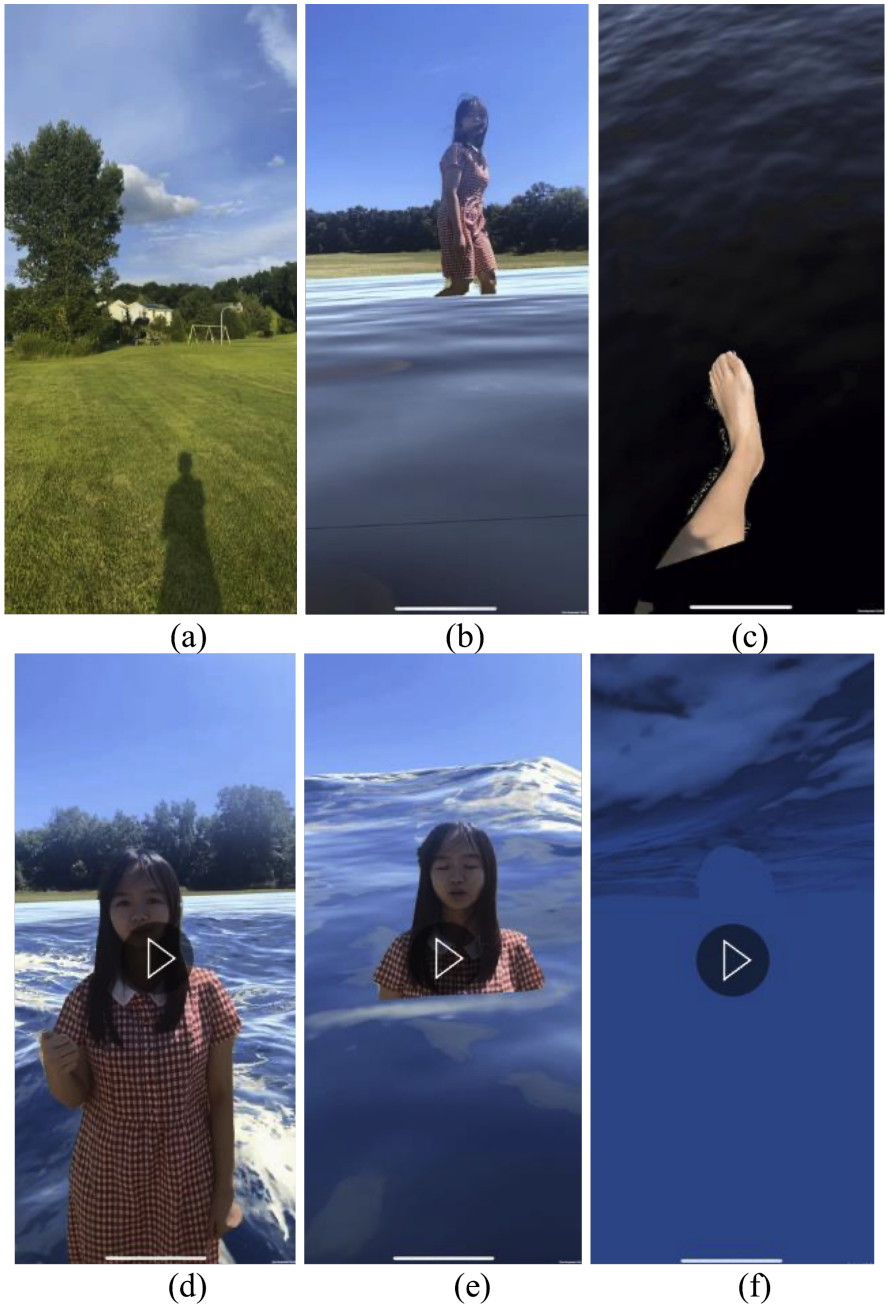
Total $849.97

Microsoft mixed reality (MR) academic seeding program at USC

"Million-atom shared immersion?"

cf. CSCI 538: Augmented, Virtual and Mixed Reality

Augmented-Reality Tsunami



AR-tsunami demo on a sloping lawn. (a) the sloping lawn in the real world without AR effect; (b) by using AR-tsunami, the author is walking in the virtual still water which is sloping along with the lawn; (c) by using AR-tsunami, the author can look down and put the feet out of "water"; (d, e, f) by using AR-tsunami, the author is "submerged" by the big waves.

Zili Zhou
Ph.D. thesis, USC
Patrick Lynett Lab