Virtual Reality Application

Aiichiro Nakano

Collaboratory for Advanced Computing & Simulations
Department of Computer Science
Department of Physics & Astronomy
Department of Chemical Engineering & Materials Science
Department of Biological Sciences
University of Southern California

Email: anakano@usc.edu
CAVE Visualization System

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

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

IEEE Virtual Reality Best Paper
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.

![Diagram of CAVE components](image)
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**:
  
  ```bash
  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

```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)) sgianap(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
```
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
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).

3D in Molecular Dynamics (1)

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

www.ks.uiuc.edu/Research/vmd/
www.scec.org/geowall/makeanaglyph.html
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

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

- 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

B. Horton, E. Moen, K. Nomura et al., SoftwareX, to be published
Scientific Augmented Reality?

Microsoft mixed reality (MR) academic seeding program at USC
“Million-atom shared immersion?”

cf. CSCI 538: Augmented, Virtual and Mixed Reality