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

[Images of CAVE and 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
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.
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:

```shell
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
#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
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**: Stereoskopische 3D-Effekt durch die Überlagerung zweier Bilder, jeweils für ein Auge kodiert mit Farbfiltern (üblicherweise Rot & Cyan).

3D in Molecular Dynamics (1)

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

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

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 (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

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

cf. CSCI 538: Augmented, Virtual and Mixed Reality