3D Stereo Visualization

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Computer based generation of stereo pairs as used to create a perception of depth. Such depth perception can be useful in many fields:

- Scientific visualization
  - Physical
  - Medical etc.
- Entertainment
- Games
- Appreciation of architectural spaces etc.
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Depth cues

There are a number of cues that the human visual system uses that result in a perception of depth. These are present even in 2D images:

- Perspective. Objects get smaller the further away they are and parallel lines converge in distance.
- Sizes of known objects. We expect certain objects to be smaller than others.
- Detail. Close objects appear in more detail, distant objects less.
- Occlusion. An object that blocks another is assumed to be in the foreground.
- Lighting, shadows. Closer objects are brighter, distant ones dimmer.
- Relative motion. Objects further away seem to move more slowly than objects in the foreground.
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There are other cues that are not present in 2D images:

- **Binocular disparity.** This is the difference in the images projected onto the back the eye (and then onto the visual cortex) because the eyes are separated horizontally by the interocular distance.

- **Accommodation.** This is the muscle tension needed to change the focal length of the eye lens in order to focus at a particular depth.

- **Convergence.** This is the muscle tension required to rotate each eye so that it is facing the focal point.
Depth cues not in 2D

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Wrong reconstruction: Illusions

On this famous illusion, we try to see a 3D object, but it is only a 2D shape. That means, with a single image, our mind uses the knowledge of how the object looks like, to be able to reconstruct the third dimension. There is a pattern recognition phase followed by a reconstruction phase.
Stereographics using stereo pairs

To render a stereo pair one needs to create two images, one for each eye in such a way that when independently viewed they will present an acceptable image to the visual cortex and it will fuse the images and extract the depth information as it does in normal viewing.
Parallax

The distance between the left and right eye projections is called the horizontal parallax:

- The object is behind the projection plane.
- Object is located in front of the projection plane.
- Object lies at the projection plane.
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**Toe-in (Incorrect)**

- **Projection planes (screen)**
- **Left**
- **Right**
- **Eye separation**
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**Toe-in (Incorrect)**

**Off-axis (Correct)**
Off-axis method requires a non symmetric camera frustum, this is supported by some rendering packages, in particular OpenGL.
Introduction

Cues

Rendering

OpenGL

Anaglyph

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Setting drawing mode glutInitDisplayMode(GLUT_STEREO);

For Drawing:
- glDrawBuffer(GL_BACK_LEFT)
- MyDrawLeft();
- glDrawBuffer(GL_BACK_RIGHT);
- MyDrawRight();
- glutSwapBuffers();
If your graphics card doesn’t support stereographics or even left and right buffers, then try Anaglyph (old method).
