

Implementing Auto-focus in a Stereographical Projection System

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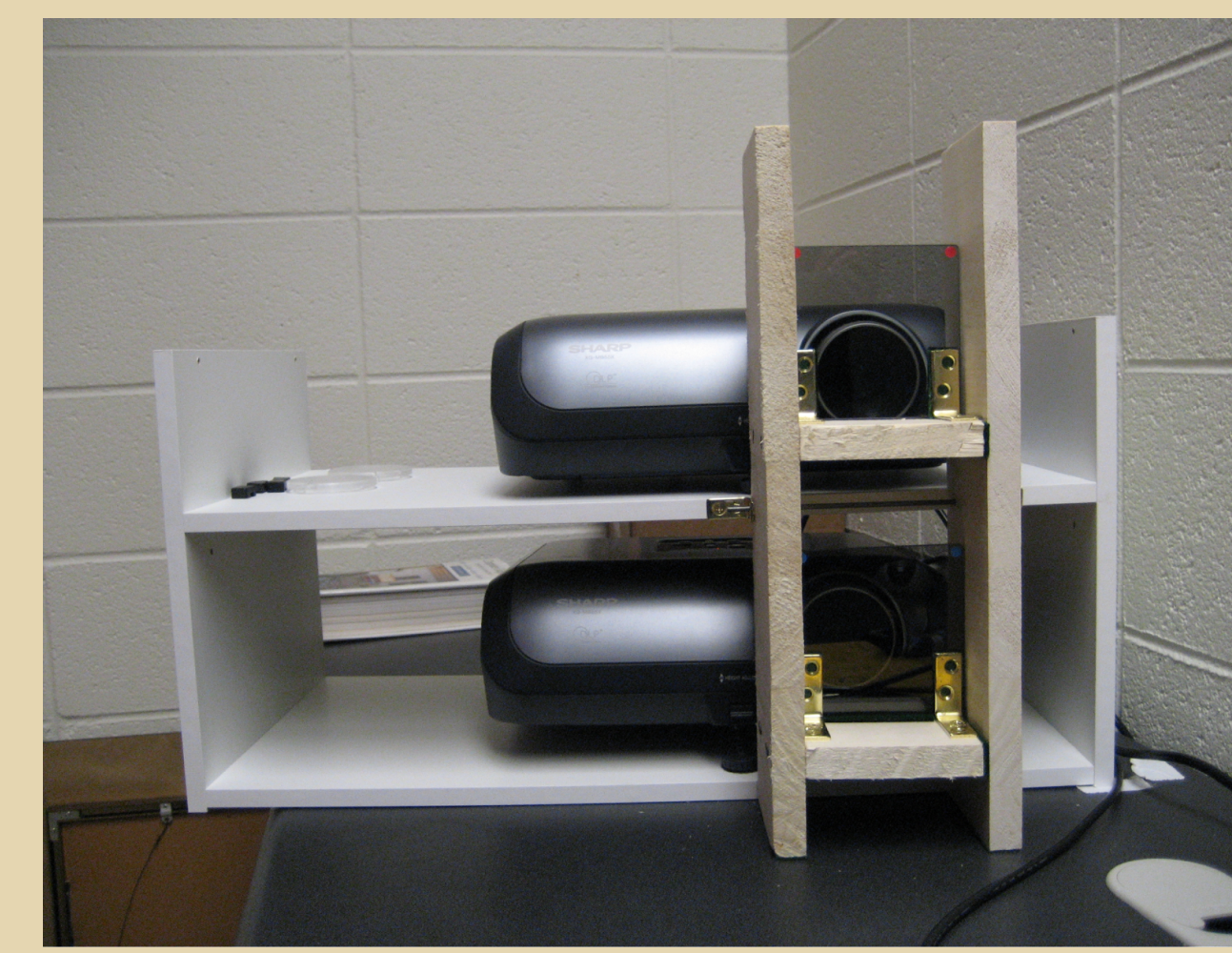
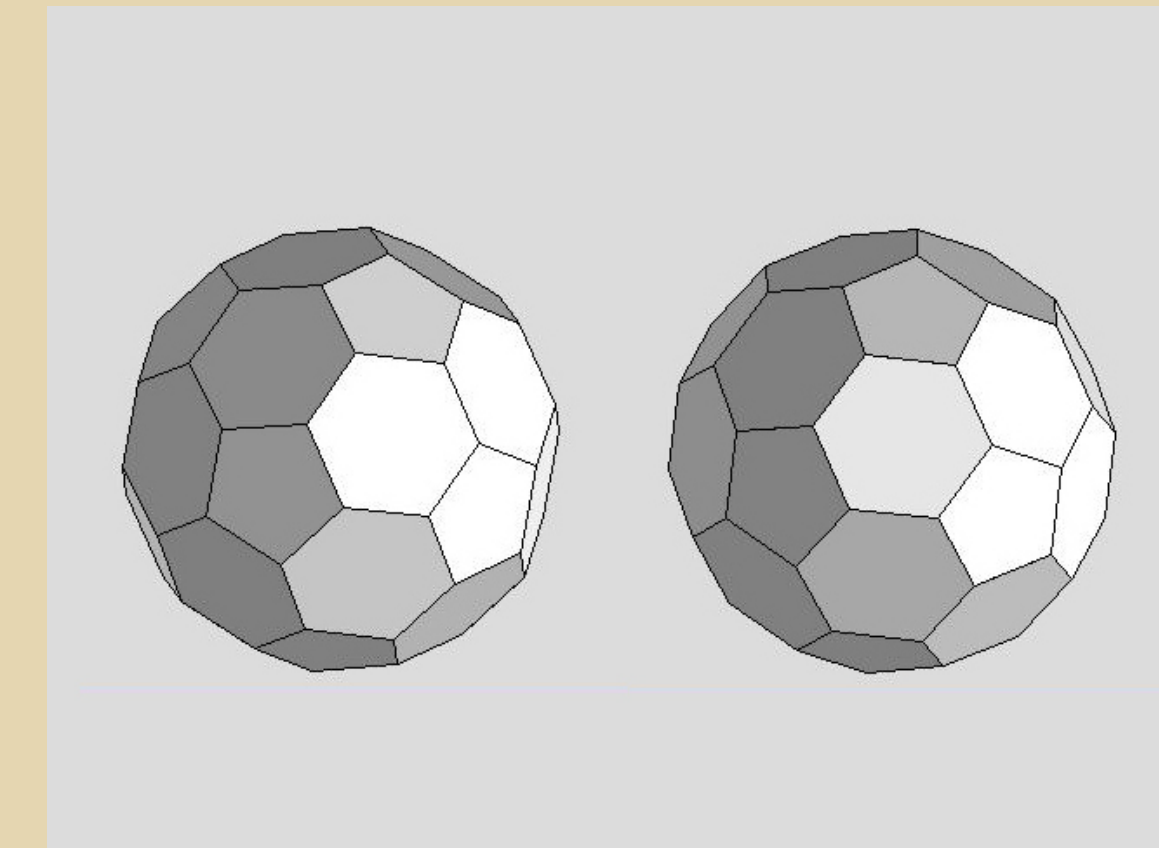


Abstract

- The goal of this project was to create a stereographical projection system capable of producing an optimally-focused image. To accomplish this, it was necessary to consider the two optical systems which the projection system involves: that of the virtual cameras receiving data from the virtual scene and that of the viewers' eyes receiving light from the projection screen. The more independently the two systems operate, the more likely it is that the viewers will experience eyestrain and duplicate images. We considered multiple methods of keeping the systems operating similarly and determined the advantages and drawbacks of each.

Stereo Pairs

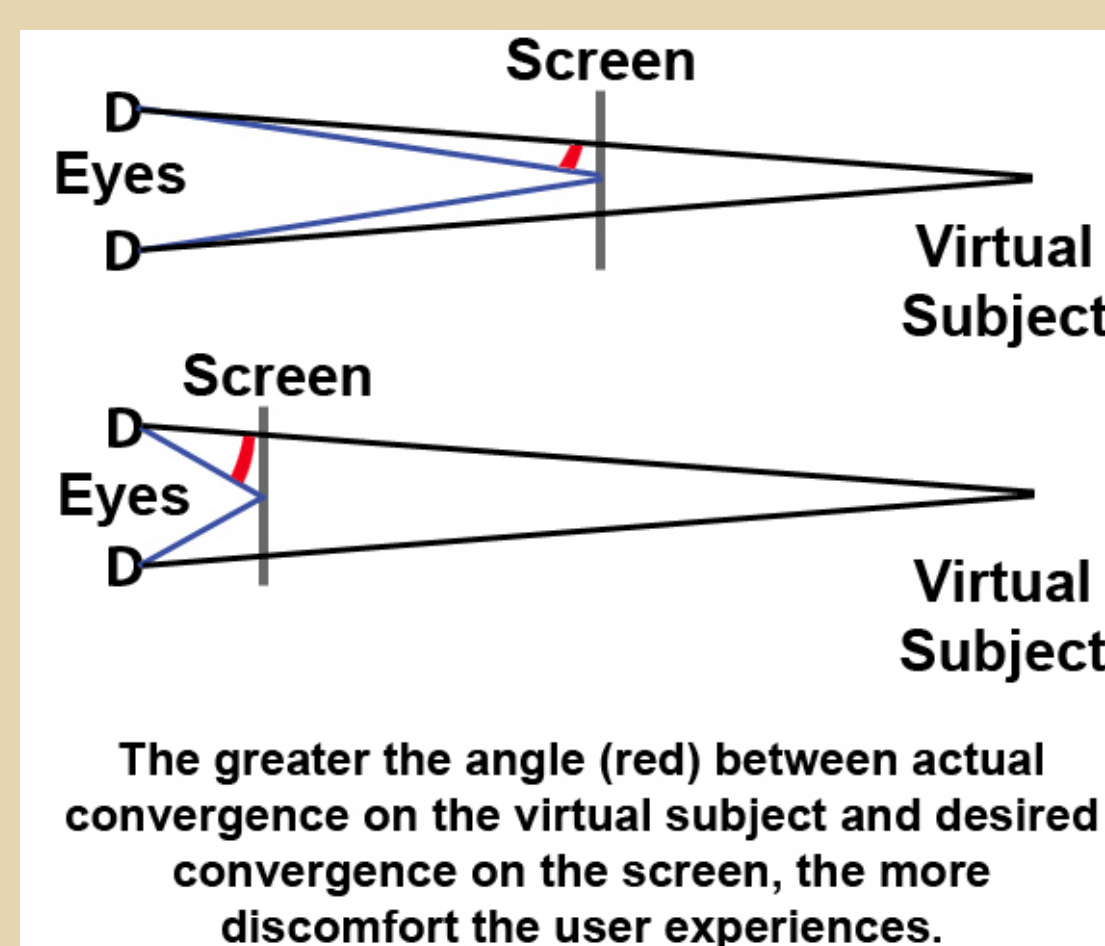
- Stereo pairs are photographs of a scene from which depth information can be derived.
- Stereo pairs are obtained by taking two photographs of an object from two locations separated a small distance along an axis parallel to the scene being photographed.
- Though both images in a stereo pair depict the same scene, the individual points which make up the scene appear at slightly different locations relative to the bounds of the image.
- The distance between corresponding points (points which depict the same portion of the scene) in the two images is referred to as the parallax.



- When a stereo pair is viewed as a single image, each image in the pair is viewed by only one eye. The brain resolves the conflicting parallaxes by perceiving them as depth cues. This is why the resulting image appears three-dimensional.
- The most common way to view a stereo pair is to place the images side by side (as at left) and aim one's eyes at a point either in front of or behind the surface on which the images are printed so that each image is interpreted by only one eye.
- Our stereographical projection system consists of two projectors stacked vertically, each receiving input from one virtual camera in a virtual 3D environment. In front of each lens is a polarizing filter. The images are projected through these and onto a silver screen, allowing the polarized light to reflect back to the viewers.
- Users of our system wear glasses with polarized lenses, limiting the light each eye receives to that coming from the appropriate virtual camera.

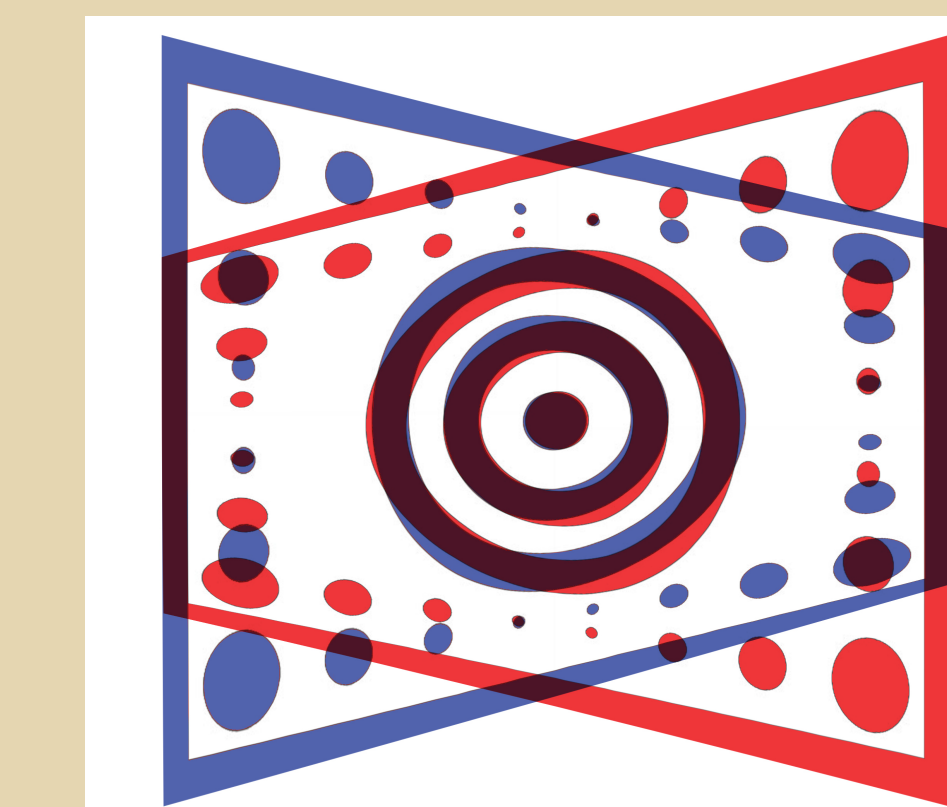
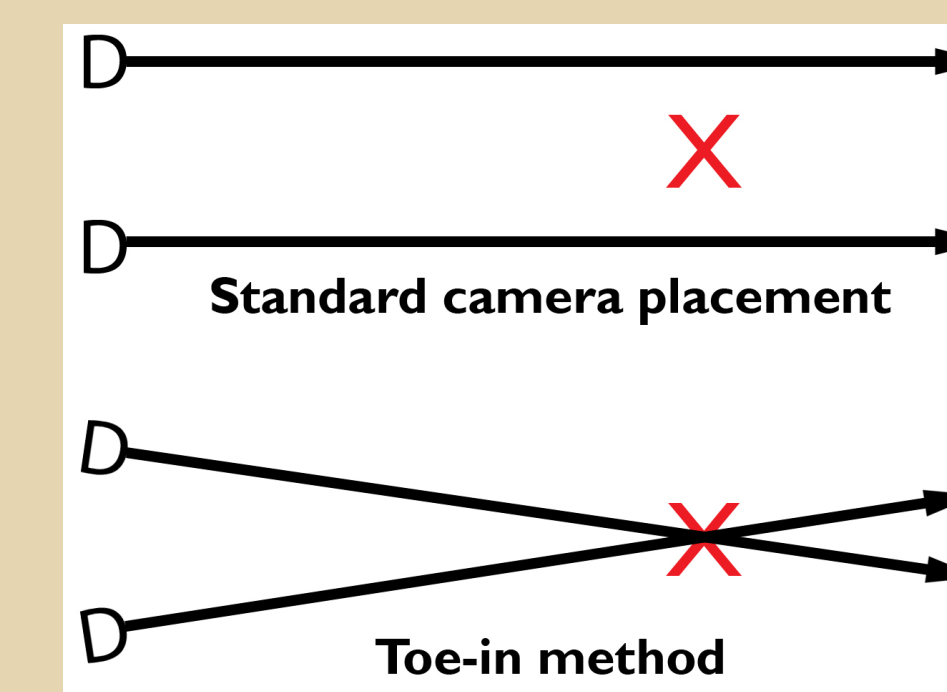
The Paradoxical Role of Parallax

- In viewing stereoscopic images, two ocular functions which always operate together in day-to-day life must behave independently: accommodation and convergence.
- Ocular accommodation is the ability of the eye to adjust its focal length by altering its lens shape. While viewing a stereoscopic image, the viewer's eyes remain accommodated to the surface on which the stereo pair is displayed.
- Ocular convergence describes the angle which the eyes' lines of sight make with each other. In stereographic viewing, ocular convergence varies based on the perceived depth of the area of the image being focused on.
- As parallax moves away from zero, the depth effect increases, but so does conflict between the ocular convergence and ocular accommodation systems.
- When conflict between the two ocular systems reaches a certain point, the viewer will experience eyestrain and likely stop perceiving the stereo pair as a single image. (See below, left.)
- It is crucial that the stereo pair be created in such a way that the portions of the image which the viewer is expected to focus on lie within the acceptable parallax range. (This range varies depending on the size of the screen and distance of the viewers from it. See below, right.)



Toe-In Parallax Management

- The toe-in method involves rotating both cameras in towards the subject. Whatever portion of the scene they converge at will have zero parallax.
- The primary advantage of the toe-in method is the ease with which it can be utilized. Whether using physical or virtual cameras, modifying the angle at which the images are captured is a simple task.
- The primary disadvantage of the toe-in method is that it introduces vertical parallax for points near the left and right edges of the final image. This occurs because the captured images must be rotated until they can be superimposed, which stretches one side of the image along the vertical dimension and compresses the other.

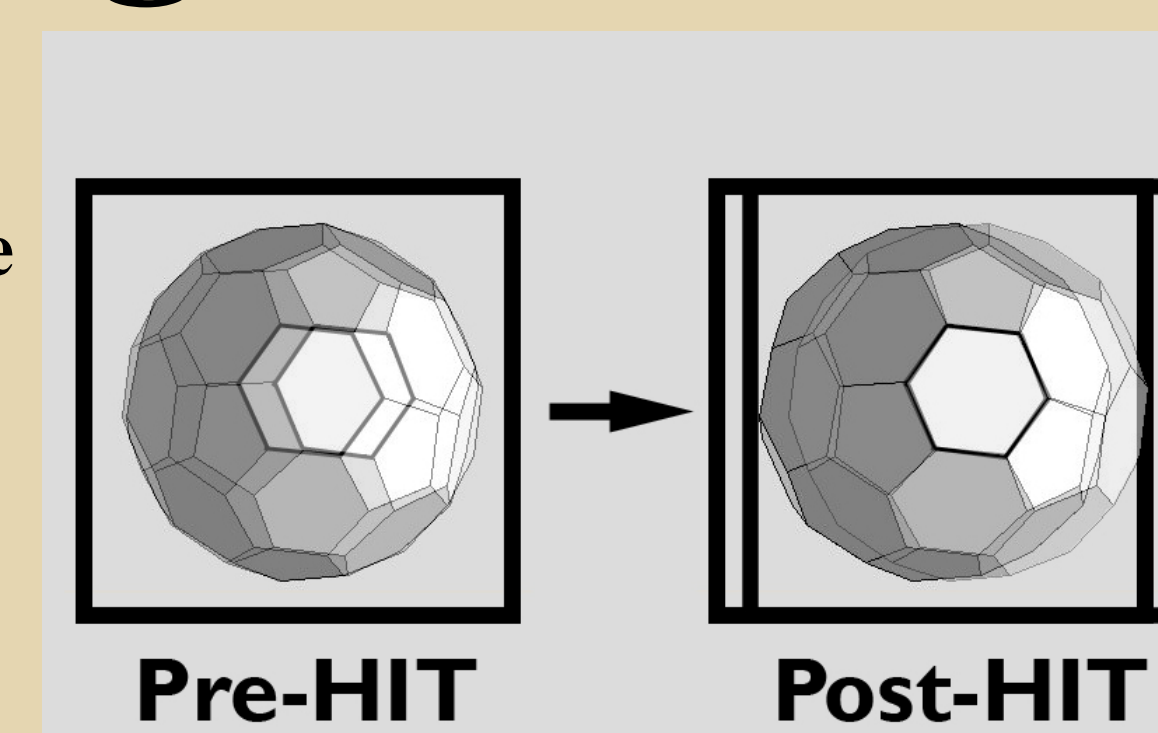


Future Work

- We plan to develop an algorithm to allow use of the HIT method in generating stereo pairs from dynamically-generated 3D environments where the user's focus is expected to change from object to object.
- We intend to determine what sorts of 3D applications can be satisfactorily achieved with the stereographical equipment we have available.

HIT Parallax Management

- The HIT (horizontal image translation) method requires shifting the captured images along the horizontal axis until the intended focal points are superimposed, therefore resulting in zero parallax to the viewer.
- This method produces none of the distortion of the toe-in method.
- A minor disadvantage is that the size of the final image is smaller than that of the original captured images. Any portions of the images which do not overlap after the shifting must be cropped.
- A more significant disadvantage is that determining the distance that the images should be shifted based on the depth of the intended focal point is significantly more complex than angling the cameras, as per the toe-in method. Accomplishing it manually is not difficult, but if the subject is dynamic, automatic parallax reduction is a necessity.



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 - The StereoGraphics Developers' Handbook