A Crystal Ball for Three-Dimensional Visualization

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Abstract

Three-dimensional display devices have been sought for many years. This paper discusses a display device that produces a true three-dimensional image. This device will be useful for medical applications and in other applications where an image must be viewed from various angles. A simple prototype was built using external projectors. Two alternatives which will produce a much clearer image are discussed.

Keywords: three-dimensional imaging, display device, visualization.

1. INTRODUCTION

True three-dimensional (3D) imaging has been a dream of many for several years. The most common device, which tricks you into visualizing a 3D image, is the toy stereograph. This device allows one to see two images, one with each eye, and the brain processes it as a single image floating in air. Other popular devices are the familiar red and green eyeglasses, which allow one to see a movie in 3D. Both these devices allow only a single perspective view of an image.

Another common device is a hologram, which permits a true 3D display of an image. This does not limit the viewer to a single view of the image. Also, in theory, it should not be too difficult to extend it for moving pictures, as in "Star Wars" movies.

LCD shutter glasses allow true-color 3D display of a movie as was done at Epcot Center in Florida in 1986. However, this too permits only a single perspective of the image.

Recent developments [Popular Science, 2004] list three devices, which do a significantly better job in achieving 3D moving picture display. The cheapest one (Sharp Actius RD3D Notebook, $3,000) has a switching LCD panel, which alternates the display between two stereo images. The next in line (IO_2 Technology HelioDisplay, $22,500) produces a 3D image on "agitated" air. Both of these permit only a single viewable side. The most expensive display (Perspecta Spatial 3D System, $40,000) produces a true 3D image inside a 10-inch glass dome with a rotating screen. Another recent development [Wojciech, 2004] at Mitsubishi Electric Research Laboratory, Cambridge, MA, uses an array of 16 cameras and 16 projectors connected to a network of computers to project a 3D image which can be viewed from 16 different angles, mostly from the front.

Many applications are mentioned in the Popular Science reference. There are many military applications such as conducting warfare, battlefield visualization and piloting drones from the ground. Medical applications also abound. These can range from monitoring patients to conducting remotely controlled surgery using robots. The entertainment field can use these for 3D movies, which can be viewed from any direction, and can include 3D computer games. More technical applications can be found in the fields of chemistry (3D visualization of molecular structure), physics (conducting experiments of various types), and engineering (3D visualization of various objects such as bridges and buildings, computer aided design of objects such as cars and planes).

3D computer graphics forms an important discipline within computer science. Many books have been written on this topic. Two of them are by Giambruno (2000) and by Watt (1999). See also (Rosenbloom, 2005) for a recent article on 3D imaging. Educators of information technology and computer science have taught computer graphics as a course, often including sections on 3D display techniques.

2. THE CRYSTAL BALL

The need for an inexpensive 3D display for moving images is felt in many applications such as the ones described in the previous section. A user should be able to either walk around the display or rotate it and see the "action" from any direction. The authors of this paper conducted a simple experiment to build a very crude prototype of a true 3D display device. Although it took less than an hour to set up, it was not easy to find all the components. Two video cameras (about $500 each) were connected to two LCD projectors (about $2,500 each) and two images of an object were projected on to a spherical ball. It was this ball, which took the longest amount of time to find until the authors accidentally discovered a white, translucent exercise ball about 24 inches in diameter (about $20). The authors were very pleased with the results when they viewed a human subject. The subject could move around in real time and was clearly visible from several angles on the spherical ball. The device described in this section can easily be made for a demonstration using the materials and techniques described above.

3. IMPROVEMENTS

Some improvements are as follows. The image can be much improved if two separate rooms are used – one with the cameras, the subject and suitable lighting, the other with the projectors and the ball. Another improvement is to use many more than two cameras and two projectors. The projectors should produce images that are adjacent to each other but do not overlap.

Not so obvious, but equally important, are several advancements that can be made in the near future. The projection equipment could be placed in the center of the display device so that it does not create shadows of the people viewing it, which are produced when external projectors are used.

The crystal ball could be made entirely using LCD technology. It would be a complete sphere with uniformly spaced pixels. These pixels could be addressed using polar coordinates. They could be separated into patches such as in a soccer ball or buckminster fullerene (see Appendix). Corresponding to each patch will be a camera sending information. Because there are 60 faces on a soccer ball, 60 cameras placed perpendicularly to each face will be required for creating a complete 3D image. Details for addressing the pixels on the crystal ball and the corresponding pixels of the camera need further investigation.

The cameras could also be synchronized (using stepping motors controlled by a computer) to provide zoom-in and zoom-out capabilities.

Recording and playback of the 3D image may need some modification of current-day recording technology. These are fairly simple tasks and can be achieved easily with expenditure of a little money and time.

4. CONCLUSIONS

This paper has discussed a leading edge device for the display of three-dimensional images, whether they are stationary or moving. A simple prototype was built to prove the feasibility of such a device. Two improvements were suggested to build more sophisticated devices which produce better images. Details need to be worked out related to distortion of an image when projected on a spherical surface. Additional work needs to be done in ascertaining that sections of the picture are adjacent to each other but do not overlap. Incorporating such devices in information systems and computer science courses dealing with computer graphics remains a long-term objective.

5. REFERENCES

Giambruno, Mark (2002), 3D Graphics & Animation, New Riders Press.

Popular Science (Jan 28th, 2004), Into the 3rd Dimension, http://www.popsci.com/popsci/computers/articles/0,12543,582748,00,html.

Rosenbloom, Andrew (2005), "3D Hard Copy", Coomunications of the ACM, June, pp 32-35.

Watt, Alan H.(1999), 3D Computer Graphics Addison Wesley.

Wojciech Matusik and Hanspeter Pfister (2004) "3D TV: A Scalable System for Real-Time Acquisition, Transmission, and Autostereoscopic Display of Dynamic Scenes", SIGGRAPH.

Appendix

A picture of a soccer ball

(Downloaded from:
http://www.nasaexplores.com/show_912_teacher_st.php?id=030107112716)