Name: Snehitha Ramasahayam

ID:01714702

Email:snehitha_ramasahayam@student.uml.edu

Computer Graphics (Literature Review 3)

The primary article chosen by me for my literature review is Pepper's Cone: An inexpensive Do- it- yourself 3D display written by Xuan Luo, Jason Lawrence and Steven Seltz and the secondary article which has a reference in the primary article is, "3D display with focused light array written by Yoshihiro Kajiki, Hiroshi Yoshikawa, Toshio Honda presented at Proceedings of SPIE, 2652, Practical Holography X on 25 March-1996.

3D display/movies are very interesting to watch and the main reason to choose this article is to know how these are displayed using the different technologies like focused light array, optical Spatters etc. in the Computer Graphics world. Going to some background, with many advances in two-dimensional and three-dimensional displays have been successful in displaying smaller images with the help of 3D glasses or head mounts. But the real challenge is to achieve 3D viewing experience that can display lifelike images without aid of glasses or head mounts.

So let's talk about the secondary paper referenced in primary paper. The secondary paper talks about three-dimensional display using Focused Light Array (FLA). The concept is still based on Electro-holographic display using acousto-optic devices. A main difference is it employs a number of smaller light sources to achieve large 3D images with high resolution and refresh rate.

A standard display concept involves Light modulation, scanning and imaging, and signal processing part. The spatial lighting modulation employs an Acoustic-opto device which does two things: Light intensity modulation (called AOM) and beam deflection (AOD). The holographic modulation of an AO device is a multiple intensity modulation of various deflecting angle. The major issue to consider here is the information content of spatial light modulating part is limited by the modulation frequency bandwidth of AO device. This can be avoided by using an array separated light beam instead of multiplexing them. This is due to the reduction in the information content by using discrete number of samples instead of continuous samples and also due to increase in the modulation frequency bandwidth for each beam. The intensity of each light source is modulated parallax image of corresponding angles

The scanning and imaging part consists of an objective lens, Horizontal scanner and imaging lens. It is similar to electro-holographic display system developed at MIT. The FLA system has advantage over the MIT system since the Horizontal scanning speed and direction need not have to synchronize with speed and direction of acoustic wave which gives flexibility to expand size image size with high refresh rate by fast scanning method. The computation required for transforming parallax images to modulating data similar to generating fringe in electro-holography is removed. Different rendering machines for each parallax in parallel processing render the parallel images. The real time 3D images are generated by conventional computer graphics. A multi-view camera is used to obtain parallax images.

Multiple prototype displays are developed to observe the performance of FLA display. The First FLA models used LED display for ease of light modulation by controlling the current pulse width and also due the stable operation of LED in changing environment. The number of light sources, horizontal viewing zone angle, and visual field width are same for both FLA1 and FLA1b systems. The refresh rate has been improved and FLA1B along the improvement in display brightness by using laser diodes instead of LED.

In summary, the FLA display does not use optical interference. Therefore spatial resolution and parallax resolution can be designed by its optical construction. Few things to consider in design of FLA is the resolution of display should be higher than resolution of human vision. The information content should match to signal processing and transmitting part. One setback of FLA display is its use of mechanical scanners and imaging lenses. The refresh rate is limited by the speed of the scanners. The aperture of imaging lenses and the effective aperture of scanner are limited which limits the field size and viewing zone angle. FLA displays have been successful in displaying real lifelike images without glasses.

This concludes the Secondary Paper that contains many different complex methods in displaying the 3D images. But in the primary paper the authors came up with the simple way of displaying the 3D image with less cost and is created with the PC.

Here we come to the first article - *Pepper's Cone: An inexpensive Do- it- yourself 3D display written by*

Xuan Luo,

Jason Lawrence and

Steven Seltz

This primary article written by authors talks about the 3D display using inexpensive and simple technique inspired from 19th century stage technique based on pepper's ghost illusion. This technique involves use of a reflective surface to project the images of object from hidden room. A similar technique is adopted with few variations. A curved reflector is used instead of planar reflector. It also uses gyro enabled table PC.

The setup consists of truncated plastic cone resting on conventional flat 2D display. When viewed from the side the user sees a distorted reflection of the display that appears to be located inside the reflector. By pre-warping the image on the flat display to compensate for the distortion created by reflector, a perspective correct image is delivered at a desired viewpoint. Also the tablet's gyroscope allows user to smoothly and interactively view a 3D scene from any direction over a 360-degree path. Multiple rotationally symmetric surfaces are studied before arriving at the cone shape.

The prior work involved volumetric and light field displays, head mounted virtual reality and augmented reality systems. The cost of these systems is significantly higher than pepper cone's 3D display. The hardware assembly of pepper cone's display consists of a tablet computer, a reflector, and a base that lets user to rotate the entire assembly. Careful considerations were made in selection of different parts of the hardware. A tablet with high-resolution display achieves better overall image quality and creates larger volume display. A low latency built in gyroscope is essential to track the user's vantage point.

A reflector size, shape and material properties are very critical to achieve the desired optical performance. A study has been done to identify ideal reflector shapes for different display sizes. A commonly found polyethylene terephthalate plastic material works well to prevent color artifacts and undesirable intensity modulation. The other important aspect to produce perspective correct image to someone viewing from the side is to minimize the distortion. In order to achieve this some type of calibration is required. The goal of calibration is compute distortion map, which allows displaying of target image on the virtual image plane by displaying the warped image on the tablet display.

There are plenty of applications where pepper cone's 3D imaging technique can be applied with very low cost and less complexity and does not require to use the glasses but there are also some **limitations** to using Pepper's Cone method as it is not suitable for bright outdoor environments. Another limitation is the 3D Display also assumes the specific viewing position and only single user can view the screen at once. However this is to improve in future where camera-based head tracking to be added for automatically accounting the actual viewing position. This would allow the user to freely walk around our display. Finally, we would like to extend our system to accommodate more than one viewer at a time.