Gamma Correction on Volumetric 3D Display System

Yi Yao, Xu Liu, Yuanfang Lin, Hui Xue, Xiangdong Liu
State Key Laboratory of Modern Optical Instrumentation,
Zhejiang University, Hangzhou, China
Phone : +86-571-8795-1187 , E-mail : will@hz.cn

Abstract
To make real 3D vision available, we have established a volumetric 3D display system that based on rotating LED matrix. The paper introduced a method to correct the problem that pixels are not symmetrical but circumferential in space, which causes the resolution of the edge area much lower than that of the central area.

1. Introduction
Since present 3D display technology is projecting 3D to 2D, people's eyes are deceived by the loss of spatial data. Therefore, it is a revolution for human vision to develop a real 3D display device.

As the trend goes on, someone begin to develop real 3D display technique such as three-dimensional holography, volumetric 3D display and stereoscopic pair and so on. It brings us a new world for human vision that we can really feel a true object with three-dimensional shape and texture.

In this paper, the technique to be stated is a new 3D display method that based on volumetric 3D LED emissive display system architecture and more accord with human vision. Due to the weakness of the system, we give an effective method to fix the problem as an improvement of this technology.

The monitor is based on emissive pad with 64*256 LED array. When rotated at a frequency of 10 Hertz, it shows real 3D images with pixels at their exact positions.

Nevertheless, there is a problem that the pixels are uniform in cylindrical coordinates, which causes the resolution not so symmetrical in Cartesian coordinates. Distorted vision always bring uncomfortable sense to observers, so the objective is to develop a compensate software to make the pixels as uniform as it can be in Cartesian coordinates.

2. Display Systems
The display panel of the system is a 16 thousand mass LED panel with 64 rows and 256 columns in a rectangle, each LED is placed in horizontal distance of 1.5mm and vertical distance of 2.5mm which form a LED dot matrix which resolution of 64*256. The LED's cathode in a row is connected and anode in a column is connected too, it constructs a meshwork with scan lines. There are 256 columns and every 8 column are connected to a flash ROM which has 256K capacity and 8 bit data bus.

The mechanical system with high stability and balance is mostly a motor which drives the panel rotating at a 10 Hertz speed which forms a 3D scene.

3. Gamma Correction

3.1 Previous results
We have successfully established the display system which shows 3D scenes well.

Figure 1

3D Guitar

As Figure 1, it is the display results of previous system, a guitar in a three-dimensional space. According to the picture, you will find LEDs close to

the axis will be much brighter than the one away from the axis that is because the LED's density is much larger when rotating with a axis. The distortion of the image makes intensity not so balance that the region far away from the axis will lose brightness as the picture shows.

3.2 Gamma Correction

The algorithm is much like transform cylindrical coordinates to Cartesian coordinates. However, as the limit of the device, not every pixel has their position in Cartesian coordinates simply by calculating with trigonometric function.

With considering the pane position, the LED distance, the refresh rate, the average resolution, and so on, we successfully setup the compensate software written by Sun Java®. In addition, evaluation system to evaluate the display effect is also established.

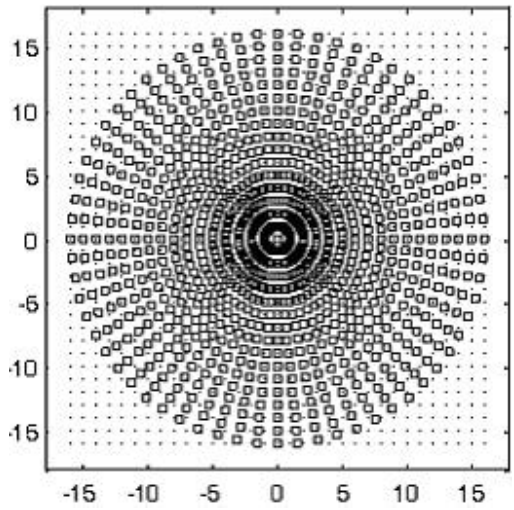

Figure 2

64 planes without compensation

Fig.2 shows the previous system in horizontal pane, be looked from the top of the device. Each small square implement a LED pixel with 64 planes in circle. The density in center is much higher than other area.

Fig.3 shows the compensated system in horizontal pane with the same parameters as Fig.2, it seems more symmetrical in Cartesian coordinates than ever.

Fig.4 shows the compensated system in horizontal pane with 256 planes in circle. It seems has proportional spacing in Cartesian coordinates. Moreover, the pixels have fewer warps than Fig.3.

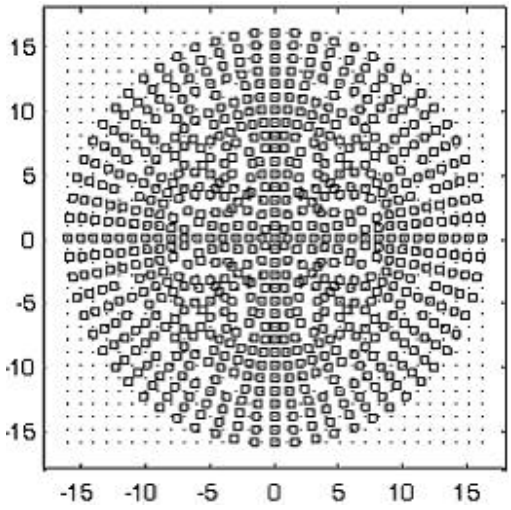

Figure 3

64 planes with compensation

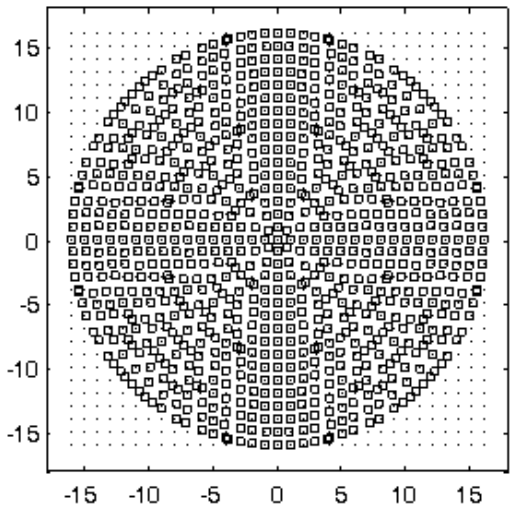

Figure 4

256 planes with compensation

Due to the pixel size, system with planes greater than 256 has same performance as Fig.4; it is no need to increase planes in circle to enhance visual effect.

3.3 Results

With the compensation system introduced above, we create a digital mask to correct the original picture. It is much like we give a small multiplying factor to the central area and a big one to the edge area. To see the results clearly, Figure 5 is given as a shark of the previous system and Figure 6 is given as the one of the compensated system.

Compare with the two figures, the next one has more balance on brightness that viewers could see the 3D scene more clearly and comfortably.

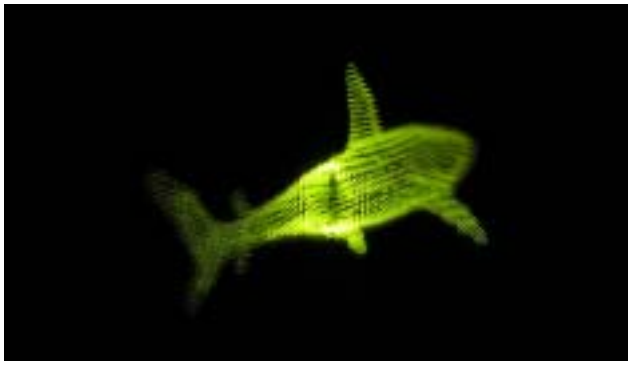

Figure 5

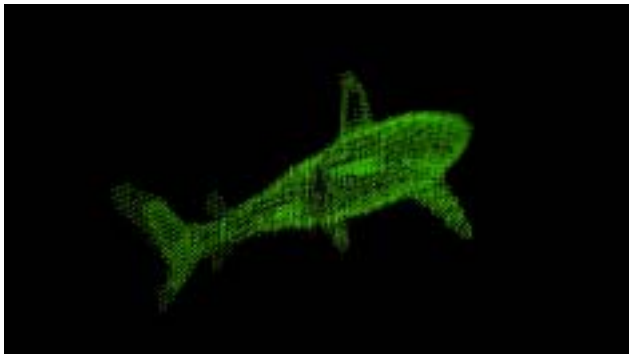

Figure 6

Shark of compensated system

4. Conclusion

This work allows viewer to see the 3D scene more comfortable. Moreover, the detail information in center area is becoming much clearer and as the redundancy data goes away, transmission of 3D data will be much faster.

In another hand, it is much like the technology called gamma correction on modern projection displays. In addition, it is the first time to make volumetric 3D display symmetric so far as I know. The intensity will no longer converge in center of the device that improves the visual effect very much.

As the 3D displayer being developed, I think people will say goodbye to previous 2D displayer in one decade or two. It can be expected that this revolution will bring a strike on modern monitors and will lead to a new world for display technology.

5. References

[1] C. Tsao and J. Chen “Volumetric Image Display for Complex 3D Data Visualization”, Proceedings of SPIE Vol. 3905 (2000).

[2] D. Bahr, K. Langhans, D. Bezecny, D. Homann and C. Vogt “FELIX: a volumetric 3D imaging technique” SP1E Vol. 3101.

[3] Williams, R.D.and Garcia, F. "Volume visualization displays", Information Display, 4/89, p. 8, U.S. patents No. 5,172,266, 5,042,909.

[4] Y. Lin, X. Liu, X. Zhang, Y. Yao and X. Liu “Volumetric 3D Display System Based on Rotating Dot-Matrix LEDs” Asia Display/IMID’04 Proceedings 2004.

[5] Y. Yao, X. Liu, Y. Lin, H. Zhang, X. Zhang, X. Liu “Data acquirement and remodeling on volumetric 3D emissive display system”, Proceedings of SPIE Vol.5632(2005).