Birds-eye View Ray Scan System for Flatbed Autostereoscopic Displays

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1 Introduction

We have proposed a flatbed autostereoscopic display using the one-dimensional (1-D) integral imaging (II) method [Hirayama 2006]. 1-D cylindrical lens array (lenticular sheet) is used in the 1D-II display, making it possible to observe a three-dimensional (3-D) image with the horizontal parallax ray. The flatbed autostereoscopic display system brought about a more effective stereoscopic experience than the conventional upright display. In the flatbed display configuration, observers perceive displayed objects as if they exist on a table, because it has real depth matching with a horizontal plane and uses bird's-eye view configuration.

In this work, we introduce a newly developed prototype of a rotatable ray scan system for the flatbed autostereoscopic display system. This system realizes not only fast acquisition of multiple high-density light rays but also a rotating mechanism of the scanning surface with a case. Therefore, it can capture photographic contents having an angle of depression suitable for flatbed autostereoscopic display.

2 Bird's-eye View Ray Scan System

We have proposed the synthesis method adapting 3-D images based on various specifications of autostereoscopic display using the scan-type ray acquisition system and reported the experimental results [Sekine 2008]; however, the system did not support tilted capturing for birds-eye view. We made several improvements to the scan-type ray acquisition system. Figure 1 shows the new prototype scanner. The main feature of the new system is the rotatable scanning unit for capturing objects with depression angle. The scanning unit of the new system can be easily rotated with the case, because it is only a quarter of the weight of the old system.

Basic elements of the new system are the same as those of the old system: a fixed camera, a scanning cylindrical lens, a fixed mirror, and two scanning mirrors. In this system, multiple rays $r(x,\theta)$ can be acquired at 1,800 positions (x) with scan-pitch of 0.2 *mm* between scanning ranges of 360 *mm*. An image captured at a certain scanning position corresponds to the different rays of 110 directions (θ) in a range of 50 degrees. The max scan speed is 6 *mm*/*sec*, and the capturing of whole photography of a 3-D object takes one minute.

3 Adaptive for flatbed-type 3-D Image Synthesis

Since the rays acquired by this system are very high density and have angle of depression, an adaptive 3-D image can be synthesized for flatbed autostereoscopic displays. By controlling the method of the ray sampling $R_{i,j,k}$ in each position (i: cylindrical lens array number, j: pixel line number in a certain cylindrical lens, k: vertical pixel number), different depression angle ϕ of 3-D images can be synthesized. Figure 2 shows examples of the following types of ray sampling.

(a) $R_{i,j,k} = r(x_i, \theta_j, y_k)$:Basic ray sampling(ϕ =0)

(b) $R_{i,j,k} = r(x_i + a(\phi,k)\theta_j, \theta_j, y_k)$: Depth correction.

(c) $R_{i,j,k} = r(x_i, \theta_j, (b(\phi)y_k+c(\phi))/(d(\phi)y_k+e(\phi)))$:Vertical perspective correction

Where x_i ,y_k and θ_j are basic sampling position and angle without depression in a position i, j, k. Usually both (b) and (c) are necessary processes for flatbed 3-D image synthesis. By changing the depth parameter a in the sampling method shown in (b), the 3-D images that have various depths and focal positions can be synthesized. In flatbed 3-D image synthesis, focal positions are shifted to each vertical position depending on depression angle ϕ. The depth correction parameter a is a function of vertical position k and depression angle ϕ. By changing the viewing vertical perspective parameters *b, c, d and e* in the sampling method shown in (c), the 3-D images that have various vertical perspective views can be synthesized. The ray acquisition data in a certain cylindrical lens has vertical perspective. In flatbed 3-D image synthesis, it is necessary to correct vertical perspective parameters *b*, *c, d* and *e.*

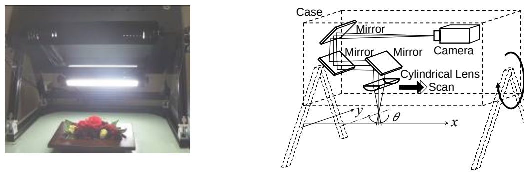

Figure 1: Bird's-eye View Ray Scan System.

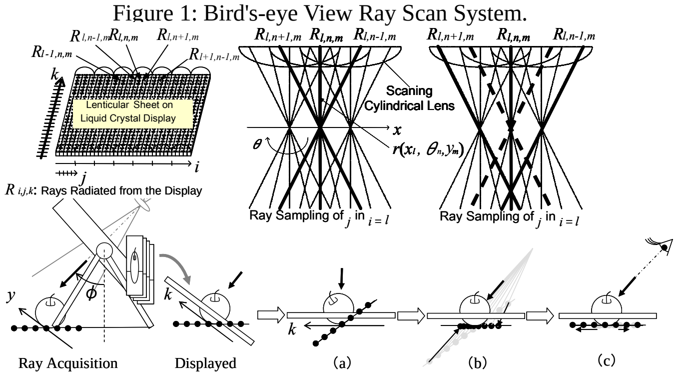

Figure 2: 3-D image synthesis with ray sampling.

(a) Before correction (b)After correction

Figure 3: Output to 1-D II autostereoscopic display.

4 Results

We acquired rays of an object and synthesized 3-D images. Figure 3 (a) shows the output pictures of synthesized 3-D images on 1-D II autostereoscopic display before correction. Figure 3 (b) shows the output pictures after correction by using equations (a), (b) and (c). This system makes it possible to represent the rays of a 3-D real object adaptively for flatbed autostereoscopic displays.

References

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