Glasses-free 3D Image Viewer by Handmade DIY Craft

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Abstract. We developed a glasses-free 3D stereoscopic display using an LCD display panel, a view control film and a grating film for stereoscopic viewing. The display screen is divided in half in order that left and right regions provide the stereoscopic images for left and right eyes. Because both stereoscopic images are not in the same position, it is difficult for the observer to view the 3D image by the stereoviewing. The grating film can solve this problem because it shifts both left and right images to the same position. Moreover the view control film can give us glasses-free 3D viewing. As the result, the observer can watch overlapped stereoscopic images for left and right eyes without special glasses such as polarized glasses.

Keywords: 3D imaging, polarized glasses, overlapping stereoscopic images, optical grating film, 3D adapter, stereoscope

1 View Control For Stereo Viewing

To overlap left and right images, the authors use an optical film "SOLF™" of 3M Company. The SOLF optical sheet is a flexible film with prisms designed to transport and diffuse the light. This sheet has interesting characteristics as follows; the prismatic phenomenon is observed and the doubling can be visible through the sheet like the Calcite. This doubling phenomenon occurs because the prism sheet diffracts two beams. This interesting thing reminds us of method to superimpose left and right stereoscopic images. A grating diffracts or scatters a light beam with a designed angle. Using the doubling phenomenon, the authors shift the images for superimposing stereoscopic images by adjusting the interval between an optical sheet and image plane as shown in Fig. 1. The optical grating film shifts both left and right images to the same position. The observer watches overlapped stereoscopic images for left and right eyes. If this overlapped images can be separated into appropriate eyes, you can perceive the left image only by a left eye and the right image by a right eye. If you are content to wear glasses, this technology enables us to enjoy 3D image viewing using polarized glasses. In order to improve a bother, it is necessary to separate a side-by-side stereoscopic image into left and right eyes.

To deliver left and right images into appropriate eyes, we use a view control film "LUMISTY™" of Sumitomo Chemical Co., Ltd. Using this film, you can see through the film from the left, but not from the right as shown in Fig. 3. One of the miraculous features of LUMISTY is that it can be either transparent or opaque, so that it looks either like transparent or frosted glass, depending on the angle of sight. It is an adhesive-type transparent plastic film which can be used simply by sticking onto a

Fig. 1. Superimposing stereo images

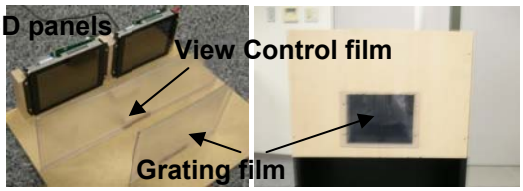

Fig. 2. Appearance of 3D display (KNA-20X)

windowpane, and it does not cut out any of the light coming through the window.

It is useful characteristics for 3D viewing that you can control what can and what cannot be seen depending on which side the viewer is on, or what angle the viewer is looking from. Using the miracle of this LUMISTY visibility control as shown in Fig. 4, it enables us to perceive left images by the only left eye and right images by the only right eye. As shown in Fig. 4, the view control film passes the light within an angle of θ. Let's design the optical layout assuming that 15-inch display panel is used. The width of the 15-inch panel is approximately 280mm. As shown in the Fig. 4, the ray of a left image is emitted with an angle α to vertical and it reaches into the left eye after the ray is diffracted by an optical grating film. Meanwhile the ray with an angle β passes into the right eye through the grating film. If the view control angle θ is α to β ($\alpha < \theta < \beta$), the left image is observerd by the only left eye because the ray with an angle β to vertical is blocked by the optical film. The rays of a right image are the same as the left image. In case of the 15-inch panel, the angle α is 13.37 deg and the angle β is 25.64 deg. The LUMISTY film has many kinds of characteristics; *e.g.*, opaque from front side, one direction, two directions and so on. The grade MFY-2555 is opaque from one direction when the ray is encountering the film with the angle more than 25 deg. Using this MFY-2555 (θ =+25 deg), the observer can perceive the left image only by a left eye and the right image by a right eye with no glasses because the view control film restricts the direction of scattering light after the grating film overlays left and right images at the same position. Therefore, the observers, who wear no glasses, can view the 3D images by the binocular stereo viewing. We have developed the prototype glasses-free stereoscopic 3D display using two commercial LCD panels for playing 3D contents by portable DVD players as shown in Fig. 2. In this display, observers can view the 3D images by the binocular stereo viewing without special glasses.

(a) viewing at front

(b) viewing from side

Fig. 3. View control film

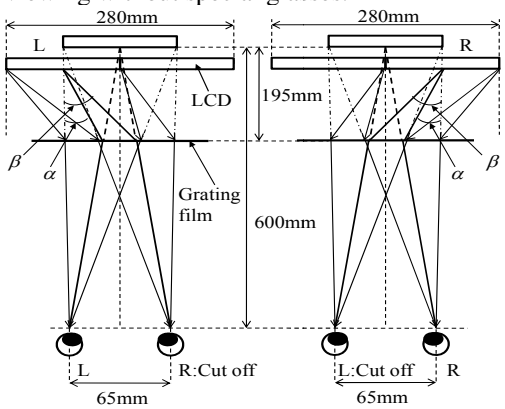

Fig. 4. Optical design for 3D viewing