Practical 3D+2D Displays

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(a) Left Eye Image (b) Right Eye Image (c) Standard 3D Display (d) Our 3D+2D Display

Figure 1: *A typical glasses-based 3D display shows a different image to each eye of viewers wearing stereo glasses, visible through the glasses: (a) Left eye image is labeled with the letter L. (b) Right eye image is labeled with the letter R. (c) On a standard 3D display, viewers without glasses see both images superimposed, visible directly on the screen at the top of the figure. (d) Our 3D+2D display likewise shows a different image to each eye of viewers wearing stereo glasses, but shows only one of these images to those without glasses, removing the "ghosted" double-image.*

1 3D+2D Displays without Ghosting

High-end televisions, monitors and gaming laptop screens are shifting from 2D to 3D. Most commercially available 3D displays show stereoscopic images to viewers wearing special glasses, while showing incomprehensible ghosted images to viewers without glasses. It is not always desirable to require that all viewers wear stereo glasses. They may cause flickering, interfere with other activities, or be prohibitively expensive.

Our method enables stereoscopic 3D displays to be watched by 3D and 2D viewers simultaneously. Ghosted images that are observed on traditional 3D displays can be eliminated for viewers without stereoscopic glasses while 3D perception is preserved for viewers with glasses. We accomplish simultaneous viewing of 3D and 2D images by replacing the pair of images [Left, Right] with a triplet [Left, Right, Neither]. Those wearing glasses see the Neither image with neither eye; only those without stereo glasses can see it. The Neither image is the negative of the Right image so that they sum to a grey image when superimposed, leaving only the Left image visible to 2D viewers.

Unfortunately, this raises the minimum black level of the display for viewers without stereo glasses, decreasing the contrast ratio. This can be mitigated by reducing the brightness level of the Right image, α_R, while maintaining the Left image at full brightness.

Reducing α_R improves the contrast ratio for 2D viewers. However if α_R is decreased too much, the 3D experience of viewers with glasses will deteriorate. We conducted experiments, on both viewers with and without glasses, identifying the acceptable range of α_R to be $20\% \leq \alpha_R \leq 60\%$. Further details validating the design for both 3D and 2D viewers can be found in [Scher et al. 2013].

2 Practical Enhancements

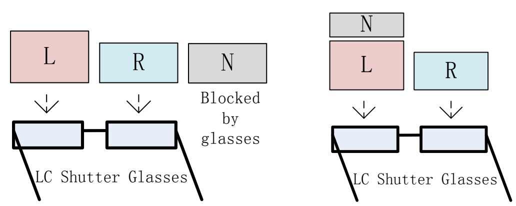
Ghosting-control weight Although viewers prefer contrast loss to a fully ghosted image, the contrast loss is also undesirable. Thus we investigated the optimal trade-off between contrast loss and ghosting for 2D viewers.

The image that 2D viewers see can be represented as:

$$[Left] + \alpha_R * [Right] + w * [Neither]$$

When w equals α_R, no ghosting is visible. Decreasing w improves the contrast ratio, at the cost of some visible ghosting. Varying w will not affect 3D viewers, but provides the benefits of searching in a larger space for a satisfying 2D image.

Initial studies were conducted by letting users modify w interactively. When $\alpha_R = 40\%$ our test subjects preferred $w = 60\%$, an intermediate level of both ghosting and contrast.



(a) (b)

Figure 2: *(a) In the three frame method, a third channel is inserted to display the [Neither] image. (b) A two frame approximation can be achieved by adding the [Neither] image to the [Left] image.*

Two frame approximation The three frame method is ideal, but can not be implemented without hardware modification. Figure 2 shows an approximation for standard 2-frame displays. The [Neither] image is simply added to the [Left] image slot.

This introduces negative crosstalk into the [Left] image. However, our display, like many existing stereo displays, has noticeable positive crosstalk due to hardware limitations. Since the negative and positive crosstalk cancel, this results in total crosstalk to the left eye only a little greater than the standard level. Test users have found the 3D image quality acceptable.

References

SCHER, S., LIU, J., VAISH, R., GUNAWARDANE, P., AND DAVIS, J. 2013. 3D+2D TV: 3D Displays With No Ghosting for Viewers Without Glasses. *ACM Trans. on Graphics (@ SIGGRAPH13).*

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SIGGRAPH 2013, July 21 – 25, 2013, Anaheim, California.

ACM 978-1-4503-2261-4/13/07