Practical 3D+2D Displays

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Problem

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.

Simultaneous 3D+2D Display

Our method enables stereoscopic 3D displays to be watched by 3D and 2D viewers simultaneously. Ghosted images observed on traditional 3D displays can be eliminated for viewers without stereoscopic glasses while 3D perception is preserved for viewers with glasses.

2D Viewer Preference

Contrast Ratio Reducing the brightness of the right eye image ($\alpha_R$) can help improve contrast ratio for 2D viewers. If $\alpha_R$ is above 20%, 3D perception is maintained. At this level, 2D viewers strongly prefer our method to ghosting.

Ghosting-control weight Even though viewers prefer contrast loss over 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:

$$[\text{Left}] + \alpha_R \cdot [\text{Right}] + w \cdot [\text{Neither}]$$

Two Frame Approximation

The three frame method is ideal, but cannot be implemented without hardware modification. The following figure shows an approximation for standard 2-frame displays. The image (N) is simply added to the [Left] image slot.

Our 3D+2D display adds a third image (N) to each frame, shown to neither eye of the viewer with glasses, but seen by a viewer without glasses. This third image is used to display the negative of the Right image, leaving the 2D viewer a low-contrast version of the Left image.

<table>
<thead>
<tr>
<th>2D</th>
<th>3D</th>
<th>3D+2D</th>
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</thead>
<tbody>
<tr>
<td><img src="Left" alt="Same Image for Left and Right Eyes" /></td>
<td><img src="Right" alt="Same Image for Left and Right Eyes" /></td>
<td><img src="Right" alt="Same Image for Left and Right Eyes" /></td>
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<tr>
<td><img src="LRN" alt="Equal Length" /></td>
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<td><img src="LRN" alt="Variable Length" /></td>
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Fully Ghosted (w=100%, w=0%)
Low Contrast (w=40%, w=40%)

With control weight (w=40%, w=24%)

Reference