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Easy huge 3D display using distributed general monitors

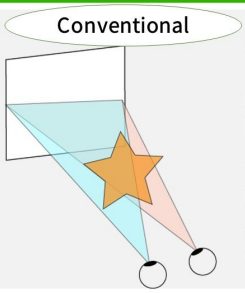
Huge 3D display by collection of monitors you have

Abstract

This research addresses the common notion that creating a large, popping-out 3D display spanning multiple monitors with gaps is impossible. We introduce a technology that allows the perception of a coherent, popping-out 3D image even when using a collection of monitors of different sizes with gaps between them. By leveraging the human visual system's ability to complete missing visual information, our technology creates the illusion of a continuous and protruding image, even if the gaps between the monitors cannot display images. Additionally, constructing a large screen using multiple general-purpose monitors ensures easy recovery if one of the monitors fails. By advancing our understanding of the human visual system, we aim to enable the presentation of immersive 3D images using common devices. This will pave the way for a future where everyone can easily experience powerful visuals in everyday settings, which are currently only available through specialized equipment or facilities.

How to present a huge 3D image?

Conventional

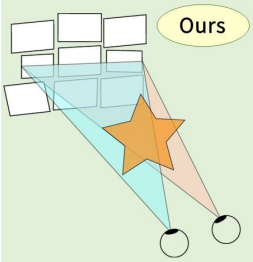


Using a single giant display

Large space, expensive displays, and high management costs are required.

Usage of a large projector screen can lower the cost, but outdoor usage is still limited (an expensive projector is required instead)

Ours



Distributed displays using collection of monitors

A huge 3D image display can be created using multiple inexpensive generic monitors.

Different types and sizes of monitors can be combined, and misalignment of monitors is allowed.

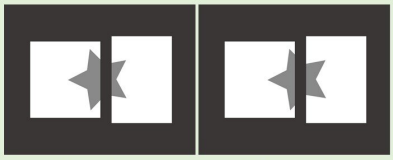
A huge, popping-out 3D image can be presented even with gaps between monitors

Gap completion with transparency perception

The gaps between monitors create a deficit in the image, and these gaps act as occlusion cues. As a result, even if a protruding 3D image is presented, the image is perceived as being behind the monitor array.

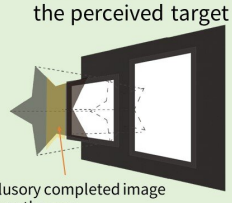
Manipulating the brightness relationship between the target, monitors, and gaps creates an illusion that the **target is semi-transparently overlapping in front of the gaps, thereby perceptually completing the image gaps.**

Example inducing transparency perception



Left-eye image　Right-eye image

Schematic of the perceived target



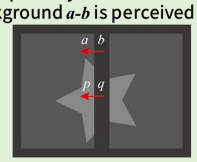
Illusory completed image over the gap

Brightness design to induce illusion

The target region (p-q) is perceived to be in front of the gap region (b-q) if both a and p are brighter (darker) than the gap, and p is darker (brighter) than a.

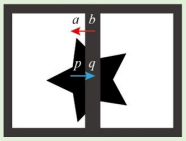
[Anderson 2003]

Transparency illusion occurs, but background a-b is perceived in front



Both a and p are brighter (darker) than the gap, and p is brighter (darker) than a

Transparency illusion does not occur, and target p-q is perceived behind

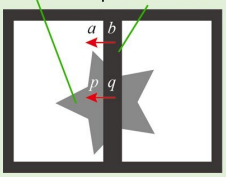


a is brighter (darker) and p is darker (brighter) than the gap

Transparency illusion occurs, and target p-q is perceived in front

p-q: Target to be perceived front

Gap between monitors



$Lbq<Lp<La$
or
$Lbq>Lp>La$

References

[1] Yuri Mikawa, Hiroyuki Shinoda, “BrickDisplay: 視差映像ディスプレイの分散配置による欠損を許した巨大空中像提示,” *The 28th Annual Conference of the Virtual Reality Society of Japan (VRSJ2023)*, 2023 [Japanese].

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