Stereoscopic Transparent Display Visible with Naked Eye

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MOTIVATION

To present a stereoscopic image that cannot be distinguished from reality, a suitable viewing environment is required. That is, the visibility of the stereoscopic display itself should be minimized and the image should be visible with the naked eye.

RELATED WORKS

- Transparent stereoscopic displays [1,2].
- Using retro-transmissive optics to present stereoscopic images to the naked eye [3].
- Current displays [1,2] have low resolutions or cannot present stereoscopic images that can be seen with the naked eye.
- Observation is limited to a small number of viewpoints [3].

OUR APPROACH

We propose a stereoscopic transparent display that can be viewed with the naked eye (Fig. 1). A **directional display** is used instead of optical elements that limit resolution or viewing range. The directional display enables naked-eye stereoscopic viewing by adding directionality to ordinary LCDs according to the viewing position. A **conical transparent reflector** allows stereoscopic images, fused with the surroundings, to be observed from all sides.

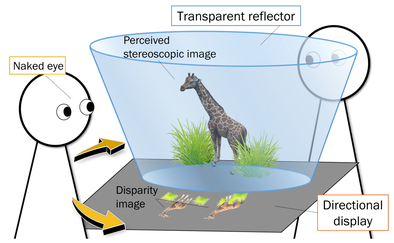
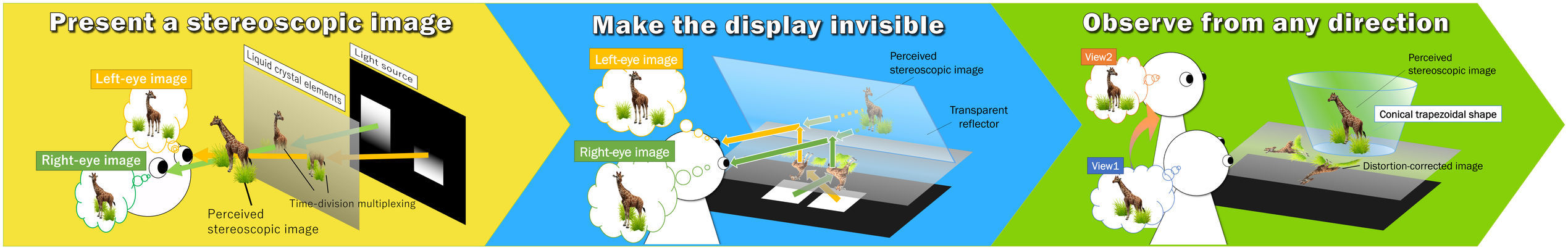


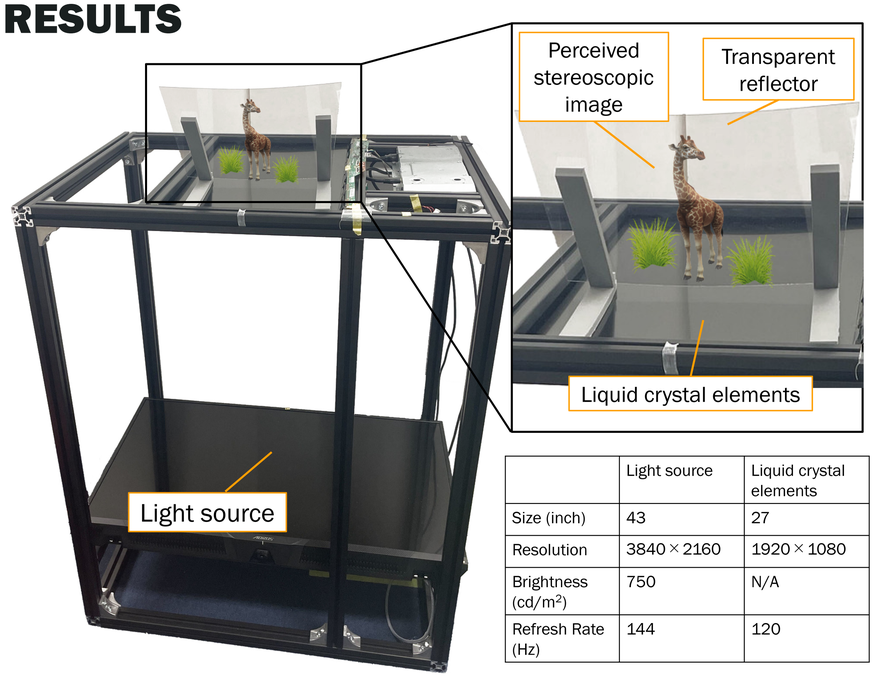
Fig. 1 : Overview of proposed method

METHOD

The directional display provides naked-eye stereoscopic viewing by presenting disparity images to the left and right eyes. The presence of the display is reduced by using Pepper's Ghost technique. By applying geometric correction to the image displayed on the directional display, distortion-free images are presented that can be observed from any direction.



RESULTS



	Light source	Liquid crystal elements
Size (inch)	43	27
Resolution	3840 × 2160	1920 × 1080
Brightness (cd/m^2)	750	N/A
Refresh Rate (Hz)	144	120

Fig. 2: Prototype display using a flat reflector

In an experiment, the prototype presented a 3D model at multiple depth positions (Fig. 2). The left- and right-eye disparity images were captured from the observer's left- and right-eye positions, respectively. The disparity images can be clearly observed at the target left- and right-eye positions (Fig. 3).

The subjects were asked to record the depth position at which they could see the 3D model. The subjects accurately perceived the depth presentation position of the stereoscopic image (Fig. 4).

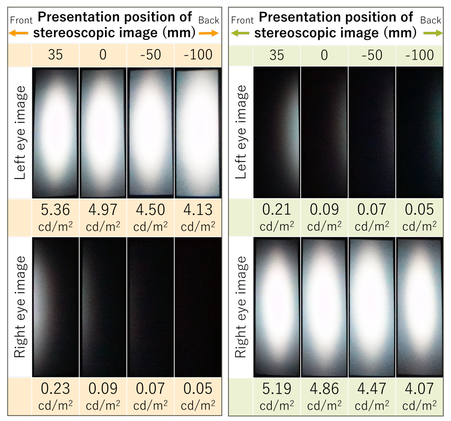


Fig. 3: Obtained disparity images

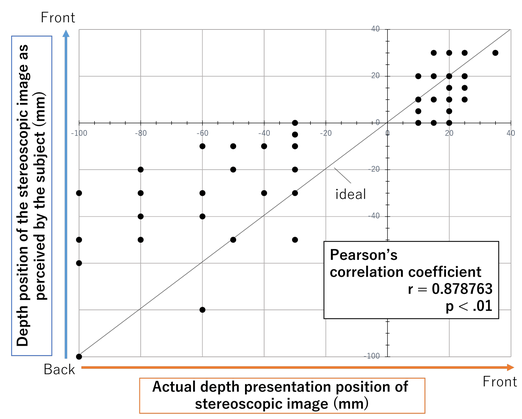


Fig. 4: Questionnaire results

FUTURE WORK

- Extends the transparent reflector in the shape of the conical trapezoid.
- Allows for observation from all sides by tracking the observer.
- Expands the image area and improves brightness by increasing directionality.

REFERENCES

[1] Shree K. Nayar and Vijay N. Anand. 2007. 3D Display Using Passive Optical Scatterers (IEEE Computer Magazine).
[2] Xuan Luo, Jason Lawrence, and Steven M. Seitz. 2017. Pepper's Cone: An Inexpensive Do-It-Yourself 3D Display (UIST '17).
[3] Tadatoshi Kurogi, Hideaki Nii, Roshan Lalintha Peiris, and Kouta Minamizawa. 2018. Scalable Autostereoscopic Display with Temporal Division Method (ICAT-EGVE2018).