An Estimation Method for Alignment of Non-parallel Plates based on Wave Optics

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1. Introduction

As the research and development of display systems are advanced, various functional panels are embedded in a single display product, and precise aligning between panels is becoming important in order to derive intended results when designing. Also, when attaching an optical element having a special function to a flat panel display, the accuracy analysis of the inter-panel alignment is the crucial keypoint and that is being studied by many researchers. [1]

In this study, we propose a method to analyze the alignment by estimating the degree, which is calculating by the positional correlation between the panels based on the wave optic analysis. Using this method, analyzing of the alignment degree of three-dimensional rotation is suggested using not only the method of measuring panel displacement and rotation in a two-dimensional plane but also the characteristics of a hologram which forms image precisely at a specific distance.
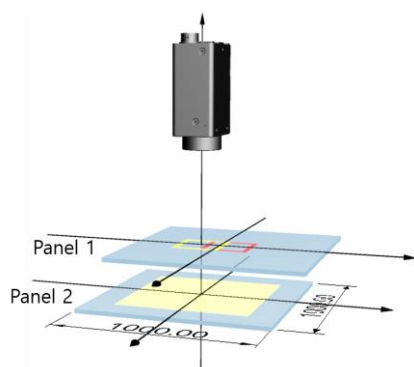
2. Simulation Method

Figure 1. System structure for simulation

Fig. 1 shows the system structure for simulation. In the simulation, a binary computer-generated hologram (CGH) pattern is engraved on the panel 2 to reconstruct an image at the panel 1. The plane waves propagate from bottom to top, incident to a binary CGH pattern engraved on glass, and pass through a region of air and glass to form an image at a specific distance (on the panel 1). The images are obtained by optical equipment such as a CCD or a microscope, and estimation of the positional relationship between the two panels are calculated.
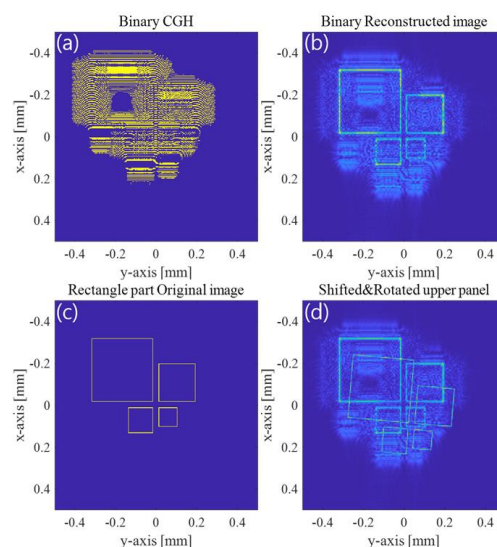

Figure 1. (a) Binary CGH, (b) Reconstructed image, (c) Pattern engraved on the panel 1, (d) Observation result of panel 1

Fig. 2 shows the simulation results assuming that the panel 1 is moved and rotated. Fig 2 (a) is reproducing the hologram to shown in Fig. 2 (b) on panel 1 as a binary CGH pattern recorded on panel 2. Fig. 2 (c) is used in CGH calculation and the recorded pattern on the top of panel 1. When the focus is on panel 1, the result shown in Fig. 2 (d) is obtained, which the recorded pattern is overlapped with the hologram image formed on panel 1. If both panel 1 and panel 2 are well-aligned, the marker will match exactly. Therefore, we can consider the alignment status between the two panels like displacement and rotation can be estimated by analyzing the positional correlation in the image.

3. Conclusions

In this study, the method of estimating and analyzing the alignment degree of the display panel is verified by simulation based on the wave optic using the binary CGH patterns. And the method is analyzed by the simulation.

Acknowledgements

References

[1] K. Matsushima, H. Schimmel, and F. Wyrowski, "Fast calculation method for optical diffraction on tilted planes by use of the angular spectrum of plane waves," J. Opt. Soc. Am. A 20, 1755-1762 (2003).