A Study on Depth Perception of Gaze in VR Space

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***Abstract*— In this study, we undertook two experiments to investigate gaze behavior related to depth perception in virtual reality (VR) environments. The first experiment examined depth gaze behavior by changing the transparency of a virtual image, then the second experiment focused on depth gaze behavior under reversed viewing in stereoscopic images. The interesting experimental results were obtained.**

I. INTORDUCTION

"HoloLens" displays an imaginary image and a real image at the same time [1]. As the imaginary image is semi-transparent, the user's gaze moves between the imaginary image and the real background. Another theme is that when the left and right images are reversed, the subject's perceived depth appears to be reversed. The complexity of the content influences this depth perception, which in turn influences gaze behavior.

This paper clarifies the depth gaze behavior in the above two experimental environments. The purpose is to provide guidelines for content display methods in virtual space, using the results.

II. PROPOSED EXPERIMENT

A. Depth gaze behavior by changing the transparency of the imaginary image object

In order to replicate the HoloLens environment in VR space, a method was used in which an imaginary image object, achieved by modulating transparency, was presented in front of the background image. In the experiment, the amount of depth gaze movement between the background image and the imaginary image object is recorded by changing the transparency ratio of the object. A head-mounted display (HMD), the HTC VIVE Pro Eye, was used.

B. Depth gaze behavior of reversed viewing in stereoscopic images

Stereoscopic reversed 3D viewing (presentation of left-right reversed images) causes an incongruity in perspective. To investigate this sense, the experiment involved subjects performing a task of moving an object in virtual space under two conditions: normal 3D viewing (correct left-right image presentation), and reversed 3D viewing. Throughout the task, gaze depth data were recorded

III. RESULTS AND DISCUSSIONS

A: Figure 1 shows a graph of the observation time transition of the depth gaze movement value when the transparency of the object is 20% and 95%. When the subject was looking at the imaginary image object, the depth gaze movement was unstable in transparency 95% and stable in 20%. The relationship between the transparency of the imaginary image and the variation of the depth gaze movement was clarified.

B: Figure 2 shows a graph displaying the frequency of occurrence for each interval distance during gaze movement measured at 40-millisecond intervals. During the reversed 3D viewing, the variability of gaze movements was notably higher, and the stability of the gaze movement was reduced compared to the normal 3D viewing.

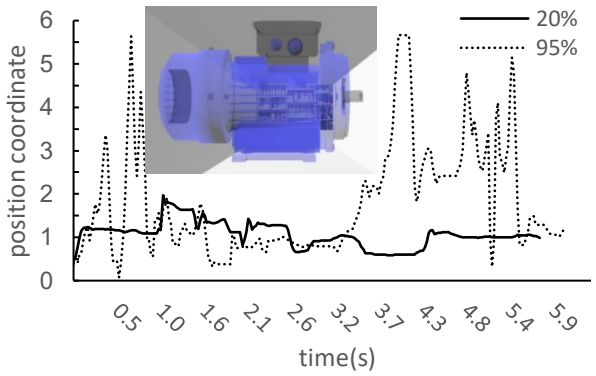

Fig.1 A: Depth gaze movement at 20% and 95% transparency

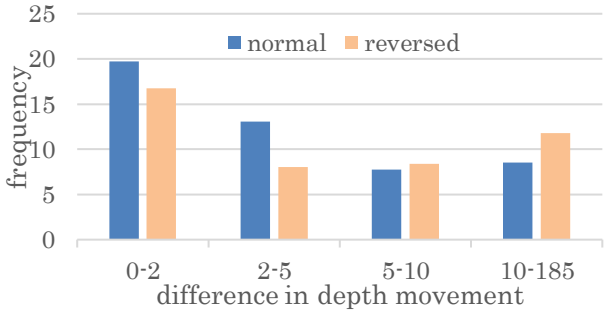

Fig.2 B: Frequency of occurrence of eye movement distance

IV. CONCLUSION

In this one-page extended abstract, we presented the results of the depth gaze behavior in VR space under the interesting conditions. The full paper comprehensively describes the detailed experimental conditions and provides an in-depth discussion of both Experiments A and B. Furthermore, we include a report on the intriguing findings derived from subjective evaluation results, which adds an additional layer of interesting insights to the study.

V. REFERENCES

[1]" Microsoft HoloLens" ,Microsoft, https://www.microsoft.com/ja-jp/hololens, 20 July 2023.
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