Frontiers in Optics + Laser Science 2023 (FiO/LS) © Optica Publishing Group 2023

Headsetless Holographic Virtual Reality Displays

KAAN AKŞIT,*

Computer Science Department, University College London (UCL), London, UK
*k.aksit@ucl.ac.uk

https://kaanaksit.com

Abstract: We introduce a headsetless holographic virtual reality display. In this new design, a custom holographic projector populates a micro-volume located at some distance with 3D images. Users view these with the help of an eyepiece.

1. Introduction

Virtual Reality (VR) headsets offer a next-generation display experience with many use cases in education, office work, and entertainment [1]. However, these VR headsets must overcome issues related to their form factors, computing, heating, and power to deliver an immersive 3D experience in the future [2]. Our previous work combats these issues by separating active and passive components of a VR headset [3] but cannot genuinely deliver 3D images. Specifically, our design offers a unique optical layout containing a stationary 2D projector and a wearable eyepiece. We upgrade this 2D projector design using Computer-Generated Holography (CGH) [4] with a new prototype that delivers 3D images, and we brand this improvement as HoloBeam [5]. HoloBeam improves resolution and Field of View (FoV) of Beaming Displays from 7 cycles-per-degree (cpd) with 30 degrees monocular FoV to 24 cpd with 70 degrees FoV. HoloBeam can use either our optimization framework for CGH [6] and a dedicated, learned method that could convert conventional 2D images (RGB without depth) to 3D holograms. All our implementations use our differentiable toolkit [7, 8]. We pitch our innovation as a headsetless device that paves the way to the potential to replace today's 2D desktop display with our 3D holographic display that could deliver perceptually accurate CGH [9] while not requiring bulky form factors or invasiveness caused by traditional wearable VR headsets.

References

1. G. A. Koulieris, K. Akşit, M. Stengel, R. K. Mantiuk, K. Mania, and C. Richardt, "Near-eye display and tracking technologies for virtual and augmented reality," in *Computer Graphics Forum,* vol. 38 (Wiley Online Library, 2019), pp. 493–519.
2. J. Orlosky, M. Sra, K. Bektaş, H. Peng, J. Kim, N. Kos'myna, T. Höllerer, A. Steed, K. Kiyokawa, and K. Akşit, "Telelife: The future of remote living," Front. Virtual Real. **2** (2021).
3. Y. Itoh, T. Kaminokado, and K. Akşit, "Beaming displays," IEEE Transactions on Vis. Comput. Graph. **27**, 2659–2668 (2021).
4. K. Kavaklı, D. R. Walton, N. Antipa, R. Mantiuk, D. Lanman, and K. Akşit, "Optimizing vision and visuals: lectures on cameras, displays and perception," in *ACM SIGGRAPH 2022 Courses,* (2022), pp. 1–66.
5. K. Akşit and Y. Itoh, "Holobeam: Paper-thin near-eye displays," in *2023 IEEE Conference Virtual Reality and 3D User Interfaces (VR),* (IEEE, 2023), pp. 581–591.
6. K. Kavaklı, Y. Itoh, H. Urey, and K. Akşit, "Realistic defocus blur for multiplane computer-generated holography," in *2023 IEEE Conference Virtual Reality and 3D User Interfaces (VR),* (IEEE, 2023), pp. 418–426.
7. K. Akşit and K. Kavaklı, "Flexible modeling of next-generation displays using a differentiable toolkit," in *Practical Holography XXXVII: Displays, Materials, and Applications,* vol. 12445 (SPIE, 2023), pp. 131–132.
8. K. Kavaklı and K. Akşit, "Introduction to odak: a differentiable toolkit for optical sciences, vision sciences and computer graphics," in *Frontiers in Optics,* (Optica Publishing Group, 2022), pp. FTu1A–1.
9. K. Aksit, K. Kavakli, D. Walton, A. Steed, H. Urey, R. K. Dos Anjos, S. Friston, T. Weyrich, and T. Ritschel, "Perceptually guided computer-generated holography," in *Advances in Display Technologies XII,* vol. 12024 (SPIE, 2022), pp. 11–14.