Realistic Image Reconstruction with Multiplane Computer-Generated Holography

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Abstract: Three-dimensional scenes reconstructed by Computer-Generated Holography (CGH) often have unintended ringing artifacts, especially within the boundaries of represented objects. This talk will overview our CGH algorithms to fix these imperfections in holographic displays.

1. Introduction

The fundamental building block for achieving realistic remote technologies is the next-generation display technologies that offer realistic visuals while supporting comfortable natural visual experiences [1]. The goal of CGH research is to provide computer-generated 3D visuals on a holographic display that is indistinguishable from real life for a human observer [2]. To meet this definition, we have investigated several critical issues in holographic displays, and CGH [3]. First and foremost, we investigate fixing visual imperfections in three-dimensional (3D) CGH. Specifically, we introduce a new algorithm to fix ringing artifacts that typically appear in 3D images reconstructed by CGH [4]. This new algorithm can calculate artifact-free 3D images either using a conventional light simulation model or a learned light transport model [5]. We also show that this framework that encapsulates our algorithm work can be extended to foveated CGH rendering [6, 7], and it is entirely differentiable [8]. We believe these algorithmic CGH components could be the primary building block for next-generation near-eye displays [9–11] that could be free from primary issues such as computational complexity, power demand, image quality, and form-factor.

References

1. 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).
2. 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.
3. 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.
4. K. Kavaklı, Y. Itoh, H. Urey, and K. Akşit, "Realistic defocus blur for multiplane computer-generated holography," arXiv preprint arXiv:2205.07030 (2022).
5. K. Kavaklı, H. Urey, and K. Akşit, "Learned holographic light transport," Appl. Opt. **61**, B50–B55 (2022).
6. D. R. Walton, K. Kavaklı, R. K. Dos Anjos, D. Swapp, T. Weyrich, H. Urey, A. Steed, T. Ritschel, and K. Akşit, "Metameric varifocal holograms," in *2022 IEEE Conference on Virtual Reality and 3D User Interfaces (VR),* (IEEE, 2022), pp. 746–755.
7. D. R. Walton, R. K. Dos Anjos, S. Friston, D. Swapp, K. Akşit, A. Steed, and T. Ritschel, "Beyond blur: Real-time ventral metamers for foveated rendering," ACM Transactions on Graph. **40**, 1–14 (2021).
8. K. Akşit, A. S. Karadeniz, P. Chakravarthula, W. Yujie, K. Kavaklı, Y. Itoh, D. R. Walton, and R. Zhu, "Odak," (2022). If you use this software, please cite it as below.
9. Y. Itoh, T. Kaminokado, and K. Akşit, "Beaming displays," IEEE Transactions on Vis. Comput. Graph. **27**, 2659–2668 (2021).
10. K. Akşit, "Patch scanning displays: spatiotemporal enhancement for displays," Opt. express **28**, 2107–2121 (2020).
11. K. Akşit, P. Chakravarthula, K. Rathinavel, Y. Jeong, R. Albert, H. Fuchs, and D. Luebke, "Manufacturing application-driven foveated near-eye displays," IEEE transactions on visualization computer graphics **25**, 1928–1939 (2019).