Towards Remote Pixelless Displays

KAAN AKŞIT*

Computer Science Department, University College London (UCL), London, UK
*k.aksit@ucl.ac.uk
https://kaanaksit.com

Abstract:
Next generation displays have to resolve major design challenges for providing frictionless user experiences. To address these issues, we introduce two concepts named as “Beaming Displays” and “Patch Scanning Displays”.

1. Introduction

Our daily lives have been fast transforming to a remote setting with telelife technologies [1] such as telework, telepresence or teleconference. In order to provide frictionless telelife user experiences, next generation display technologies [2] have to resolve a set of major challenges in display design space such as data bandwidth requirements, power and computational limitations and form-factor issues. To address these display design related issues, we introduce two novel concepts that we call as "Beaming Displays" [4] and "Patch Scanning Displays" [5]. We develop both of these concepts using our own scientific computing library for optical sciences [3].

2. Beaming displays

Augmented reality near-eye displays promise to improve our daily lives with countless applications in communication, healthcare, and manufacturing industries. However, there are technical challenges and obstacles in achieving compact form factors, while equipping an augmented reality display with necessary optical components, sensors, power banks, and computational resources.

Fig. 1. Beaming Displays. Left: Our new optical layout decomposes a near-eye display design into two parts, an all passive light-weight wearable headset, and a remotely located projector, this decomposition effectively avoids trade-offs between ergonomics, computational and power requirements. Middle: We build a physical setup to demonstrate the possibilities with our optical layout. Right: We show experimentally that our design supports resolutions matching a consumer level near-eye display.

We redefine the design framework for see-through near-eye displays by physically separating the image generating parts from the eyepiece as depicted in Fig. 1. In this configuration, an image generating beaming unit beams images from a distance to a light receiving unit equipped with an eyepiece on the user’s side. Our final implementation can be described as a remotely controllable all passive wearable AR display with a light-weight body that is free from batteries or electronics that can heat up or any other active components that can pose design trade-offs related challenges in traditional display hardware.

3. Patch scanning displays

The advent of emerging fields such as virtual reality, augmented reality, and electronic sports necessitate greater pixel density and higher presentation rates in next generation displays [2].

Fig. 2. Patch Scanning Displays. (Left) Image generation of a spatial light modulator (SLM) at its native resolution is compared with a patch scanning display basing on the same SLM. (Right) Zoomed comparison on the same data provided in left photograph is shown. Both images are simulated. Source images courtesy Erhan Meço.

We propose a new type of scanning display method that enhances spatiotemporal qualities of Spatial Light Modulators (SLMs) as depicted in Fig. 2, in which multiple patches that represent the bases of blocks in a target image are scanned across a predefined trajectory to reconstruct the image. Our method combines a computational approach that discovers the right patches to be scanned with a new hardware design. The hardware part of our method consists of a locally addressable high refresh rate backlight with an off-the-shelf low refresh rate SLM, which are used to build a display module. The image generated in a combined display module is projected and scanned with the help of optical components. Using the hardware in our approach, we tile bases of a target image side by side over an SLM, and use the backlight as coefficients to select the intensities of each presented basis. As the backlight varies in intensity over time synchronous to the scanning trajectory, a complete image can be reconstructed as bases are scanned and projected optically.

4. Conclusion

We introduce two novel display concepts that are targeting existing and emerging display applications such as virtual reality and augmented reality. We believe these fundamentally different display designs can potentially lead to next generation remote and pixeless displays that are free from conventional issues.

References

1. J. Orlosky, M. Sra, K. Bektaş, H. Peng, J. Kim, N. Kosmyna, T. Hollerer, A. Steed, K. Kiyokawa, M. Nowatkowski, and K. Akşit, "Telelife: The future of remote living," in *(IN REVIEW),* (IEEE, 2021), pp. XXX–YYY.
2. 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.
3. K. Akşit, P. Chakravarthula, A. S. Karadeniz, K. Kavaklıı, Y. Wang, and Y. Itoh, "Odak: Scientific computing library for optical sciences," (2021).
4. Y. Itoh, T. Kaminokado, and K. Akşit, "Beaming displays," IEEE transactions on visualization computer graphics (2021).
5. K. Akşit, "Patch scanning displays: spatiotemporal enhancement for displays," Opt. express **28**, 2107–2121 (2020).