

## **Ultra-wide angle and ultra-high definition holography**

The advent of holographic visualization marks a significant leap in the evolution of display technology, addressing the inherent limitations of traditional 3D displays such as stereoscopic, light-field, and volumetric displays. The primary shortcoming of conventional 3D displays lies in the vergence-accommodation conflict, a physiological phenomenon that causes visual discomfort and fatigue. This conflict arises when the eyes' focus (accommodation) and the angle at which they converge to view objects (vergence) do not align, a common issue in 3D displays.

**Holographic visualization solves this conflict by providing a genuinely three-dimensional viewing experience, where accommodation and vergence occur naturally as they would in real-world vision.**

This advancement not only enhances the viewer's comfort but also enriches the depth and realism of the visual content. The scope of holographic visualization even extends beyond merely resolving the vergence-accommodation conflict; it also offers a continuous viewing angle range, whereas this is limited to a discrete set of viewing angles for light-field displays. **Ultra-wide viewing angle holography further improves over current technology by providing an extended visual field (extended eye box and field of view (FoV) bigger than 100°). In combination with colour holography and ultra-high resolution, this technology has the potential to achieve a realistic viewing and immersive experience matching the human visual system.**

Nevertheless, the transition to ultra-wide-angle holography remains challenging. The need for higher resolution and larger bandwidth, the associated complexity of capturing, generating, and processing and the requirement for spatial light modulators with wavelength-order pixel pitches are among the hurdles to be overcome. The path toward wide-angle holography is fraught with challenges; its benefits in enhanced visual comfort and immersive viewing experience make it a promising frontier in display technology.

Overcoming these challenges will undoubtedly lead to significant advancements in the field of holography and open new avenues for its application. **UltraHolo introduces novel solutions for ultra-resolution ultra-wide angle hologram recording, generation, management, display, and quality assessment spanning the complete E2E system.** Hologram recording of computer-generated holograms and optical holograms will encode large colour 3D objects in ultra-high resolution. Hologram management tools will be designed to improve the quality of holograms by reducing noise and system errors and to enable large, colour, and complex shape 3D objects to be moved or enlarged. **Learning-based predictive architectures will enhance throughput and SNR, accelerate computations in the capture-display processing pipeline, and enable single frame/single beam but also colour architectures.** The display will be based on a novel SLM with an ultra-resolution of 16K × 16K and a sub-wavelength pixel pitch of 250 nm. FoV will be enlarged by a novel multi-order technique enabling simultaneous enlarged FoV and eye box. Moreover, a visual quality assessment toolset will be designed to validate capture-management-display line quantitatively and subjectively.

**UltraHolo overall goal is to design and validate novel solutions and algorithms to record, generate, manage and display ultra-wide angle and ultra-high resolution colour holograms in support of ultra-realistic 3D visualization systems in education, health, design, architecture and entertainment applications.**

This is an ambitious prospect targeting the realization of an ultra-wide-angle and ultra-high-resolution holographic solution through the following main research objectives:

- Optical holograms and computer generation holograms will be made available at ultra-wide-angle and ultra-resolution;
- Processing tools for ultra-wide and ultra-high-resolution holograms enabling to manipulate objects and significantly improve quality of holograms will be proposed;
- First public database of holograms and tools for ultra-wide and ultra-high-resolution holograms will be made available;
- Ultra-wide-angle holographic display with FoV beyond 140° will be shown.
- Visual quality assessment for wide-angle hologram-processing-display path will be proposed.