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**Email of Convenor:** igor.curcio@nokia.com

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# Abstract

This document summarizes the current status of the discussions about object wave compression within WG2 and invites contributions from within and outside MPEG on this topic. Contributions might include expression on interest on using such a format in applications, or in working on the creation and standardization of the technology. Contributions might also amend the list of application areas listed in this document.

Interested parties might be, but are not limited to, academic institutions, research labs, service providers, device manufacturers, equipment vendors, network operators, and technology providers.

# Introduction

Computer holography is a promising 3D display technology that reconstructs highly realistic 3D images by taking a 3D model as input and recording its light propagation information in a digital fringe pattern called a computer-generated hologram (CGH). CGH requires a huge number of pixels and fine pixel pitch. The holographic near-eye display (HNED) alleviates this pixel requirement because the HNED is a wearable-type device, which places the display close to the eye, thereby relaxing screen size and viewing angle requirements. Thus, it is a strong candidate for early commercialization of computer holography. HNED is a hot research field with various studies and is being considered for product development [1]. In our target applications of holographic displays over a network, especially for HNEDs, it is reasonable to transmit object wave, which is the intermediate data representation for CGH calculations, from the following perspectives.

* The CGH calculation process requires information from the playback device (optical system), making it impossible to broadcast common data and play it back on multiple devices. The object wave can be treated independently of the playback device optics except for the wavelength, number of pixels, and pixel pitch, and it is versatile considering the following corrections. For wavelength mismatch, an initial study has been proposed to interpret and correct this problem as optical refraction [2]. While limited to shallow depths, it is possible to correct for wavelength mismatch regardless of its degree, and it is expected to expand to deep depths. Additionally, the number of pixels and pixel pitch can be corrected by resampling or interpolation. The transmitted object wave can be adjusted for the user side’s HNED, although this may limit the image quality and viewing angle based on the original data.
* The object wave transmission is also sensible in terms of computational complexity. The calculation of CGH from an object wave has a lower computational complexity than that of an object wave from a 3D model. Calculating an object wave from a 3D model requires an iterative wave propagation calculation for each component of the 3D model, such as a point and a polygon. On the other hand, the conversion process from an object wave to CGH is a simple calculation, such as the sum or product of complex numbers. Therefore, it is expected to be sufficiently processed by low-performance user terminals.
* The object wave is complex image data and consists of two parts: a real part and an imaginary part (or an amplitude and a phase part) in the 2D plane. Thus, video coding technology can be applied by packing these parts.

MPEG (under ISO/IEC JTC1/SC29/WG2) has been exploring the use cases and requirements for object wave compression within ISO/IEC JTC1/SC29 since 2023. MPEG has published a use case for computer holography transmission based on object wave compression in 2023 [3]. This Call for Interest invites contributions in holography, related technologies, and market players to explore the market needs for computer holography transmission.

1. **Application areas**

## Use case 1 – One-way distribution and downloading

Use cases in this category suppose one-way communication, where object wave data is distributed or downloaded from a server to an HNED. The main calculations of the object wave are performed on the server side. Thus, only minor calculations for corrections are needed on the user side, which can be processed by a low-performance computer on the HNED, as mentioned in the Introduction. Users can watch 3D images of remote objects and spaces indistinguishable from real objects for a long time without stress through the HNED. This is because the object wave transmission enables holographic image distribution even to low-performance computers installed in HNEDs, solving the vergence-accommodation conflict (VAC), which causes discomfort and eye fatigue for viewers [4], due to the benefit from computer holography. More specifically, possible use cases include watching highly realistic sports games or concerts as if users were at the venue, watching realistic movies as if users were the character in the movie, and 3D educational videos that require accurate depth representation.

## Use case 2– Real-time two-way space transmission

In this category of use cases, two-way communication is assumed to transmit 3D model data of real objects or 3D avatars on the user side to the server, in addition to the distribution of object wave data as in Use case 1. 3D model data is converted into an object wave in real-time on the server side and distributed to the opponent, enabling multiple users located remotely to experience as if they are present in the same space. The computational requirements on the user side are minimal, as with Use case 1, making real-time interaction feasible. Specifically, the following use cases are possible: remote meeting that makes people appear as if they were in the same room, remote tasks that provide accurate visual information such as depth as if they were on-site, remote surgery, remote inspection, sports experiences, and remote coaching that are comparable to real ones in virtual space. Holographic real-time spatial transmission enables highly specialized tasks such as remote surgery.

Further information on the above use cases can be found in [3].

# Further Information

## Relating SC 29/WG 2 output documents

N329, Use cases for object wave compression, ISO/IEC JTC 1/SC 29/WG 2 Hannover October 2023.

## Relating documents outside SC 29/WG 2

In the ITU-T/ISO/IEC Joint Video Experts Team (JVET), which was created on 27 October 2017 to develop Versatile Video Coding (VVC), Supplemental Enhancement Information (SEI) messages have been proposed to compress object wave using VVC [5].

# How to Contribute

If you are an MPEG Member, you can use the ISO/IEC JTC 1/SC 29/WG2 N159 “Template of the MPEG WG2 Market and practical considerations” and submit an individual input to the next MPEG meeting via https://dms.mpeg.expert/.

Please select Working Group “WG 02 MPEG Technical requirements” and AhG “Market Needs”.

If you are not an MPEG Member, or if you want to support the activity as a user but do not want to be visible, you can send an email to the Convenor of WG2 <igor.curcio@nokia.com>.

# References

1. VIVIDQ: Holography: The future of augmented reality wearables [White paper], 2020.
2. C.-J. Lee, H. Nishi, and K. Matsushima: Correction algorithm for wavelength mismatch of sampled wavefield in full-color computer holography, 12th International Symposium on Display Holography (ISDH2023), Seoul (Korea), ISDH2023-ED-0247, 200-205, June 2023.
3. Use cases for object wave compression, ISO/IEC JTC 1/SC 29/WG2 N329, Hannover, October 2023.
4. D.M. Hoffman, A.R. Girshick, K. Akeley, and M.S. Banks: Vergence–accommodation conflicts hinder visual performance and cause visual fatigue, J. Vis. 8(3), 33, 2008.
5. AHG9: SEI message extension of VVC for computer-generated hologram use, ITU-T/ISO/IEC Joint Video Experts Team (JVET), Teleconference, JVET-AG0049, January 2024.