

JVET-AE0182

AHG9: SEI message extension of VVC for computer-generated hologram use

July, 2023

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- **Computer holography is promising 3D video display technology**
 - Transmission of object wave, the intermediate data for computer holography, realizes applications with flexibility of the playback devices
- **object wave compression by using VTM is conducted as a preliminary study to see the feasibility of transmission framework**
- **SEI message extension realizing the above framework is shown**
- **Recommend including the extension in the next version of VSEI for use with VVC**

- Computer holography is expected to be a technology that enables **highly realistic 3D video experiences** that solves the burden on the user, e.g. eye fatigue, VR motion sickness, etc.

- Use case:

Work style



Remote collaboration on design / discussion

Remote communication using 3D images that make you feel like you're next to someone

Education



Immersive e-learning

Immersive e-learning opportunities through 3D images that are safe for children

Healthcare



Telemedicine

Remote surgery with intuitive and accurate 3D images

Example of computer holography



The characteristics of holography, which **faithfully reproduce light waves of objects**, allow the user to observe **a 3D image like a real object, even if the viewpoint is moved.**

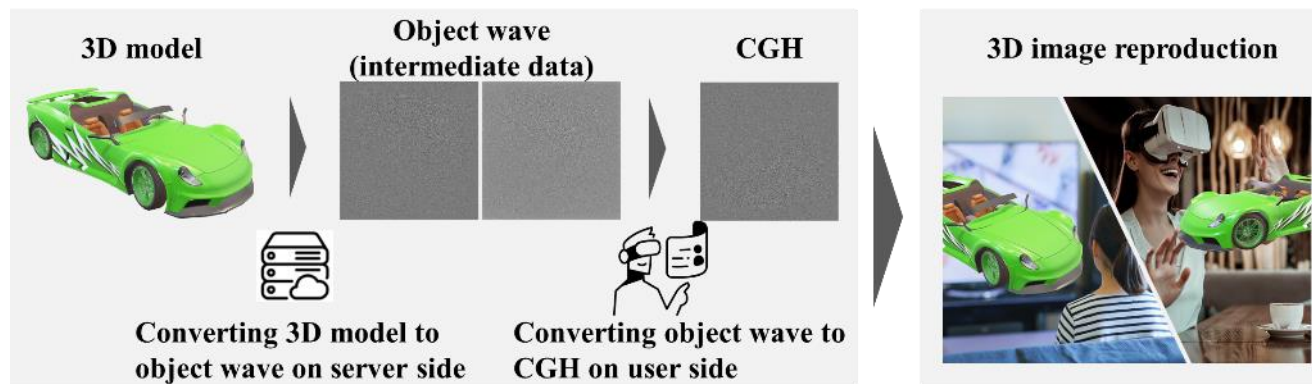
[1] <https://www.kddi-research.jp/english/newsrelease/2022/050901.html>

■ Problem

- Data used for computer holography, **computer-generated hologram (CGH)**, is **incompatible with broadcasting** because the data content must be generated for each playback device's optical system

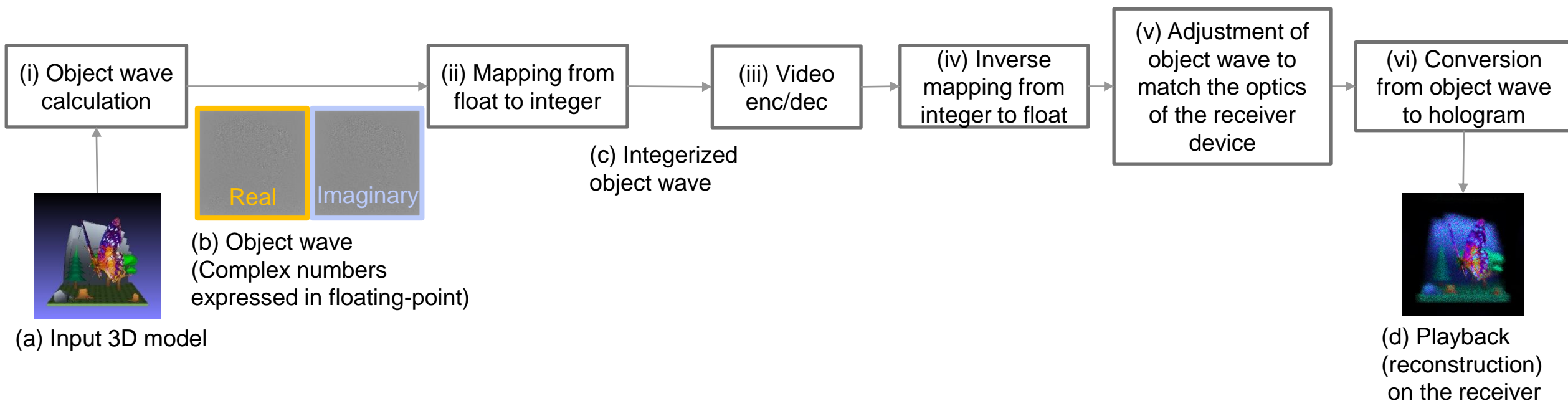
■ Solution

- **object wave (intermediate data representation)** transmission
 - solve the above playback device dependence
 - can be treated as a type of image/video data



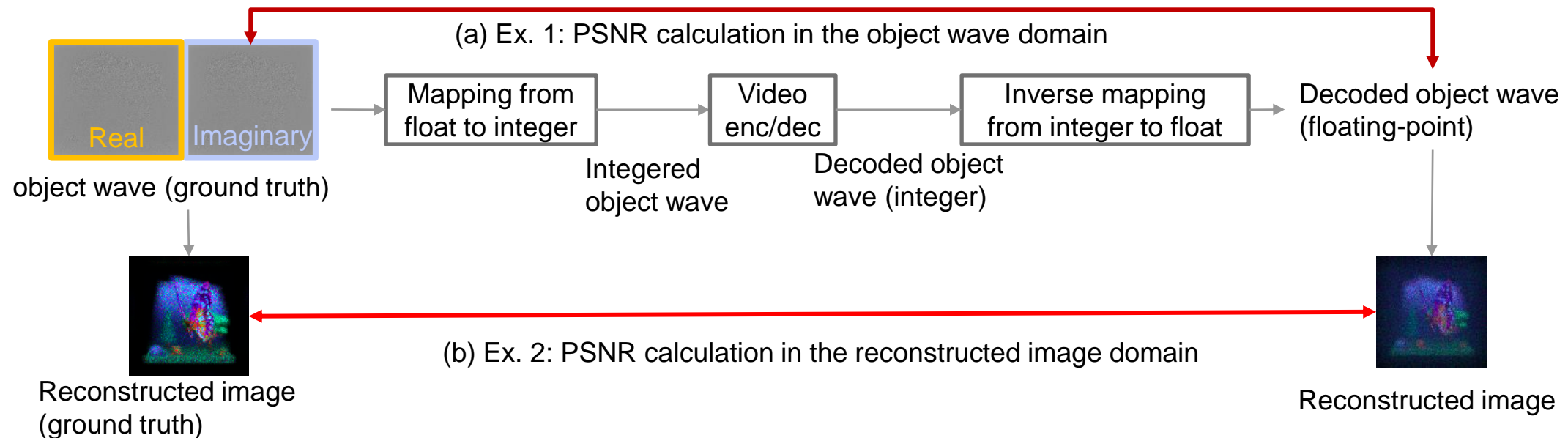
■ We propose **SEI extension for object wave transmission**

- object wave is represented by a two-dimensional distribution with a **floating-point complex number** consisting of real and imaginary parts
- They can be input to existing video codecs by **converting them to integers**

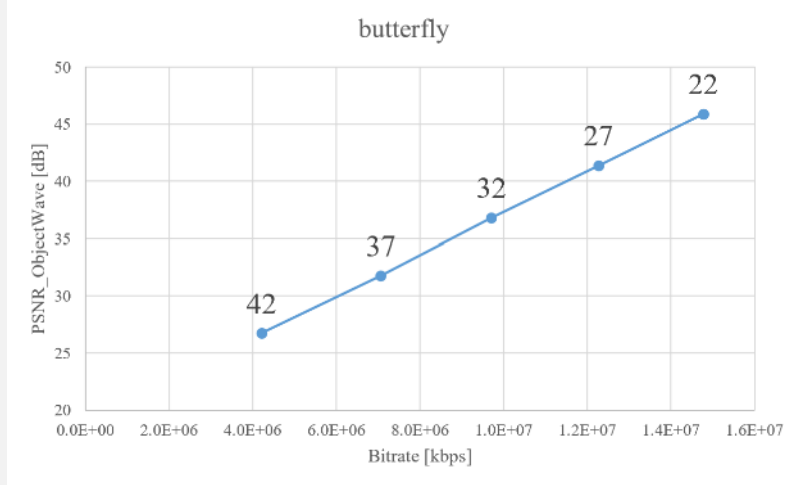


■ Experimental settings

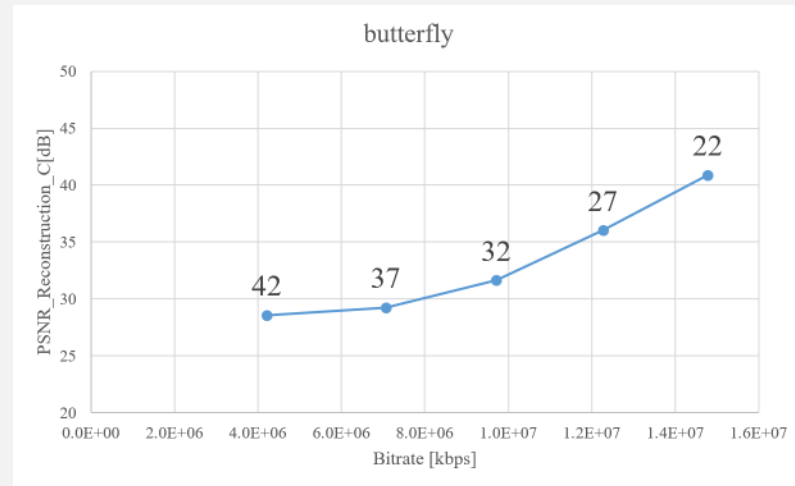
- **Codec:** VTM-20.0 with intra mode (QP = 22, 27, 32, 37, 42)
- **Input:** 3D mesh model (only one frame for this preliminary study)
- **Integered object wave:**
 - 8-bit depth, RGB color (4:4:4) format, 4K x 4K resolution for each real part and imaginary part
- **Experiment 1:** RD calculation in the object wave domain
- **Experiment 2:** RD calculation in the reconstructed image domain



Preliminary study of object wave compression [results]



Experiment 1: RD curve (Bitrate vs PSNR of the object wave)

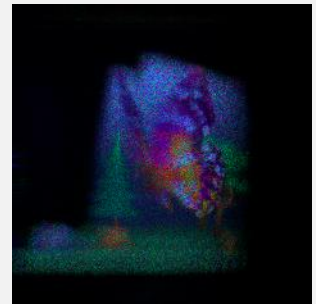
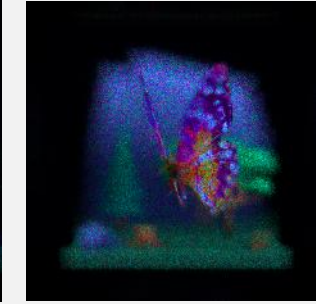
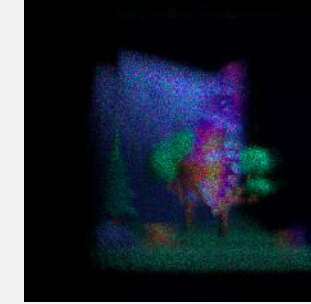


Experiment 2: RD curve (Bitrate vs PSNR of the reconstructed image)

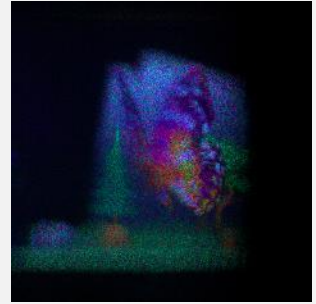
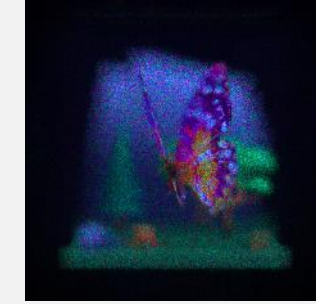
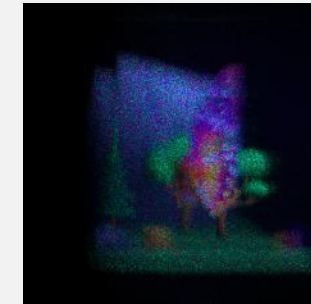


(a) Input 3D model

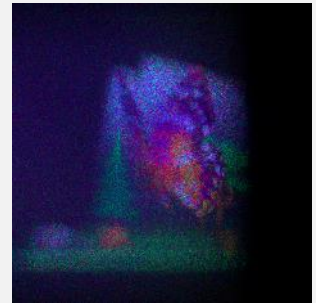
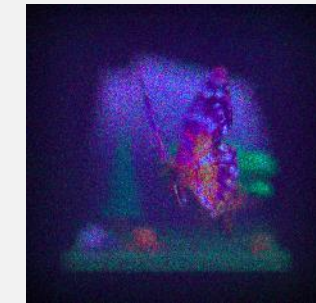
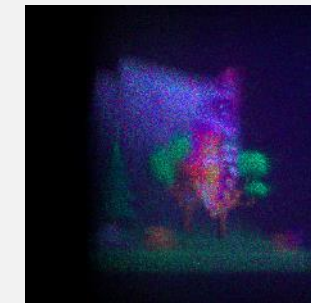
QP=22



QP=32



QP=42



Left 10°

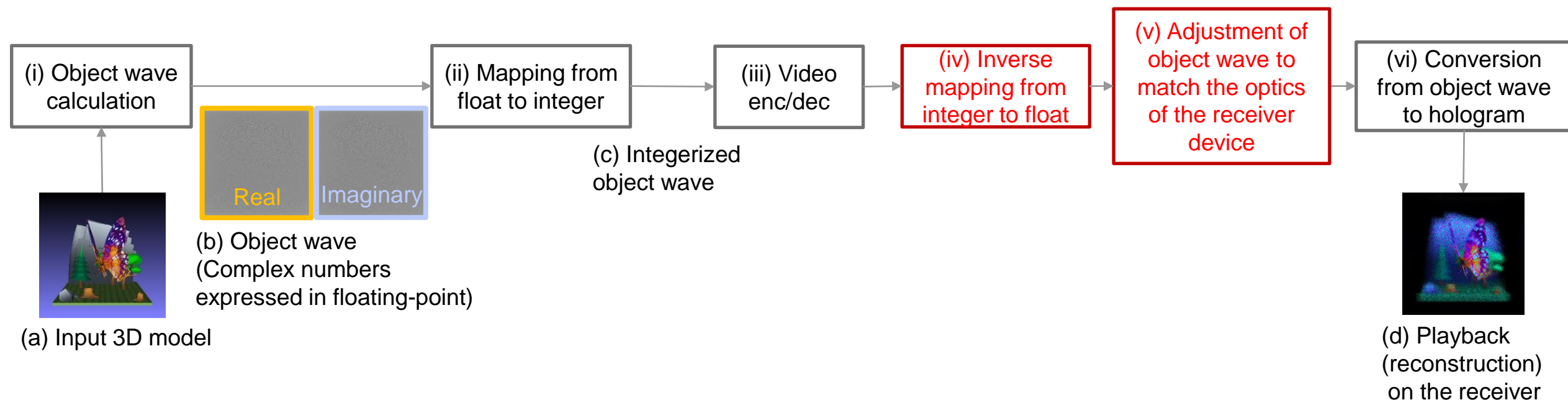
Center

Right 10°

The reconstructed images from the three viewpoints

Propose the extension of SEI message
that implements the flow of the object wave transmission

■ The proposed SEI is corresponding the procedure of the red box



Proposal of SEI extension [Syntax and semantics]

object_wave_parameters(payloadSize) {	Descriptor
<i>mapping_type</i>	u(4)
if(mapping_type == 0) {	
<i>real_max</i>	se(v)
<i>real_min</i>	se(v)
<i>imaginary_max</i>	se(v)
<i>imaginary_min</i>	se(v)
}	
else if(mapping_type == 1) {	
<i>real_max</i>	se(v)
<i>real_min</i>	se(v)
<i>imaginary_max</i>	se(v)
<i>imaginary_min</i>	se(v)
<i>non_linear_param</i>	ue(v)
}	
<i>pixel_pitch_x</i>	ue(v)
<i>pixel_pitch_y</i>	ue(v)
<i>wavelength_r</i>	ue(v)
<i>wavelength_g</i>	ue(v)
<i>wavelength_b</i>	ue(v)
<i>object_depth</i>	ue(v)
}	

For determination of pixel value mapping mode

Value	Mapping type	Informative Remark
0	Linear	
1	$x = \text{sgn}(f) 1/\mu \{ (1+\mu)^{ f } - 1 \}$	ITU-T G.711
2 ... 16	Reserved	For future use by ITU-T ISO/IEC

For linear mapping from integer to float

For non-linear mapping from integer to float

For adjustment of object wave

- **object wave transmission is necessary for realizing practical computer holography use cases**
 - We show some promising use cases realized by computer holography
 - We show the necessity of the compression and computational complexity analysis of object wave generation

- **Preliminary study for object wave compression by using the existing video codec is shown**

- **Propose on the extension of SEI for the object wave compression**
 - The additional SEI supports the functions for the mapping of object wave to video format and the adjustment of the object wave to the playback device

- **Recommend including the extension in the next version of VSEI for use with VVC**