

**JVET-AE0182**

**AHG9: SEI message extension of VVC for object-wave compression and computer-generated hologram use**

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**KDDI**

- **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**.

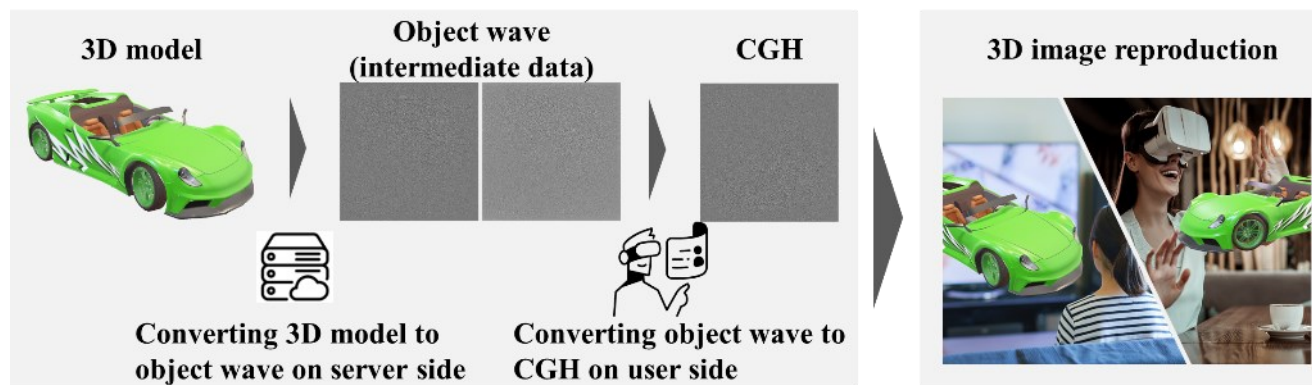
[1] <https://www.kddi-research.jp/english/newsrelease/2022/050901.html>

## ■ 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

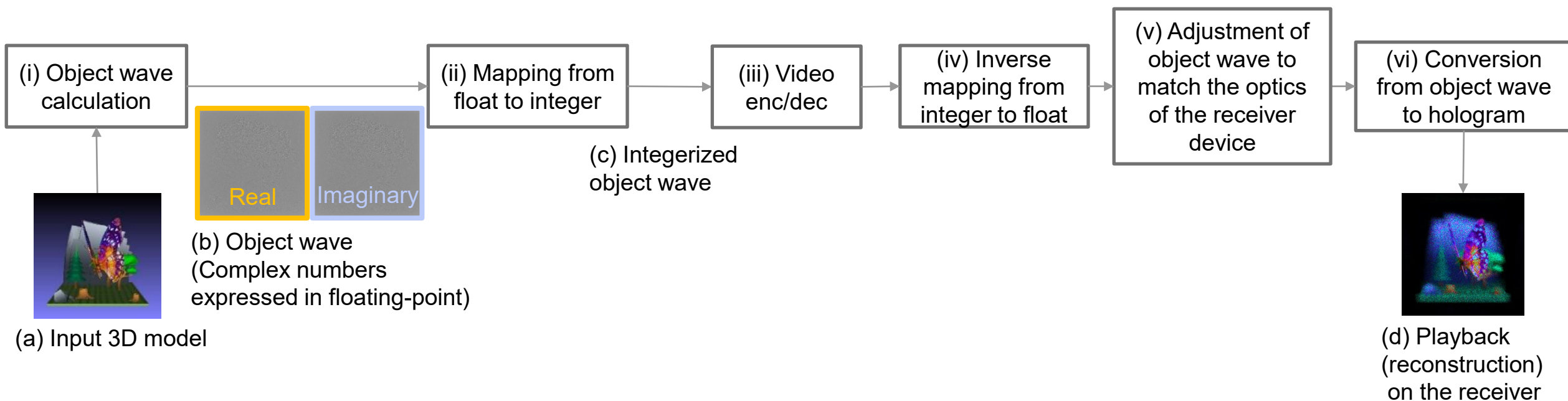
## ■ Solution

- **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**

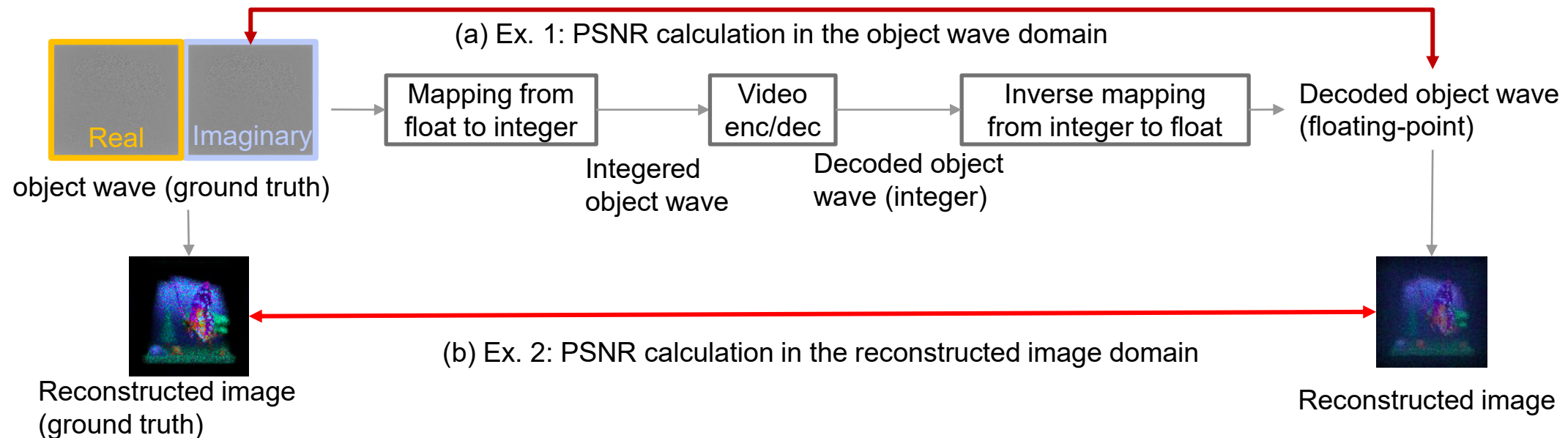
- object wave is represented by a two-dimensional distribution with a **floating-point complex number** consisting of real and imaginary parts
- They can be input to existing video codecs by **converting them to integers**



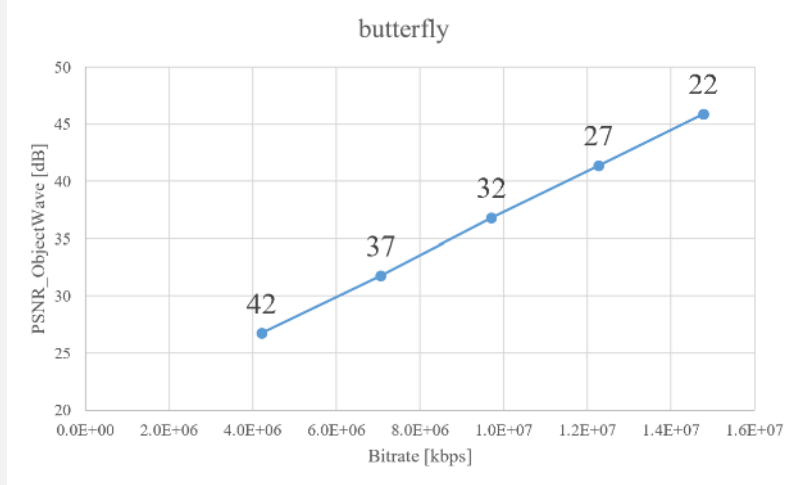


## ■ Experimental settings

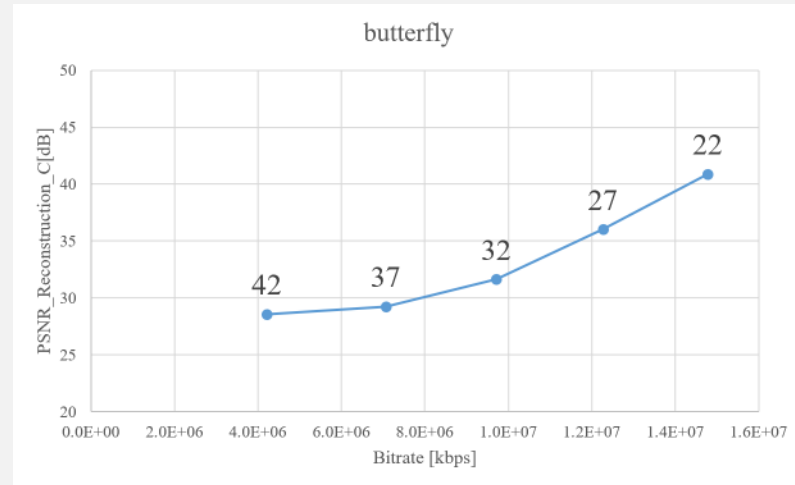
- **Codec:** VTM-20.0 with intra mode (QP = 22, 27, 32, 37, 42)
- **Input:** 3D mesh model (only one frame for this preliminary study)
- **Integered object wave:**
  - 8-bit depth, RGB color (4:4:4) format, 4K x 4K resolution for each real part and imaginary part
- **Experiment 1:** RD calculation in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

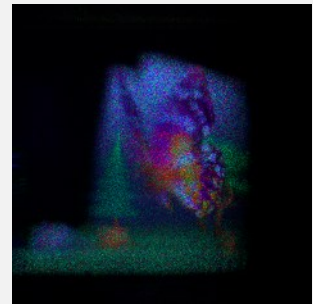
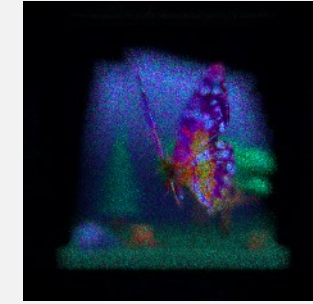
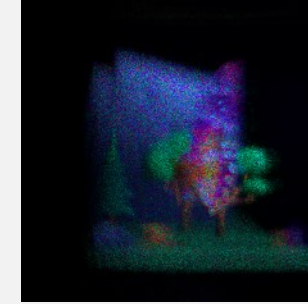


Experiment 2: RD curve (Bitrate vs PSNR of the reconstructed image)

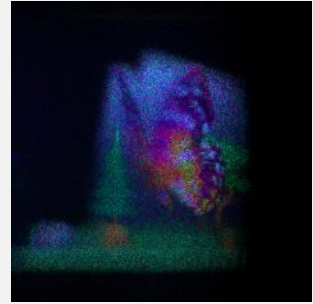
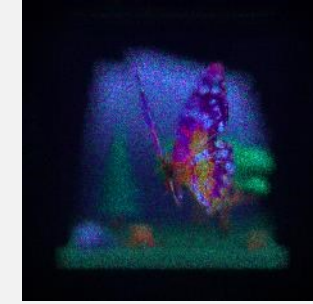
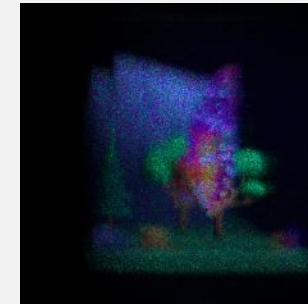


(a) Input 3D model

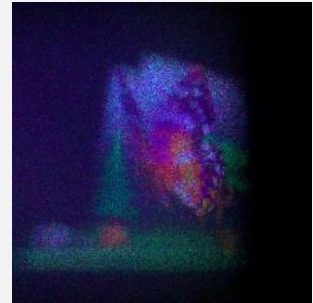
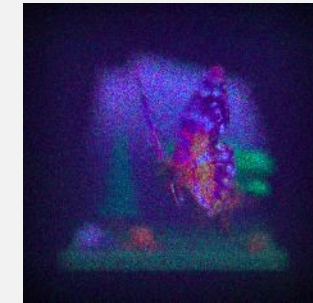
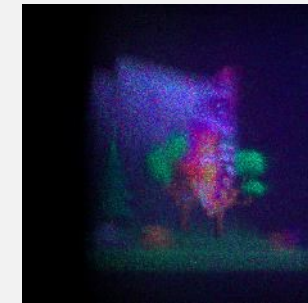
QP=22



QP=32



QP=42



Left 10°

Center

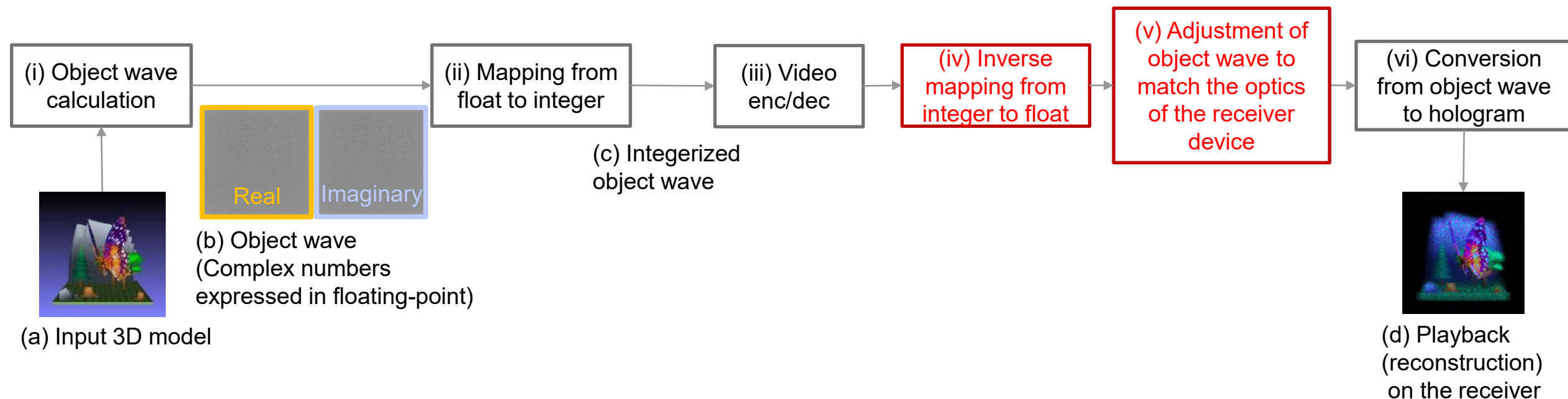
Right 10°

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**