|  |  |
| --- | --- |
| **Joint Collaborative Team on Video Coding (JCT-VC)**  **of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29/WG 11**  29th Meeting: Macao, CN, 19–24 Oct. 2017 | Document: JCTVC-AC0022 |

|  |  |  |  |
| --- | --- | --- | --- |
| *Title:* | **Sphere rotation SEI message** | | |
| *Status:* | Input document to JCT-VC | | |
| *Purpose:* | Proposal | | |
| *Author(s) or Contact(s):* | Ye-Kui Wang 5775 Morehouse Drive San Diego, CA 92122, USA | Tel: Email: | +1-858-651-8345 [yekuiw@qti.qualcomm.com](mailto:yekuiw@qti.qualcomm.com) |
| *Source:* | Qualcomm Incorporated | | |

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

# Abstract

This contribution proposes a new SEI message, named the sphere rotation SEI message, for signalling of rotation parameters in a separate SEI message from the equirectangular projection (ERP) SEI message. It is claimed that, this way, the rotation signalling can be applied to any projection type, and the design is more aligned with the Omnidirectional MediA Format (OMAF) that is being developed by the MPEG Systems subgroup. It is further claimed that the proposal resolves issue#2 in JCTVC-AC0021.

# Introduction

The ERP SEI message includes the signalling of rotation information as part of the SEI message. However, the cubemap projection (CMP) SEI message does not include the signalling of rotation information. In OMAF, the rotation information is signalled in file format level using a separate structure than that for the projection, and that rotation information signalling applies to any projection type (e.g., both ERP and CMP).

It is therefore proposed to use a separate SEI message for signalling of rotation parameters such that the same syntax could be used for any type of projection.

# Proposal

## Introduction

The proposal includes the following four parts:

1. Syntax and semantics of the proposed sphere rotation SEI message,
2. Removal of the syntax and semantics of erp\_rotation\_flag, erp\_yaw\_rotation, erp\_pitch\_rotation, and erp\_roll\_rotation from the ERP SEI message,
3. Removal of the syntax and semantics of cmp\_rotation\_flag, cmp\_yaw\_rotation, cmp\_pitch\_rotation, and cmp\_roll\_rotation from the CMP SEI message,
4. Changes to the sample location remapping process.

For parts 2-4, changes relative to JCTVC-AB1005-v1 are marked.

## Rotation SEI message syntax and semantics

|  |  |
| --- | --- |
| sphere\_rotation( payloadSize ) { | **Descriptor** |
| **sphere\_rotation\_cancel\_flag** | u(1) |
| if( !sphere\_rotation\_cancel\_flag ) { |  |
| **sphere\_rotation\_persistence\_flag** | u(1) |
| **sphere\_rotation\_reserved\_zero\_6bits** | u(6) |
| **yaw\_rotation** | i(32) |
| **pitch\_rotation** | i(32) |
| **roll\_rotation** | i(32) |
| } |  |
| } |  |

The sphere rotation SEI message provides information on rotation angles yaw (α), pitch (β), and roll (γ) that are used for conversion between the global coordinate axes and the local coordinate axes.

Relative to an (x, y, z) Cartesian coordinate system, yaw expresses a rotation around the z (vertical, up) axis, pitch rotates around the y (lateral, side-to-side) axis, and roll rotates around the x (back-to-front) axis. Rotations are extrinsic, i.e., around x, y, and z fixed reference axes. The angles increase clockwise when looking from the origin towards the positive end of an axis.

**sphere\_rotation\_cancel\_flag** equal to 1 indicates that the SEI message cancels the persistence of any previous sphere rotation SEI message in output order. sphere\_rotation\_cancel\_flag equal to 0 indicates that sphere rotation information follows.

**sphere\_rotation\_persistence\_flag** specifies the persistence of the sphere rotation SEI message for the current layer.

sphere\_rotation\_persistence\_flag equal to 0 specifies that the sphere rotation SEI message applies to the current decoded picture only.

Let picA be the current picture. sphere\_rotation\_persistence\_flag equal to 1 specifies that the sphere rotation SEI message persists for the current layer in output order until one or more of the following conditions are true:

– A new CLVS of the current layer begins.

– The bitstream ends.

– A picture picB in the current layer in an access unit containing a sphere rotation SEI message that is applicable to the current layer is output for which PicOrderCnt( picB ) is greater than PicOrderCnt( picA ), where PicOrderCnt( picB ) and PicOrderCnt( picA ) are the PicOrderCntVal values of picB and picA, respectively, immediately after the invocation of the decoding process for picture order count for picB.

When an equirectangular projection SEI message with erp\_cancel\_flag equal to 0 or a cubemap projection SEI message with cmp\_cancel\_flag equal to 0 is not present in the CLVS that applies to the current picture and precedes the sphere rotation SEI message in decoding order, a sphere rotation SEI message with sphere\_rotation\_cancel\_flag equal to 0 shall not be present in the CLVS that applies to the current picture. Decoders shall ignore sphere rotation SEI messages with sphere\_rotation\_cancel\_flag equal to 0 that do not follow, in decoding order, an equirectangular projection SEI message with erp\_cancel\_flag equal to 0 or a cubemap projection SEI message with cmp\_cancel\_flag equal to 0 in the CLVS that applies to the current picture.

**sphere\_rotation\_reserved\_zero\_6bits** shall be equal to 0 in bitstreams conforming to this version of this Specification. Other values for sphere\_rotation\_reserved\_zero\_6bits are reserved for future use by ITU-T | ISO/IEC. Decoders shall ignore the value of sphere\_rotation\_reserved\_zero\_6bits.

**yaw\_rotation** specifies the value of the yaw rotation angle, in units of 2−16 degrees. The value of yaw\_rotation shall be in the range of −180 \* 216 (i.e., −11 796 480) to 180 \* 216 − 1 (i.e., 11 796 479), inclusive. When not present, the value of yaw\_rotation is inferred to be equal to 0.

**pitch\_rotation** specifies the value of the pitch rotation angle, in units of 2−16 degrees. The value of pitch\_rotation shall be in the range of −90 \* 216 (i.e., −5 898 240) to 90 \* 216 (i.e., 5 898 240), inclusive. When not present, the value of pitch\_rotation is inferred to be equal to 0.

**roll\_rotation** specifies the value of the roll rotation angle, in units of 2−16 degrees. The value of roll\_rotation shall be in the range of −180 \* 216 (i.e., −11 796 480) to 180 \* 216 − 1 (i.e., 11 796 479), inclusive. When not present, the value of roll\_rotation is inferred to be equal to 0.

## Changes to the ERP SEI message syntax and semantics

|  |  |
| --- | --- |
| equirectangular\_projection( payloadSize ) { | **Descriptor** |
| **erp\_cancel\_flag** | u(1) |
| if( !erp\_cancel\_flag ) { |  |
| **erp\_persistence\_flag** | u(1) |
| **erp\_explicit\_coverage\_range\_flag** | u(1) |
| **erp**\_**reserved\_zero\_5bits** | u(5) |
| if( erp\_explicit\_coverage\_range\_flag  = =  1 ) { |  |
| **erp\_azimuth\_min** | i(32) |
| **erp\_azimuth\_max** | i(32) |
| **erp\_elevation\_min** | i(32) |
| **erp\_elevation\_max** | i(32) |
| } |  |
| } |  |
| } |  |

The equirectangular projection SEI message provides information to enable remapping (through an equirectangular projection) of the colour samples of the projected pictures onto a sphere coordinate space in sphere coordinates (ϕ, θ) for use in omnidirectional video applications for which the viewing perspective is from the origin looking outward toward the inside of the sphere. The sphere coordinates are defined so that ϕ is the azimuth (longitude, increasing eastward) and θ is the elevation (latitude, increasing northward).

When an equirectangular projection SEI message is present for any picture of a CLVS of a particular layer, an equirectangular projection SEI message shall be present for the first picture of the CLVS and no SEI message indicating a different type of projection shall be present for any picture of the CLVS.

When general\_non\_packed\_constraint\_flag is equal to 1 in the active SPS for the current layer, there shall be no equirectangular projection SEI messages applicable for any picture of the CLVS of the current layer.

...

**erp\_explicit\_coverage\_range\_flag** indicates the presence of syntax elements that describe the coverage sphere region.

**erp**\_**reserved\_zero\_5bits**, when present, shall be equal to 0 in bitstreams conforming to this version of this Specification. Other values for erp\_reserved\_zero\_5bits are reserved for future use by ITU-T | ISO/IEC. Decoders shall ignore the value of erp\_reserved\_zero\_5bits.

**erp\_azimuth\_min** specifies the minimum azimuth value of the coverage sphere region, in units of 2−16 degrees. The value of erp\_azimuth\_min shall be in the range of −360 \* 216 (i.e., −23 592 960) to 360 \* 216−1 (i.e., 23 592 959), inclusive. When not present, the value of erp\_azimuth\_min is inferred to be equal to −180 \* 216 (i.e., 11 796 480).

...

## Changes to the CMP SEI message syntax and semantics

|  |  |
| --- | --- |
| cubemap\_projection( payloadSize ) { | **Descriptor** |
| **cmp\_cancel\_flag** | u(1) |
| if( !cmp\_cancel\_flag ) { |  |
| **cmp\_persistence\_flag** | u(1) |
| **cmp\_padding\_flag** | u(1) |
| **cmp\_reserved\_zero\_5bits** | u(5) |
| if( cmp\_padding\_flag  = =  1 ) { |  |
| **cmp\_padding\_type** | u(2) |
| **cmp\_reserved\_zero\_6bits** | u(6) |
| **cmp\_padding\_chroma\_sample\_range\_minus1** | u(8) |
| } |  |
| } |  |
| } |  |

The cubemap projection SEI message provides information to enable remapping (through a cubemap projection) of the colour samples of the projected pictures onto a sphere coordinate space in sphere coordinates (ϕ, θ) for use in omnidirectional video applications for which the viewing perspective is from the origin looking outward toward the inside of the sphere. The sphere coordinates are defined so that ϕ is the azimuth (longitude, increasing eastward) and θ is the elevation (latitude, increasing northward).

When a cubemap projection SEI message is present for any picture of a CLVS of a particular layer, a cubemap projection SEI message shall be present for the first picture of the CLVS and no SEI message indicating a different type of projection shall be present for any picture of the CLVS.

When general\_non\_packed\_constraint\_flag is equal to 1 in the active SPS for the current layer, there shall be no cubemap projection SEI messages applicable for any picture of the CLVS of the current layer.

...

**cmp**\_**reserved\_zero\_5bits** when present, shall be equal to 0 in bitstreams conforming to this version of this Specification. Other values for cmp\_reserved\_zero\_5bits are reserved for future use by ITU-T | ISO/IEC. Decoders shall ignore the value of cmp\_reserved\_zero\_5bits.

...

**cmp\_padding\_chroma\_sample\_range\_minus1** plus 1 indicates the thickness of the padding areas in units of chroma samples. The value of cmp\_padding\_chroma\_sample\_range\_minus1 shall be in the range of 0 to 255.

## Changes to the CMP SEI message syntax and semantics

Make the following changes to the text in clause D.3.41.5.1:

...

– If a sphere rotation SEI message with sphere\_rotation\_cancel\_flag equal to 0 that applies to the picture is present, RotationFlag is set equal to 1, and RotationYaw, RotationPitch, and RotationRoll are set equal to yaw\_rotation ÷ 216, pitch\_rotation ÷ 216, and roll\_rotation ÷ 216, respectively.

– Otherwise, RotationFlag is set equal to 0.

...

# Patent rights declaration(s)

**Qualcomm Incorporated does not have any current or pending patent rights relating to the technology described in this contribution (to the extent of the personal awareness of the authors).**