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| --- | --- |
| **Source** | Philips |
| **Status** | Input document |
| **Title** | Improved specification of geometry scaling |
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# Abstract

On request of the group, this contribution provides improvements to the specification of geometry scaling: a) replace fixed parameters with a SEI message with deferred values, b) simplify syntax.

# Introduction

Geometry scaling was introduced to MIV in input document [M52365](http://wg11.sc29.org/doc_end_user/current_document.php?id=72807&id_meeting=) and adopted into the fourth working draft (WD4) of ISO/IEC 23090-12 Immersive Video (MIV) [[N19001](http://wg11.sc29.org/doc_end_user/current_document.php?id=73414&id_meeting=181)]. In the 129th MPEG meeting it was decided to make the geometry upscaling a normative process. However, in agreement with the proponent, it was decided in AHG Call 1 to have a conformance point on the decoded geometry video data prior to upscaling and move the geometry upscaling to the hypothetical reference renderer (MIV Annex G).

The upscaling method has multiple parameters and in WD4 their values have been fixed. One of the thresholds had been set to 1.0 which effectively removed the threshold from the text. While the values have been carefully tuned by Philips, it is conceivable that a better combination of parameters is available in general, or based on knowledge available within the encoder.

Philips was requested to provide a proposal for a SEI message that carries the parameter values. In addition to that, we propose a simplification of the syntax in the ASPS extension.

# Syntax

## Annex 7.3.6.14 MIV atlas sequence parameters syntax[[1]](#footnote-1)

|  |  |
| --- | --- |
| miv\_atlas\_sequence\_params( vuh\_atlas\_id ) { | **Descriptor** |
| if( vuh\_atlas\_id == 0 ) |  |
| **masp\_omaf\_v1\_compatible\_flag** | u(1) |
| **masp\_group\_id** | u(v) |
| **masp\_auxiliary\_atlas\_flag** | u(1) |
| **masp\_depth\_occ\_threshold \_flag** | u(1) |
| if( msp\_geometry\_scale\_enabled\_flag == 1 ) { |  |
| **masp\_geometry\_frame\_scale\_factor\_x\_minus1** | ue(v) |
| **masp\_geometry\_frame\_scale\_factor\_y\_minus1** | ue(v) |
| } |  |
| } |  |

Motivation:

* Restrict to integer downscale factors.
* Use less bits.

## Annex F.2.1 General SEI message syntax

Add:

|  |
| --- |
| else if( payloadType  = =  67 ) |
| geometry\_upscaling\_parameters( payloadSize ) |

## Annex F.2.5 Geometry upscaling parameters SEI payload syntax

We propose the following syntax for the SEI message payload.

|  |  |
| --- | --- |
| geometry\_upscaling\_parameters( payloadSize ) { | **Descriptor** |
| **gup\_type** | ue(v) |
| if (gup\_type == 0 ) { |  |
| **gup\_erode\_threshold** | fl(16) |
| **gup\_delta\_threshold** | ue(v) |
| **gup\_max\_curvature** | u(3) |
| } |  |
| } |  |

Motivation:

* gup\_type: Provide room for future extensions.
* gup\_erode\_threshold: This threshold is the ratio and was fixed at 1.0 in WD4. It would be possible to encode this in u(8) and provide an equation to map it to a range around 1.0 but we have chosen for the fl(16) descriptor because it is simple and it has the right distribution of coding points.
* gup\_delta\_threshold: While MIV currently uses HEVC Main10 for geometry video data, special care has been taken to make the SEI message flexible enough for geometry data up to the maximum allowed u(32) precision. Because we expect gup\_delta\_threshold to be a small value we have chosen for ue(v).
* gup\_max\_curvature: We do not want to make the region size (Connectivity) a parameter because we do not have evidence for that and it adds complexity to the implementation. With a 3 x 3 region the maximum sensible value is 7. Hence u(3).

# Semantics

## Annex 7.4.6.14 MIV atlas sequence parameters semantics

**masp\_geometry\_frame\_scale\_factor\_x\_minus1** + 1 specifies the frame width of the geometry video data of the atlas in relation to the nominal atlas width. When not present, the value of masp\_geometry\_frame\_scale\_factor\_x\_minus1 is inferred to be equal to 0.

The variable MaspGeometryFrameScaleFactorX[ vuh\_atlas\_id ] is set equal to masp\_geometry\_frame\_scale\_factor\_x\_minus1 + 1. The variable MaspGeometryFrameWidth[ vuh\_atlas\_id ] is set equal to AspsFrameWidth[ vuh\_atlas\_id ] / MaspGeometryFrameScaleFactorX[ vuh\_atlas\_id ]. It is a requirement of bitstream conformance that AspsFrameWidth[ vuh\_atlas\_id ] is divisible by MaspGeometryFrameScaleFactorX[ vuh\_atlas\_id ].

**masp\_geometry\_frame\_scale\_factor\_y\_minus1** + 1 specifies the frame height of the geometry video data of the atlas in relation to the nominal atlas height. When not present, the value of masp\_geometry\_frame\_scale\_factor\_y\_minus1 is inferred to be equal to 0.

The variable MaspGeometryFrameScaleFactorY[ vuh\_atlas\_id ] is set equal to masp\_geometry\_frame\_scale\_factor\_y\_minus1 + 1. The variable MaspGeometryFrameHeight[ vuh\_atlas\_id ] is set equal to AspsFrameHeight[ vuh\_atlas\_id ] / MaspGeometryFrameScaleFactorY[ vuh\_atlas\_id ]. It is a requirement of bitstream conformance that AspsFrameHeight[ vuh\_atlas\_id ] is divisible by MaspGeometryFrameScaleFactorY[ vuh\_atlas\_id ].

Motivation: The new variables and divisibility constraint simplifies G.2.1 and implementations.

## Annex F.3.5 Geometry upscaling parameters SEI payload semantics

**gup\_type** is the type of geometry upscaling to which the provided parameters apply. This version of the standard defines the value 0 in accordance with the geometry video scaling process in clause (G.2). All positive even values are reserved for future use by ISO/IEC. All odd values are unspecified (available for specification by other standards).

**gup\_erode\_threshold** specifies the threshold that is applied in the texture aligned geometry erosion process (G.2.5) to determine if selective erosion is applied for a pixel or not. When not present, the value of gup\_erode\_threshold is inferred to be equal to 1.0.

The variable GupErodeThreshold is set equal to gup\_erode\_threshold.

**gup\_delta\_threshold** specifies the threshold that is applied in the texture aligned geometry erosion process (G.2.5) to determine the partial depth order between two samples. When not present, the value of gup\_delta\_threshold is inferred to be equal to 10.

The variable GupDeltaThreshold is set equal to gup\_delta\_threshold.

**gup\_max\_curvature** specifies the threshold that determines if the curvature correction of the geometry contour smoothing process (G.2.6) is applied to a geometry sample. When not present, the value of gup\_max\_curvature is inferred to be equal to 5.

The variable GupMaxCurvature is set equal to gup\_max\_curvature.

# Processes

## Annex G.2.1 Nearest neighbor interpolation scaling process

The MaspGeometryFrameScaleFactorY[ a ] and MaspGeometryFrameScaleFactorX[ a ] variables together with the divisibility constraint help to simplify this process:

This process scales the geometry frame at decoded size DecGeoFrame[ 0 ][ orderIdx ][ 0 ][ y ][ x ] to a geometry frame at nominal atlas size using nearest neighbour interpolation. The output of this process ScaledGeoFrame[ y ][ x ] is derived as follows:

for( y = 0; y < AspsFrameHeight[ a ]; y++ ) {

for( x = 0; x < AspsFrameWidth[ a ]; x++) {

v = y / MaspGeometryFrameScaleFactorY[ a ]

u = x / MaspGeometryFrameScaleFactorX[ a ]

ScaledGeoFrame[ y ][ x ] = DecGeoFrame[ 0 ][ orderIdx ][ 0 ][ v ][ u ]

}

}

## Annex G.2.3 Foreground edge flag process

* Remove: The GeoDeltaThreshold parameter is set to 10 in this version of the standard.
* Rename DeoDeltaThreshold to GupDeltaThreshold.

## Annex G.2.4 Selective geometry erosion process

* Rename DeoDeltaThreshold to GupDeltaThreshold.
* Editorial improvements.
* Insertion of GupErodeThreshold in:

ErodeFlag[ y ][ x ] = sadForeground \* countBackground > GupErodeThreshold \* sadBackground \* countForeground ? 1 : 0

This equation is written to avoid division, but in mathematical form the line is clearer:

with the indicator function.

## Annex G.2.5 Geometry contour smoothening process

* Remove: The MaxCurvature parameter is set to 5 in this version of the standard
* Fixed lack of specification of Connectivity in WD4 by adding: where NgX, NgY and NumNeighbours are computed according to G.2.2 with Connectivity equal to 8
* Rename geoDeltaThreshold to GupDeltaThreshold, and MaxCurvature to GupMaxCurvature.

# Recommendations

We recommend to adopt this proposal into the specification.

1. Section numbering of draft d1 [[m53929](http://wg11.sc29.org/doc_end_user/current_document.php?id=74580&id_meeting=182)] [↑](#footnote-ref-1)