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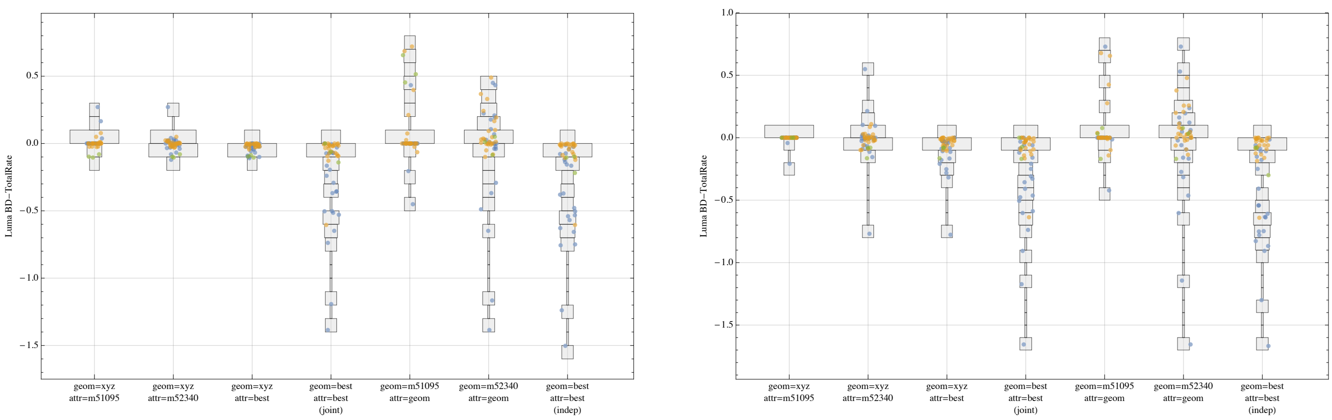
Abstract

CE13.26 is tasked with studying the effects of permitting a different (independent) attribute axis coding order to that used for geometry coding, including methods to efficiently select an appropriate order. In this report the existing codec features that permit jointly varying both the geometry and attribute axis coding order are quantified. The performance limit for independent coding orders is identified and used to determine the effectiveness of the proposed non-normative decision processes.

Summary

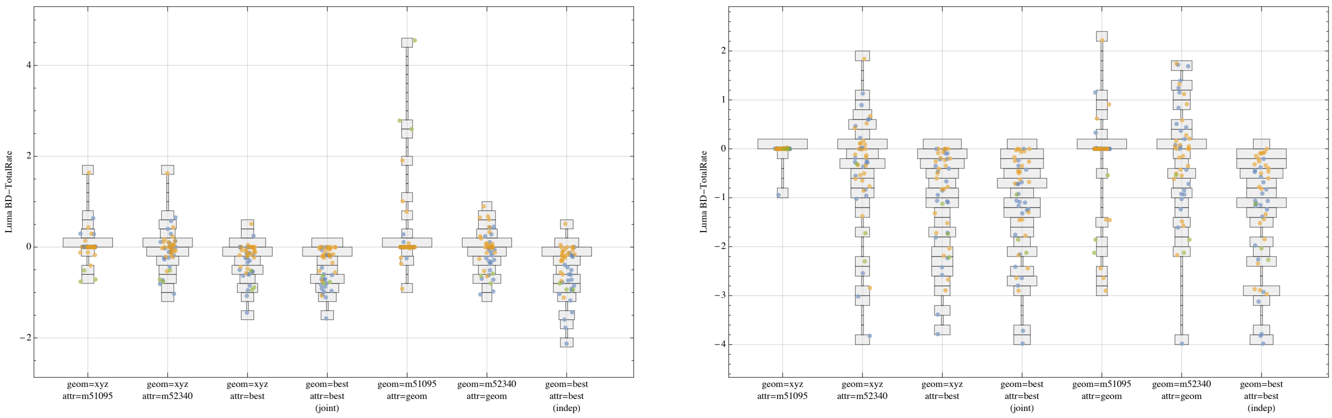
Figures 1 to 3 provide a visual summary of the pertinent results studied in this report. Each vertical column represents a particular combination of coding mode and determination process. The vertical axis represents coding performance compared to the CTC anchor. Individual points represent the coding performance of a sequence in the content categories cat1-A (blue), cat1-B (yellow), and cat3-fused (green).

From left to right, the first two columns summarise behaviour of the two candidate methods and their non-normative decision process. The third column indicates the maximum gain achievable assuming an ideal decision process. The fourth column shows the maximum gain achievable using the existing codec tools assuming again an ideal decision process. Columns five and six show the behaviour of the non-normative



(a) LoD (b) RAHT

Figure 1 – Lossless geometry – lossy attribute performance of studied methods



(a) LoD

(b) RAHT

Figure 2 – Lossy geometry – lossy attribute performance of studied methods

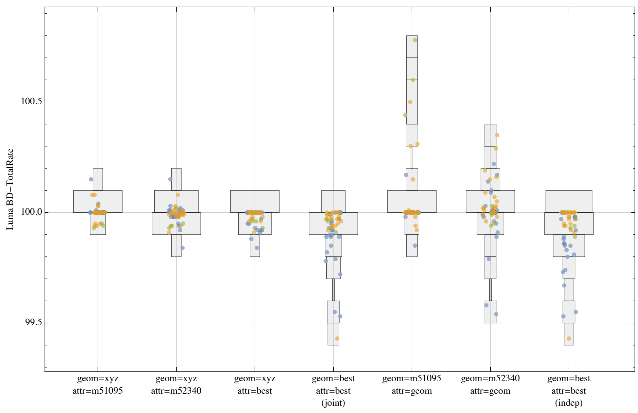


Figure 3 – Lossless geometry – lossless (LOD) attribute performance of studied methods

aspect of each method when applied to the existing codec tools. The final column shows the maximum gain achievable assuming an ideal decision processes that independently decides both the geometry and attribute axis coding orders.

Overview of tools

The current G-PCC working draft [1] permits choosing one of six axis coding order permutations, eg xyz, or zxy. The chosen permutation applies to both geometry and attribute coding for all frames in a sequence.

The proposed methods [2, 3] introduce the flexibility of using different axis coding orders for geometry and attribute coding. It includes a non-normative method to select the attribute coding order. The order is signalled in the APS. The use of a different order for attribute coding requires that points are re-sorted after geometry decoding, loosing any opportunities for efficient implementations to exploit the ordering characteristics of the octree derived position data.

The two proposals each focus on one of LoD (m51095) or RAHT (m52340). However, both are trivially extended to all attribute coding methods.

The non-normative decision process examines the input point cloud prior to scaling, and slicing to determine the attribute coding order. Determination is based purely on geometry. The same attribute order is used for all attributes and all slices in the sequences even though the HLS provides greater flexibility.

Evaluation methodology

Since the attribute order of the geometry and attributes are linked in the current design, it is the case that a given order may provide a gain in geometry but a loss in attributes or vis versa. In order to reconcile this, compression performance is determined using BD-TotalRate and Total Compression Ratios. The TotalRate is the entire bitstream size (geometry, attributes, hls, and headers).

Geometry coding itself in "lossy-geometry" conditions is always lossless (the lossy part is a pre-process), changing the axis order will not affect the geometry distortion at a given rate point.

This permits the evaluation of the C1, C2 and CY conditions using just the attribute BD-TotalRate. Admittedly this is more complicated for the three sequences with two attributes.

All results presented in this document use the TMC13v9 common test conditions [4] as an anchor for consistent reporting of results.

NB: The front page of the CTC reporting work book does not report TotalRate values. Each individual page must be inspected.

Objectives

This evaluation attempts to address the following questions:

- What is the maximum benefit of adding the flexibility of using different geometry and attribute coding orders? How does this compare what is achievable with the current design.
- Are the non-normative decision processes of m51095 and m52340 effective in exploiting the potential coding benefit?
- Can the non-normative decision processes be applied effectively to geometry coding?

Since neither m51095 nor m52340 provide a method to select the geometry order, all analysis is performed assuming the default xyz geometry order unless specified otherwise.

Study of limits

Joint geometry & attribute order

The current encoder does not provide a means to determine the optimal axis permutation to use. However, it is possible to determine a bound on what could be achieved using the existing functionality. The following method is employed: For each sequence of each test condition, identify the order that minimises the following metric computed against the xyz reference order:

- the Luma-BDTotalRate for C1, and C2 (for sequences with colour)
- the Reflectance-BDTotalRate for C1, and C2 (for sequences with only reflectance)
- the Total bpip ratio for CW

The metric is computed against the xyz reference order.

A set of simulated experiment results are generated from raw results of the identified order for each sequence in each condition. These are compared to the reference (xyz) order and reported in Tables 1[1] and 2[2].

Results for each permutation are included with this contribution.

[1] m51027-joint-geom+attr=best__vs__v9.1-xyz_octree_predlift.xlsm
[2] m51027-joint-geom+attr=best__vs__v9.1-xyz_octree_raht.xlsm

Table 1 – m51027 (G-PCCv9) best joint geometry+attribute (LoD) order vs CTC (xyz)

Condition	Class	BPP Ratio [%] Total	BD-Rate [Δ%] D1	D2	Y	Cb	Cr	R
C1_ai	cat1-A		−0.5	−0.5	−0.4	−0.4	−0.4	
C1_ai	cat1-B		−0.1	−0.1	−0.1	−0.1	−0.1	
C1_ai	cat3-fused		−0.1	−0.1	−0.1	−0.1	−0.1	−0.1
C1_ai	cat3-frame		0.0	0.0				0.0
C1_ai	overall		−0.2	−0.2	−0.2	−0.2	−0.2	−0.0
C2_ai	cat1-A		−0.3	−0.3	−0.6	−0.1	−1.2	
C2_ai	cat1-B		−0.1	−0.1	−0.2	−0.0	−0.0	
C2_ai	cat3-fused		−0.1	−0.1	−0.7	−0.7	−0.5	−0.6
C2_ai	cat3-frame		−0.0	−0.0				−0.1
C2_ai	overall		−0.2	−0.2	−0.4	−0.1	−0.6	−0.2
CW_ai	cat1-A	99.9						
CW_ai	cat1-B	99.9						
CW_ai	cat3-fused	100.0						
CW_ai	cat3-frame	100.0						
CW_ai	overall	99.9						
CY_ai	cat1-A		−0.2	−0.2	−0.3	−0.3	−0.3	
CY_ai	cat1-B		−0.0	−0.0	−0.1	−0.1	−0.1	
CY_ai	cat3-fused		−0.0	−0.0	−0.1	−0.1	−0.1	−0.1
CY_ai	cat3-frame		0.0	0.0				−0.0
CY_ai	overall		−0.1	−0.1	−0.1	−0.1	−0.1	−0.0

NOTE — Condition CY metrics reported using Hausdorff PSNR.

Table 2 – m51027 (G-PCCv9) best joint geometry+attribute (RAHT) order vs CTC (xyz)

Condition	Class	BPP Ratio [%] Total	BD-Rate [Δ%] D1	D2	Y	Cb	Cr	R
C1_ai	cat1-A		−0.4	−0.4	−0.4	−0.4	−0.4	
C1_ai	cat1-B		−0.1	−0.1	−0.1	−0.1	−0.1	
C1_ai	cat3-fused		−0.0	−0.0	−0.1	−0.1	−0.1	−0.1
C1_ai	cat3-frame		−0.0	−0.0				−0.0
C1_ai	overall		−0.2	−0.2	−0.2	−0.3	−0.3	−0.0
C2_ai	cat1-A		−0.3	−0.3	−1.4	−2.7	−2.4	
C2_ai	cat1-B		−0.1	−0.1	−0.9	−0.9	−0.9	
C2_ai	cat3-fused		−0.1	−0.1	−1.6	−1.8	−2.1	−2.3
C2_ai	cat3-frame		0.0	0.0				0.0
C2_ai	overall		−0.2	−0.2	−1.2	−1.8	−1.6	−0.7

Best independent attribute order given xyz geometry order

In order to determine how effective the proposed attribute order determination proccesses are, a best attribute order is determined assuming a fixed the geometry order (xyz). The attribute order is varied for each sequence in a test condition to attain the best Luma-BDRate or Reflectance-BDRate. In the case of cat3-fused, Luma-BDRate is used (the same order is used for both colour and reflectance attributes).

These results are compared to the reference (xyz) order and reported in Tables 3[3] and 4[4].

Results for each permutation are included with this contribution.

Best independent geometry & attribute order

This section estimates the limits of what can be achieved if independent sequence level geometry and attribute axis orders are used. This is approximated for each sequence in each condition by:

- Identifying the HLS overhead (total bits less geometry and attributes)
- Identify the geometry order that minimises the geometry metric
- Identify the attribute order that minimises the attribute metric

Where the geometry metric is:

- the D1-BDGeomRate for C2
- the Geom bpip ratio for C1, and CW

[3] m51027-indep-geom=zyx+attr=best__vs__v9.1-xyz_octree_predlift.xlsm
[4] m51027-indep-geom=zyx+attr=best__vs__v9.1-xyz_octree_raht.xlsm

Table 3 – Theoretic best independent attribute (LoD) order with xyz geometry order vs CTC (xyz)

Condition	Class	BPP Ratio [%] Total	D1	D2	BD-Rate [Δ%] Y	Cb	Cr	R
C1_ai	cat1-A		0.0	0.0	−0.0	−0.0	−0.0	
C1_ai	cat1-B		0.1	0.1	0.1	0.1	0.1	
C1_ai	cat3-fused		0.1	0.1	−0.0	−0.0	−0.0	−0.0
C1_ai	cat3-frame		30.0	30.0				29.0
C1_ai	overall		3.8	3.8	0.0	0.0	0.0	20.3
C2_ai	cat1-A		−0.1	−0.1	−0.5	0.2	−1.0	
C2_ai	cat1-B		0.0	0.0	−0.0	0.1	0.0	
C2_ai	cat3-fused		−0.1	−0.1	−0.7	−0.7	−0.5	−0.6
C2_ai	cat3-frame		9.3	9.4				10.7
C2_ai	overall		1.1	1.1	−0.3	0.1	−0.5	7.3
CW_ai	cat1-A	100.0						
CW_ai	cat1-B	100.0						
CW_ai	cat3-fused	100.0						
CW_ai	cat3-frame	124.3						
CW_ai	overall	102.5						
CY_ai	cat1-A		−0.0	−0.0	−0.0	−0.0	−0.0	
CY_ai	cat1-B		0.1	0.1	0.1	0.1	0.1	
CY_ai	cat3-fused		−0.0	−0.0	0.0	0.0	0.0	0.0
CY_ai	cat3-frame		26.2	26.2				28.0
CY_ai	overall		3.3	3.3	0.0	0.0	0.0	19.6

NOTE — Condition CY metrics reported using Hausdorff PSNR.

Table 4 – Theoretic best independent attribute (RAHT) order with xyz geometry order vs CTC (xyz)

Condition	Class	BPP Ratio [%] Total	D1	D2	BD-Rate [Δ%] Y	Cb	Cr	R
C1_ai	cat1-A		0.0	0.0	−0.1	−0.1	−0.2	
C1_ai	cat1-B		0.1	0.1	0.1	0.0	0.1	
C1_ai	cat3-fused		0.1	0.1	−0.0	−0.1	−0.1	−0.1
C1_ai	cat3-frame		30.0	30.0				29.1
C1_ai	overall		3.8	3.8	−0.0	−0.0	−0.0	20.3
C2_ai	cat1-A		−0.1	−0.1	−1.2	−2.0	−1.7	
C2_ai	cat1-B		0.0	0.0	−0.8	−0.8	−0.7	
C2_ai	cat3-fused		−0.1	−0.1	−1.6	−1.8	−2.0	−2.3
C2_ai	cat3-frame		9.5	9.6				9.5
C2_ai	overall		1.1	1.2	−1.0	−1.4	−1.2	6.0

Where the attribute metric is:

- the Luma-BDAttrRate for C1, and C2 (for sequences with colour)
- the Refl-BDAttrRate for C1, and C2 (for sequences with only reflectance)
- the Colour bpip ratio for CW (for sequences with colour)
- the Reflectance bpip ratio for CW (for sequences with only reflectance)

The metrics are computed against the xyz reference order.

A set of simulated experiment results are generated from the raw results by, for each test point:

- using the geometry rate from the identified geometry order
- using the attribute rate from the identified attribute order
- determining the total rate (geometry + attribute + hls overhead)

These results are compared to the reference (xyz) order and reported in Tables 5[5] and 6[6].

Results for each permutation are included with this contribution.

[5] m51027-indep-geom+attr=best__vs__v9.1-xyz_octree_predlift.xlsm
[6] m51027-indep-geom+attr=best__vs__v9.1-xyz_octree_raht.xlsm

Table 5 – Theoretic best independent geometry+attribute (LoD) order vs CTC (xyz)

Condition	Class	BPP Ratio [%] Total	BD-Rate [Δ%] D1	D2	Y	Cb	Cr	R
C1_ai	cat1-A		−0.5	−0.5	−0.4	−0.5	−0.4	
C1_ai	cat1-B		−0.0	−0.0	−0.1	−0.1	−0.1	
C1_ai	cat3-fused		−0.1	−0.1	−0.1	−0.2	−0.2	−0.1
C1_ai	cat3-frame		−0.0	−0.0				−0.0
C1_ai	overall		−0.2	−0.2	−0.2	−0.2	−0.2	−0.1
C2_ai	cat1-A		−0.4	−0.5	−0.8	−0.1	−1.3	
C2_ai	cat1-B		−0.2	−0.1	−0.2	−0.1	−0.1	
C2_ai	cat3-fused		−0.3	−0.3	−0.9	−0.8	−0.6	−0.8
C2_ai	cat3-frame		−0.1	−0.1				−0.4
C2_ai	overall		−0.3	−0.3	−0.5	−0.1	−0.7	−0.5
CW_ai	cat1-A	99.9						
CW_ai	cat1-B	100.0						
CW_ai	cat3-fused	99.9						
CW_ai	cat3-frame	100.0						
CW_ai	overall	99.9						
CY_ai	cat1-A		−0.2	−0.2	−0.3	−0.3	−0.3	
CY_ai	cat1-B		−0.0	−0.0	−0.0	−0.0	−0.0	
CY_ai	cat3-fused		−0.1	−0.1	−0.1	−0.1	−0.1	−0.1
CY_ai	cat3-frame		−0.0	−0.0				−0.0
CY_ai	overall		−0.1	−0.1	−0.2	−0.2	−0.2	−0.0

NOTE — Condition CY metrics reported using Hausdorff PSNR.

Table 6 – Theoretic best independent geometry+attribute (RAHT) order vs CTC (xyz)

Condition	Class	BPP Ratio [%] Total	BD-Rate [Δ%] D1	D2	Y	Cb	Cr	R
C1_ai	cat1-A		−0.5	−0.5	−0.6	−0.6	−0.6	
C1_ai	cat1-B		−0.0	−0.0	−0.1	−0.1	−0.1	
C1_ai	cat3-fused		−0.0	−0.0	−0.2	−0.2	−0.2	−0.2
C1_ai	cat3-frame		0.0	0.0				−0.1
C1_ai	overall		−0.2	−0.2	−0.3	−0.3	−0.3	−0.1
C2_ai	cat1-A		−0.5	−0.5	−1.6	−2.4	−2.0	
C2_ai	cat1-B		−0.2	−0.2	−0.9	−1.0	−0.9	
C2_ai	cat3-fused		−0.2	−0.2	−1.8	−1.9	−2.2	−2.4
C2_ai	cat3-frame		−0.1	−0.1				−1.7
C2_ai	overall		−0.3	−0.3	−1.3	−1.7	−1.5	−1.9

Performance of m51095 and m52340

The proposed methods are used to select an attribute coding order for each sequence in each configuration. The geometry order is the default xyz geometry order.

Joint geometry-attribute order

To study the use of joint coding orders, the proposed non-normative decision processes are repurposed and used to instead determine the axis_coding_order parameter present in the current draft. Effectively, this is the same as choosing the attribute order and then setting the geometry order to be the same.

It should be noted that the use of angular geometry coding in cat3-frame data is severely affected by changes to the coding order. Angular coding in these sequences works on the third component. If the angular prior from the sequence (z-axis) is not mapped to the third component, then the angular coding mode becomes ineffective.

Table 7 – Independent attribute (LoD) order with xyz geometry order vs CTC (xyz)

(a) m52340

		BPP Ratio [%]	BD-Rate [Δ%]					
Condition	Class	Total	D1	D2	Y	Cb	Cr	R
C1_ai	cat1-A		−0.0	−0.0	0.0	−0.0	0.0	
C1_ai	cat1-B		0.0	0.0	−0.0	−0.0	0.0	
C1_ai	cat3-fused		−0.0	−0.0	−0.1	−0.1	−0.1	−0.1
C1_ai	cat3-frame		−0.0	−0.0				−0.0
C1_ai	overall		−0.0	−0.0	−0.0	−0.0	0.0	−0.0
C2_ai	cat1-A		−0.0	−0.0	−0.1	−0.3	−0.3	
C2_ai	cat1-B		0.0	0.0	0.1	0.1	−0.4	
C2_ai	cat3-fused		−0.2	−0.2	−0.7	−0.5	−0.6	−0.6
C2_ai	cat3-frame		−0.0	−0.0				−0.1
C2_ai	overall		−0.0	−0.0	−0.1	−0.1	−0.3	−0.3
CW_ai	cat1-A	100.0						
CW_ai	cat1-B	100.0						
CW_ai	cat3-fused	99.9						
CW_ai	cat3-frame	100.0						
CW_ai	overall	100.0						
CY_ai	cat1-A		−0.0	−0.0	0.0	0.0	0.0	
CY_ai	cat1-B		−0.0	−0.0	−0.0	−0.0	−0.0	
CY_ai	cat3-fused		−0.1	−0.1	−0.1	−0.1	−0.1	−0.1
CY_ai	cat3-frame		−0.0	−0.0				−0.0
CY_ai	overall		−0.0	−0.0	0.0	0.0	0.0	−0.0

NOTE — Condition CY metrics reported using Hausdorff PSNR.

(b) m51095

		BPP Ratio [%]	BD-Rate [Δ%]					
Condition	Class	Total	D1	D2	Y	Cb	Cr	R
C1_ai	cat1-A		0.0	0.0	0.0	0.0	0.0	
C1_ai	cat1-B		−0.0	−0.0	0.0	0.0	0.0	
C1_ai	cat3-fused		−0.0	−0.0	−0.1	−0.1	−0.1	−0.1
C1_ai	cat3-frame		−0.0	−0.0				−0.0
C1_ai	overall		0.0	0.0	0.0	0.0	0.0	−0.1
C2_ai	cat1-A		0.0	0.0	0.1	0.2	0.3	
C2_ai	cat1-B		−0.0	−0.0	0.1	0.0	−0.3	
C2_ai	cat3-fused		−0.2	−0.2	−0.7	−0.5	−0.6	−0.6
C2_ai	cat3-frame		−0.0	−0.0				−0.3
C2_ai	overall		−0.0	−0.0	0.0	0.1	−0.1	−0.4
CW_ai	cat1-A	100.0						
CW_ai	cat1-B	100.0						
CW_ai	cat3-fused	99.9						
CW_ai	cat3-frame	100.0						
CW_ai	overall	100.0						
CY_ai	cat1-A		0.0	0.0	0.0	0.0	0.0	
CY_ai	cat1-B		0.0	0.0	0.0	0.0	0.0	
CY_ai	cat3-fused		−0.1	−0.1	−0.1	−0.1	−0.1	−0.1
CY_ai	cat3-frame		−0.0	−0.0				−0.0
CY_ai	overall		−0.0	−0.0	0.0	0.0	0.0	−0.0

NOTE — Condition CY metrics reported using Hausdorff PSNR.

Table 8 – Independent attribute (RAHT) order with xyz geometry order vs CTC (xyz)

(a) m52340

		BPP Ratio [%]	BD-Rate [Δ%]					
Condition	Class	Total	D1	D2	Y	Cb	Cr	R
C1_ai	cat1-A		−0.0	−0.0	−0.0	−0.0	−0.0	
C1_ai	cat1-B		0.0	0.0	−0.0	−0.0	−0.0	
C1_ai	cat3-fused		0.0	0.0	−0.1	−0.2	−0.2	−0.2
C1_ai	cat3-frame		0.0	0.0				−0.0
C1_ai	overall		0.0	0.0	−0.0	−0.0	−0.0	−0.1
C2_ai	cat1-A		−0.0	−0.0	−0.5	−1.8	−2.1	
C2_ai	cat1-B		−0.0	−0.0	−0.2	−0.5	−0.8	
C2_ai	cat3-fused		−0.1	−0.1	−1.4	−1.8	−2.1	−2.3
C2_ai	cat3-frame		−0.0	−0.0				−0.5
C2_ai	overall		−0.0	−0.0	−0.4	−1.1	−1.4	−1.0

(b) m51095

		BPP Ratio [%]	BD-Rate [Δ%]					
Condition	Class	Total	D1	D2	Y	Cb	Cr	R
C1_ai	cat1-A		−0.0	−0.0	−0.0	−0.0	−0.0	
C1_ai	cat1-B		0.0	0.0	0.0	0.0	0.0	
C1_ai	cat3-fused		0.0	0.0	0.0	0.0	0.0	0.0
C1_ai	cat3-frame		0.0	0.0				0.0
C1_ai	overall		−0.0	−0.0	−0.0	−0.0	−0.0	0.0
C2_ai	cat1-A		0.0	0.0	−0.0	−0.1	−0.2	
C2_ai	cat1-B		0.0	0.0	0.0	0.0	0.0	
C2_ai	cat3-fused		0.0	0.0	0.0	0.0	0.0	0.0
C2_ai	cat3-frame		0.0	0.0				0.7
C2_ai	overall		0.0	0.0	−0.0	−0.0	−0.1	0.5

Table 9 – Joint geometry and attribute (LoD) order vs CTC (xyz)

(a) m52340

		BPP Ratio [%]	BD-Rate [Δ%]					
Condition	Class	Total	D1	D2	Y	Cb	Cr	R
C1_ai	cat1-A		−0.2	−0.2	−0.1	−0.1	−0.1	
C1_ai	cat1-B		0.1	0.1	0.1	0.1	0.1	
C1_ai	cat3-fused		0.1	0.1	−0.0	−0.0	−0.0	−0.0
C1_ai	cat3-frame		21.5	21.5				23.3
C1_ai	overall		2.7	2.7	−0.0	−0.0	−0.0	16.3
C2_ai	cat1-A		−0.2	−0.2	−0.2	−0.3	−1.1	
C2_ai	cat1-B		0.1	0.1	0.1	0.4	−0.0	
C2_ai	cat3-fused		−0.1	−0.1	−0.7	−0.5	−0.5	−0.6
C2_ai	cat3-frame		6.9	7.0				64.6
C2_ai	overall		0.8	0.8	−0.1	−0.0	−0.5	45.0
CW_ai	cat1-A	100.0						
CW_ai	cat1-B	100.1						
CW_ai	cat3-fused	100.0						
CW_ai	cat3-frame	120.9						
CW_ai	overall	102.2						
CY_ai	cat1-A		−0.0	−0.0	−0.1	−0.1	−0.1	
CY_ai	cat1-B		0.1	0.1	0.1	0.1	0.1	
CY_ai	cat3-fused		−0.0	−0.0	0.0	0.0	0.0	0.0
CY_ai	cat3-frame		19.3!	19.3!				22.0!
CY_ai	overall		2.4!	2.4!	0.0	0.0	0.0	11.0!

NOTE — Condition CY metrics reported using Hausdorff PSNR.

(b) m51095

		BPP Ratio [%]	BD-Rate [Δ%]					
Condition	Class	Total	D1	D2	Y	Cb	Cr	R
C1_ai	cat1-A		−0.0	−0.0	−0.0	−0.0	−0.0	
C1_ai	cat1-B		0.1	0.1	0.1	0.1	0.1	
C1_ai	cat3-fused		0.1	0.1	0.5	0.7	0.6	0.6
C1_ai	cat3-frame		29.3	29.3				29.7
C1_ai	overall		3.7	3.7	0.1	0.1	0.1	21.0
C2_ai	cat1-A		0.0	0.0	0.0	0.2	0.3	
C2_ai	cat1-B		0.0	0.0	0.1	0.1	−0.2	
C2_ai	cat3-fused		0.9	0.9	3.3	5.2	4.6	4.9
C2_ai	cat3-frame		10.3	10.4				28.1
C2_ai	overall		1.3	1.4	0.3	0.4	0.3	21.2
CW_ai	cat1-A	100.0						
CW_ai	cat1-B	100.0						
CW_ai	cat3-fused	100.6						
CW_ai	cat3-frame	125.5						
CW_ai	overall	102.7						
CY_ai	cat1-A		0.0	0.0	−0.0	−0.0	−0.0	
CY_ai	cat1-B		0.1	0.1	0.1	0.1	0.1	
CY_ai	cat3-fused		0.7	0.7	0.8	0.8	0.8	0.8
CY_ai	cat3-frame		27.3	27.3				28.6
CY_ai	overall		3.5	3.5	0.1	0.1	0.1	20.3

NOTE — Condition CY metrics reported using Hausdorff PSNR.

Table 10 – Joint geometry and attribute (RAHT) order vs CTC (xyz)

(a) m52340

		BPP Ratio [%]	BD-Rate [Δ%]					
Condition	Class	Total	D1	D2	Y	Cb	Cr	R
C1_ai	cat1-A		−0.2	−0.2	−0.1	−0.1	−0.1	
C1_ai	cat1-B		0.1	0.1	0.1	0.1	0.1	
C1_ai	cat3-fused		0.1	0.1	−0.0	−0.1	−0.1	−0.1
C1_ai	cat3-frame		21.5	21.5				20.9
C1_ai	overall		2.7	2.7	−0.0	−0.0	−0.0	14.6
C2_ai	cat1-A		−0.2	−0.2	−0.1	−0.9	−1.6	
C2_ai	cat1-B		0.1	0.1	−0.1	0.0	−0.0	
C2_ai	cat3-fused		−0.1	−0.1	−1.5	−1.7	−2.1	−2.3
C2_ai	cat3-frame		6.7	6.8				7.6
C2_ai	overall		0.8	0.8	−0.2	−0.5	−0.9	4.6

(b) m51095

		BPP Ratio [%]	BD-Rate [Δ%]					
Condition	Class	Total	D1	D2	Y	Cb	Cr	R
C1_ai	cat1-A		−0.0	−0.0	0.0	0.0	0.0	
C1_ai	cat1-B		0.1	0.1	0.1	0.1	0.1	
C1_ai	cat3-fused		0.1	0.1	−0.0	−0.1	−0.1	−0.1
C1_ai	cat3-frame		29.3	29.3				28.4
C1_ai	overall		3.7	3.7	0.0	0.0	0.0	19.9
C2_ai	cat1-A		−0.0	−0.0	0.1	0.1	0.2	
C2_ai	cat1-B		0.0	0.0	−0.3	−0.5	−0.5	
C2_ai	cat3-fused		−0.1	−0.1	−1.5	−1.7	−2.1	−2.3
C2_ai	cat3-frame		9.2	9.3				9.4
C2_ai	overall		1.2	1.2	−0.2	−0.3	−0.2	5.9

Software and configuration

While there is no implementation to check (the base code forms part of tmc13v9), configuration snippets are provided for each permutation in the following branch of the CE repository `mpeg129/ce13.26/sps-axis-order-permutations`.

The following snippets are provided in the cfg directory:

- cfg-geomswizzle-xzy.yaml
- cfg-geomswizzle-yxz.yaml
- cfg-geomswizzle-yzx.yaml
- cfg-geomswizzle-zxy.yaml
- cfg-geomswizzle-zyx.yaml

NB: the default configuration of the reference software uses the order xyz.

NB: these snippets are based upon a bugfixed v9.1, as available in the master tmc13 branch.

Configuration files may be generated using the gen-cfg.sh script. For example:

```
$ cd cfg
$ ../scripts/gen-cfg.sh -- cfg-geomswizzle-zyx.yaml
```

References

[1] 3DG, “Text of ISO/IEC 23090-9 DIS Geometry-based PCC,” ISO/IEC JTC1/SC29/WG11, 129th meeting, Brussels, Tech. Rep. w19088, Jan. 2020.

[2] Y. Park and S. Oh, “[G-PCC](New Proposal) Morton code generation with adaptive axis order,” ISO/IEC JTC1/SC29/WG11, 128th meeting, Geneva, Tech. Rep. m51095, Oct. 2019.

[3] W. Zhang, N. Dai, F. Yang, Z. Sun, Y. Yu, and Y. Liu, “[G-PCC] CE13.26 Report On RAHT transform order,” ISO/IEC JTC1/SC29/WG11, 129th meeting, Brussels, Tech. Rep. m52340, Jan. 2020.

[4] 3DG, “G-PCC performance evaluation and anchor results,” ISO/IEC JTC1/SC29/WG11, 129th meeting, Brussels, Tech. Rep. w19086, Jan. 2020.