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Abstract

The G-PCC geometry coder represents geometry via an octree. Conceptually under a breadth-first traversal, each tree node may convey parameters about the current node and indicate the presence of up to eight child nodes that are in turn processed at the next tree level. However, in the current design, some coding tools split information across tree levels. In particular, the planar mode conveys in a current node additional independent information about the state of each child. A consequence of this has been multiple interactions with geometry quantisation and qtbt, and necessitates maintaining additional local information. This document proposes a conceptually simpler node structure and removes workarounds implemented to address certain tool interactions.

Introduction

A G-PCC octree node currently consists of the following information:

- A QP (if signalled, otherwise inherited).
- The node's occupancy, indicating the presence of up to eight child nodes.
- Planar information about each child node.
- Duplicate point count for leaf points.
- IDCM flag and residual (for single child nodes).

The QP is an attribute of each node. At the QP signalling depth of the octree, a QP is signalled. The selected QP applies to all points within the subtree of the node.

The inferred direct coding mode provides a means to terminate early an octree sub-tree. If, after coding the occupancy, a qualifying node is determined to contain only single child, instead of deferring the coding of the child to the next octree level, the remaining positions of up to two points are coded directly.

Similarly, early in the G-PCC design, the coding of the leaf tree level (with Log2NodeSize = 0) which do not contain occupancy was moved into the parent node.

The planar mode indicates information about the planar nature of each child node's occupancy. This information is saved and then used in entropy coding of the corresponding child node's occupancy. At the encoder, its effect is to study the occupancy of a child node (ie, the presence of grandchild nodes) in order to determine the mode information of the child nodes occupancy.

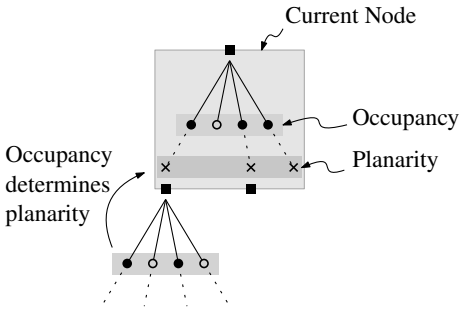


Figure 1 – Encoding dependencies when coding child node planar information

Planar is the odd one out

The current signalling of planar information has had interactions with:

- QtBt: planar eligibility must be set based upon the qtbt state of the child nodes.
- Quantisation: planar is disabled if quantisation can change the child occupancy between the point it was inspected for to determine the planar mode information and the point that it would be signalled. This interaction prevented the adoption of signalling the quantisation depth on a per-level basis (since this knowledge is needed one level in advance).
- Us: The introduction of planar means that when coding the current node, information must be determined about both ancestor nodes and future child nodes. This is additional cognitive load compared to a design where information flow is unidirectional.

In order to determine the planar information (by inspection of child node occupancy), it is necessary to maintain extra state about current and future child node sizes.

Figure 1 shows how the planar information signalled in one node relates to its child nodes. Clearly, the planar information applies to the immediately descending child node. It may be signalled instead at the start of a node (prior to the occupancy) rather than at the end of each node for occupied child.

Interaction with IDCM

Due to the current octree node design, the planar mode controls the eligibility of IDCM early termination. Due to this dependency, the first bit of the IDCM residual may be inferred based upon the just signalled planar information.

Proposal

The proposed octree node order is as follows:

- QP
- IDCM flag + residual (for qualifying nodes)
- Planar information
- Occupancy
- Duplicate point count (for each child of terminating nodes)

This design eliminates the need to track multiple node sizes for the current node. It eliminates both the QtBt interaction that required tracking state about child node splitting, and it eliminates the quantisation

interaction that required planar to be disabled (since quantisation can no longer occur between determination of the planar information and the signalling of occupancy).

Since IDCM eligibility is conditioned as a side-effect of planar, moving IDCM signalling from the leaf of one node to the in this design it is necessary to track that the node is eligible for IDCM. Ie, IDCM elegibility is determined as per the current design, but acted upon at the start of the next level. This will result in IDCM nodes having one extra round trip through the octree fifo.

Table 1 shows the performance of the proposed ordering. In this scheme, the contextualisation and update periods are maintained as in the current design.

It should be noted that it is possible to avoid reordering the IDCM flag and residual (to keep it in the current order after signalling occupancy). However, doing so will lose the ability to infer the first bit of the IDCM residual.

Table 1 – Performance of same-node signalling of planar information

		BPP Ratio [%]			BD-Rate [Δ%]						Avg. of ratio maxrssk [%]		Ratio of avg. runtime [%]	
Condition	Class	Geometry	Colour	Refl	D1	D2	Y	Cb	Cr	R	Encoder	Decoder	Encoder	Decoder
C1_ai	cat1-A				0.0!	0.0!	0.0!	−0.1!	0.0!		100	100	100	102
C1_ai	cat3-fused				0.0	0.0	0.0	0.0	0.0	0.0	100	101	103	111
C1_ai	cat3-frame				−0.0	−0.0				0.0	101	101	99	100
C1_ai	overall				0.0!	0.0!	0.0!	−0.1!	0.0!	0.0	100	100	100	102
C2_ai	cat1-A				−0.1!	−0.1!	0.1!	−0.1!	−0.2!		100	100	98	97
C2_ai	cat1-B				−0.0	−0.0					100	102	101	98
C2_ai	cat3-fused				0.1	0.1	0.0	0.0	0.0	0.0	100	100	104	106
C2_ai	cat3-frame				−0.0	−0.0				−0.0	101	101	96	101
C2_ai	overall				−0.0!	−0.0!	0.1!	−0.1!	−0.2!	−0.0	100	101	99	98
CW_ai	cat1-A	100.0	100.0								101	99	101	105
CW_ai	cat1-B	100.0									101	101	96	104
CW_ai	cat3-fused	100.0	100.0	100.0							100	99	101	106
CW_ai	cat3-frame	100.0		100.0							101	101	112	113
CW_ai	overall	100.0	100.0!	100.0							101	100	100	106
CY_ai	cat1-A				0.0	0.0	0.0	0.0	0.0		101	100	100	100
CY_ai	cat3-fused				0.0	0.0	0.0	0.0	0.0	0.0	100	99	104	104
CY_ai	cat3-frame				−0.0	−0.0				0.0	101	101	104	105
CY_ai	overall				0.0	0.0	0.0	0.0	0.0	0.0	101	100	102	101

NOTE — Condition CY metrics reported using Hausdorff PSNR.

References