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Title: G-PCC: An IDCM specific QP for in-tree geometry quantisation

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Abstract

In-tree geometry scaling [1, m49232] provides a means to quantise (encoder) and scale (decoder) geometry positions in a non-uniform manner, even while the coding tree is being constructed. However, due to the use of IDCM, some positions may escape quantisation if they occur earlier in the tree than the quantisation tree depth. This contribution suggests signalling an independent quantisation parameter for use with IDCM nodes.

Introduction

From the point of view of a decoder, in-tree geometry scaling operates on the least significant bits of the decoded position data. The number of bits corresponds to the scaling node size.

In core experiment 13.29 [2] on geometry quantisation, it is observed [3], and reproduced in Figure 1, that there is a disparity between the rate-distortion curves for different scaling node sizes.

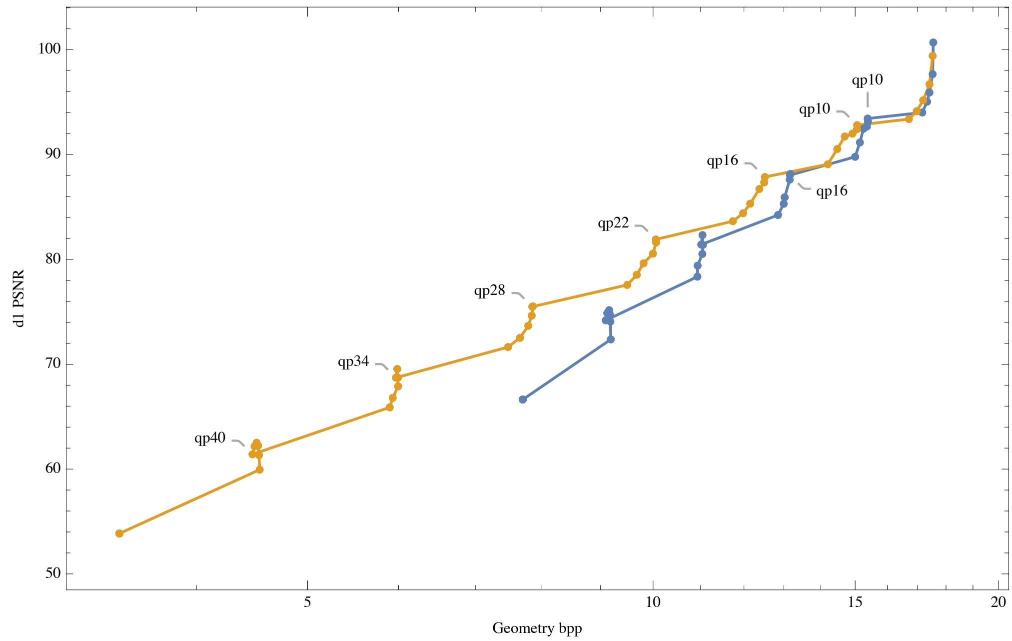

Figure 1 – Rate-distortion behaviour of qnxadas-junction-approach for varying QP with scaling node sizes 2^5 (blue) and 2^7 (orange)

In order to reduce the overhead of coding isolated points, the octree coding scheme detects if a node is isolated and offers the opportunity to explicitly signal the remaining point position. These nodes are called IDCM nodes. If such a node occurs at a depth prior to the signalling of QP offsets, then the node inherits the default QP (4), which results in no quantisation or scaling.

Quantisation of IDCM nodes

In general, since information conveyed by isolated points is potentially less accurate than more dense regions, it may not be necessary to use the full precision available from the octree. Similarly, in order to match the quantisation behaviour of IDCM nodes with their non-IDCM counterparts, an independent QP is proposed for use by non-IDCM nodes that occur prior to the depth at which per-node scaling QP offsets are signalled.

Figure 2 illustrates this problem, where an IDCM node occurs prior to the quantisation depth. Each node after the quantisation node size is able to specify a quantisation parameter for its respective subtree. However, the node marked ‘a’ is not quantised.

The proposed solution is to quantise any IDCM nodes to the left of the line with a dedicated quantisation parameter, idcmQp. Since nodes to the right of the line may have been quantised already according to the subtree that they belong, any IDCM nodes in subtrees to the right are not requantised, unless they belong to a subtree that has a derived QP of 4.

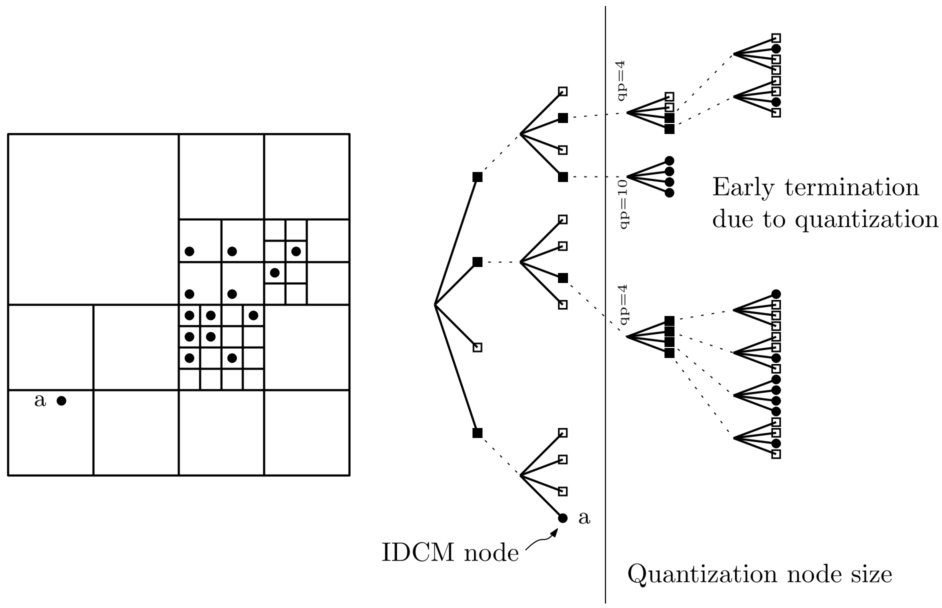

Figure 2 – Illustration of a quad tree with in-tree quantisation and an IDCM node

To achieve this, an additional parameter is added to the slice header indicating the QP to use relative to the sliceQp for IDCM nodes.

```
 geometry_slice_header() {
 ...
   if( geom_scaling_enabled_flag ) {
     geom_slice_qp_offset = se(v)
+    geom_direct_mode_qp_offset = se(v)
     geom_octree_qp_offsets_enabled_flag = u(1)
   }
 ...
 }
```

geom_direct_mode_qp_offset indicates an offset relative to the sliceQp for use in scaling point positions coded by the direct coding mode. The variable IdcmQp is derived as follows:

IdcmQp = sliceQp + geom_direct_mode_qp_offset

… **direct_mode_flag** …

When direct_mode_flag is equal to 1, and NodeQp is equal to 4, NodeQp is set equal to IdcmQp.

Results

In order to study the proposed method, the CE13.29 test is repeated. A sweep of QP is performed with the IDCM QP set equal to the tested QP. Figure 3 shows that applying in-tree quantisation to IDCM nodes higher than the quantisation signalling depth results in the elimination of the disparity between the two curves.

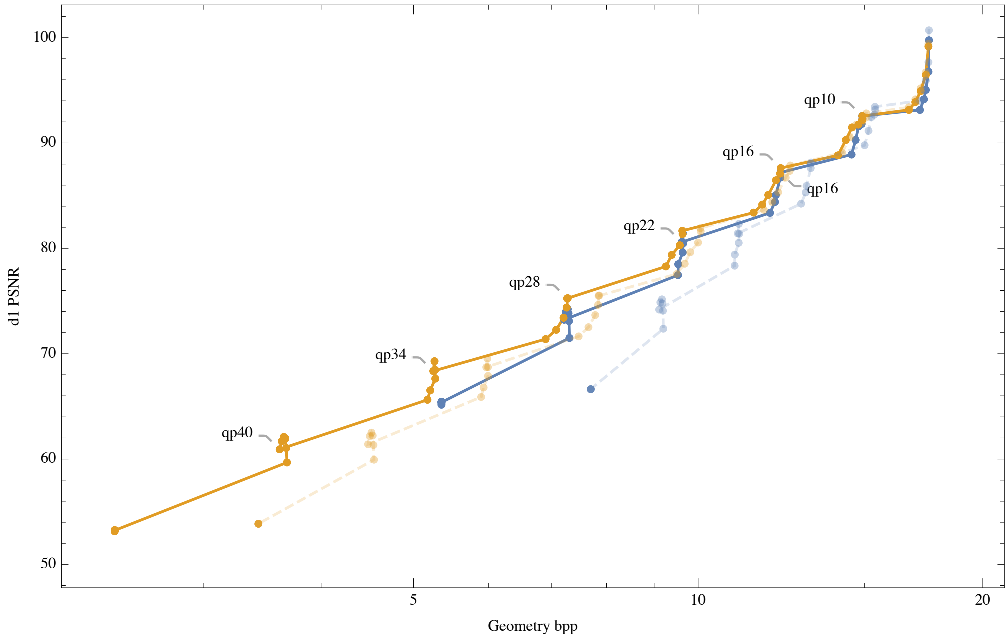

Figure 3 – Rate-distortion behaviour of qnxadas-junction-approach using an IDCM QP for varying QP with scaling node sizes 2^5 (blue) and 2^7 (orange). Dotted lines represent CE result.

Recommendation

It is suggested to add a slice parameter that sets the node QP for IDCM nodes that have not been quantised by some other in-tree means.

References

[1] X. Zhang, W. Gao, S. Yea, and S. Liu, "[G-PCC][New proposal] Signaling delta QPs for adaptive geometry quantization in point cloud coding," ISO/IEC JTC1/SC29/WG11, 127th meeting, Gothenburg, Tech. Rep. m49232, Jul. 2019.

[2] 3DG, "CE 13.29 Geometry Quantization QP control," ISO/IEC JTC1/SC29/WG11, 128th meeting, Geneva, Tech. Rep. w18936, Oct. 2019.

[3] D. Flynn and K. Mammou, "G-PCC CE13.29 report on in-loop geometry quantisation," ISO/IEC JTC1/SC29/WG11, 129th meeting, Brussels, Tech. Rep. m52517, Jan. 2020.