INTERNATIONAL ORGANISATION FOR STANDARDISATION
ORGANISATION INTERNATIONALE DE NORMALISATION
ISO/IEC JTC1/SC29/WG11
CODING OF MOVING PICTURES AND AUDIO

ISO/IEC JCTC1/SC29/WG11 MPEG/m53390
April 2020, Online

Source: Apple Inc.
Status: Input document
Title: EE13.35 report on OtQtBt partition signalling
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Abstract

G-PCC permits coding of cuboid volumes through the use of quad-tree and binary-tree nodes in the geometry octree. The node type at a given level of the tree is determined by a parameterised normative process. This report studies alternative methods evaluated in EE13.35 to convey the node types.

Background

The release of TMC13v9 includes a refactoring of the geometry coding loop to be formed of two loops, an outer per tree-level loop, and an inner node loop. This release also refactored the OtQtBt decision logic into standalone procedure that computes a list of node sizes given initial conditions of the OtQtBt parameters and root node size. Previous versions of the software embedded the node size determination into the coding loop and was difficult to comprehend and verify.

Review of method one: Explicit signalling

The studied method one makes use of the refactored tmc13v9.1 and modifies the per tree-level node-size list determination to encode the OtQtBt splitting flags for each tree level as a side effect. The decoding process simply reads these flags and rebuilds the tree. Flags are signalled using a non-bypass arithmetically coded bins.

With the proposed design, the list terminates only when the node decomposition reaches the unit cube, as per the current design.

The effect of this design change is to move the current normative OtQtBt splitting determination to a non-normative encoder issue.

The software has been reviewed and implementation verified under the common test conditions [1]. A cross-check report is attached. The only comment is that it would be preferable to avoid having processes with side effects. That is, a function that generates a list of node sizes is more generally useful than a function that generates a list of node sizes and encodes splitting information as a side effect.

Alternative explicit signalling

The design as proposed is reasonable. However, upon review, the method itself gives a greater opportunity to improve the signalling of the tree information.

Principally, it is believed that the octree is represented by n levels, where 2^n corresponds to the root node size. However, recent additions to the OtQtBt derivation process can actually generate more than n levels, without changing the root node size.

A more straightforward signalling comprises replacing the signalling of the root node size with instead the number of octree levels (minus1). This value would then correspond to the number of OtQtBt splitting decisions signalled.

Instead of signalling the splitting decision list using cabac as part of the geometry octree data, it should instead be signalled using u(3) elements in the geometry data unit header.

The generation of the node size list should then operate in reverse, starting from the unit node size (or the trisoup node size) and doubling dimensions according to the OtQtBt splitting decisions.

```
geometry_data_unit_header() {
  ...
  num_octree_levels_minus1 = ue(v)
  for (lvl = 0; lvl < num_octere_levels_minus1; lvl++)
    octree_partition[lvl] = u(3)
}
```

To summarise:

- Remove the signalling of the root node size
- Signal the number of tree levels in the octree
- Signal the splitting information for each tree level in the slice header
- Use u(3) to encode the splitting information

Constraints

Increasing the flexibility of the spiting decision signalling increases the ability for an implementation to generate perverse octree constructions. The worst case would be that in any level of the octree, only one axis is split, resulting in a tree three times as deep as necessary.

To bound this value, it is proposed to limit the number of extraneous levels to four.

Remarks

Given the simplicity of signalling involved in method 1, it (or the alternative construction) seems preferable to method 2, wherein part of the implicit OtQtBt decision process is retained.

References

[1] 3DG, “Common Test Conditions for PCC,” ISO/IEC JTC1/SC29/WG11, 129th meeting, Brussels, Tech. Rep. w19084, Jan. 2020.