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**ISO/IEC JTC 1/SC 29/WG 11**

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# Abstract

In this document, we provide descriptions for the core experiment 13.22 on the study of improvements on tree-based geometry coding for Geometry-based PCC. This is a continuation of the Core Experiment [8].

The current implementation of the octree representation of the geometry in G-PCC may suffer from non-optimal compression performance in case of strong acquisition priors, e.g. acquisition by a Lidar, or in very sparse regions of the point cloud due to the nature of the octree that requires many nodes to represent a single point.

Moreover, the breadth-first scanning order as implemented in the current Test Model does not allow for fast and parallel processing of the nodes. Also, it induces a high decoding latency because a decoded point cannot be obtained before reaching the last depth of the octree, imposing the decoding of all depths from the root node to the last depth before outputting the first decoded point.

The goals of this Core Experiment are now focused on:

* introducing new representations of the geometry
  + either at the node level of the octree
  + or by providing an alternative tree representation for part of the octree
* allowing parallel processing of branches of the octree to allow faster geometry decoding

# CE 13.22 on Improvements to Octree coding

## Mandates

* study the impact on compression performance of the proposed new representations (improved planar mode, aka Angular Mode, and Predictive Geometry Coding) of the geometry
* evaluate the trade-off compression performance vs complexity of such representations
* evaluate the gain in runtime and impact on the compression performance of the Parallel Octree Coding
* evaluate combination of these tools

Related changes to the G-PCC Improvements [2] shall be reported.

## Participants, description of tools, and implementation notes

The following people are participating in this CE. Their specific roles are detailed in the next section. Proposals are based on the input contributions

1. m50642, *An improvement of the planar coding mode,* and m50643, *Harmonization of the improved planar coding mode and implicit QTBT*,BlackBerry
2. m50930, *Parallel octree coding for point cloud compression*, Tencent
3. m51012, *Predictive Geometry Coding*

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## Information on proposed tools

### An improvement of the planar coding mode (angular mode) from m50642 and m50643

For Lidar-acquired point clouds, some priors of the sensing system may be used to improve the compression of the geometry. It is proposed to introduce the angular coding mode, plugged over the planar mode, such as to obtain an improved plane vertical position prediction by using the knowledge of positions and angles of sensing laser beams. By doing so, planar mode syntax is much better compressed, leading to overall significant gains of compression for the OT/QT/BT-based geometry coding.

Preliminary tests have also shown that gains obtained from the OT/QT/BT structure, relative to the pure OT structure, may be piled over the proposed angular mode.

### Parallel octree coding for point cloud compression from m50930

In current TMC13 design, the octree encoding and decoding processes have to be conducted in a predefined sequential order, the coding of current node is dependent on the status of coded neighboring nodes. Besides, the context variables of arithmetic coding engine are updated on the fly, therefore, the octree coding of every partition depth cannot be started until the last node is coded in one depth above.

In this contribution, we propose to reinitialize the context variables at certain octree partition depths such that the coding of these octree level can be implemented in parallel. In addition, we proposal a mechanism to further enable parallel parsing in decoder by signaling the bitstream offsets of each parallel octree depth at the header. The coding time can be reduced significantly by the proposed octree coding with parallelism, while the performance impact is negligible***.***

Please refer to [6] for details.

### Predictive Geometry Coding from m51012

This geometry coder defines a prediction structure on the point cloud. Such a structure could be described by a prediction tree, where each point in the point cloud is associated with a vertex of the tree. Each vertex can only predict from its ancestors in the tree. The proposed method includes four prediction modes (PCM, DPCM, Linear, Parallelogram). The tree structure is encoded be traversing the tree in a depth order and encoding for each vertex the number of its children. The positions of the vertices are encoded by storing the chosen prediction mode and the obtained prediction residuals.

## Information for conducting tests

Adoption of the tool should be based on the discussion of the compression gains and the complexity of said tools.

The three proposed tools will be tested individually. However, if meaningful, it is encouraged to study the compatibility of the tools and report the results of a subsequent combination.

### Software

TMC13v8 shall be used for these experiments. The proposed tools shall be implemented on top of TMC13v8.

### Test configurations

Parameters and configurations for the modified TMC13v8 software will be provided by the proponent.

### Evaluation Method

The point cloud test material will be tested for the test sequences of category

* (1) Static Objects and Scenes only for proposal m50930
* (3) Dynamic Acquisition

as defined by the CTC [3]. The following test conditions will be under evaluation

1. *CW AI lossless geometry – (lossless attribute)*
2. *C2 AI, lossy geometry – (lossy attribute)*

Note that the tested technologies should have an impact on geometry compression only and that attribute compression performance are reported informatively.

## CE 13.22 Coordinators

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# Timeline:

* **2019-11-01**: Expected date for TMC13v8 release;
* **2019-11-01- 2019-11-29 [TMC13v8 + 4 weeks]**: study the compatibility of the tools and evaluate performances
* **2019-12-13 [TMC13v8 + 6 weeks]** Deliver source code and results for cross check;
* **2019-12-27 [TMC13v8 + 8 weeks]** Deliver cross check results;
* **2020-01-08**: MPEG document upload deadline.

# References

1. “*G-PCC Test Model v8*”, ISO/IEC JTC1/SC29/WG11 MPEG2019 Doc. w18882, Geneva, Switzerland, October 2019
2. “*G-PCC Future Enhancements*”, ISO/IEC JTC1/SC29/WG11 MPEG2019 Doc. w18887, Geneva, Switzerland, October 2019
3. “Common Test Conditions for PCC” ISO/IEC JTC1/SC29 WG11 MPEG2019”, ISO/IEC JTC1/SC29/WG11 MPEG2019 Doc. w18883, Geneva, Switzerland, October 2019
4. m50642, *An improvement of the planar coding mode,* Geneva, Switzerland, October 2019
5. m50643, *Harmonization of the improved planar coding mode and implicit QTBT,* Geneva, Switzerland, October 2019
6. m50930, *Parallel octree coding for point cloud compression,* Geneva, Switzerland, October 2019
7. m51012, *Predictive Geometry Coding*, Geneva, Switzerland, October 2019
8. w18712, *G-PCC CE13.22 Improvements to octree coding*