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Abstract

This document provides a description of the Exploration Experiment EE4FE 13.40 on improving RAHT in terms of low complexity.

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1. Introduction

Since the 129th MPEG meeting in Geneva, the interest in low-complexity/latency techniques has been intensified, especially for geometry coding [1]. Given the ongoing status of the G-PCC specification, there are two possible ways of achieving low-complexity/latency. The first one is to consider proposals of completely new tools, which would be used as alternatives to those that are available. The second one is to use the existing fundamental methods that were already assessed in the context of G-PCC. The main advantage of the second approach is that the existing methods have been exhaustively investigated and would not represent a concerning impact in the specification, which is in its final stages.

In relation to geometry coding, proposals that represent these two points of view have been presented [2, 3]. After a long period of evaluation, a new low-latency coding tool based on predictive geometry for automotive/mapping applications was adopted [2]. As for attribute coding, the discussion has not yet been made so explicit and given the current finalization status of G-PCC, proposals of completely new tools may not be desirable. However, one must also take attribute coding into consideration if the construction of an overall low-complexity/latency scheme is intended. In summary, to achieve low-complexity/latency attribute coding using the already existing methods is a more convenient approach.

In the document [4], proponents show evidences that using the original fixed-point RAHT implementation, in TMC13v6, offers the possibility of low-complexity attribute coding for cat3 sequences under C1 and C2 conditions in terms of average encoding and decoding time. The effect of the geometry encoding parameter adjustments proposed in [5] in combination with the proposed scheme is also evaluated. Experiments show that it is possible to enable a lower complexity codec setup in exchange of acceptable coding performance losses. More details about encoding and decoding times reductions and coding performance trade-off, the reader is encouraged to consult the document [4].

2. Mandates

The mandates for EE 13.40 are as follows:

1. Perform more detailed comparative experiments to better quantify the complexity and performance differences of RAHT implementations in TMC13v6 and TMC13v10 for automotive/mapping applications.
2. Investigate a potential RAHT-based low-latency attribute encoder for automotive/mapping applications.
3. Aggregate the group's efforts in the direction of understanding and improving the low-complexity/latency possibilities of both RAHT implementations.

3. Participants

As an EE, this activity is open to anyone who wishes to propose something or to be a cross-checker.

4. Proposals to be Evaluated

First, this EE suggests the following definitions of low-latency and low-complexity:

1. PCC Requirements [6]
   - Low latency: "Encode plus decode as low as one point cloud frame duration shall be supported. For some applications, an even lower latency should be supported."
   - Low complexity: "The complexity shall allow for feasible implementation of encoding and decoding within the constraints of the available technology at the expected time of usage."

2. EE13.8 on low-latency coding for automotive/mapping applications [2]
    - Low latency: "For the purposes of this evaluation, the concept of end-to-end latency is approximated. Given a list of input points, the end-to-end latency is the maximum distance that a point may be displaced in the list."

Although low-latency and low-complexity are different concepts, in [6] the idea of low-latency is not completely decoupled from low-complexity, because both are presented as functions of time. In other words, low-complexity helps to achieve low-latency. In [2], however, an attempt of a time-free definition of low-latency is present. It is described only in terms of distances between points in a list. But even in this case, there is an arbitrary value that must be set, which is the distance between points. In the end, this distance will be determined by the data acquisition system throughput, the encoding and decoding time capabilities of the codec implementation and a tolerable potential loss of performance. In this EE, tests considering encoding and decoding time will be performed as well as using a reduced set of points. By doing this, the intention is to take both definitions of low-latency into account. Regarding low-complexity, the RAHT implementation in TMC13v6 already offers a significant improvement over TMC13v9.1. With the release of TMC13v10, both implementations, TMC13v6 and TMC13v10, will be further studied and code optimization of TMC13v10 may also be presented.

At least three evaluation scenarios are enumerated:

1. Considering that a lower-complexity/latency attribute coding tool is desired, one may assume that there is nothing that prevents a different implementation of RAHT to be use instead of a completely new attribute coding tool (given that their behavior in terms of low-complexity/latency is equivalent).
    - In this case, the proposal is to adopt TMC13v6 implementation of RAHT as a low-complexity attribute coding tool, with the possibility to extend it to low-latency applications, depending on the outcome of the investigations carried out in the present EE.
2. Having two different implementations of the same transform is considered not to be appropriate.
    - Here the proposal is to at least use TMC13v6 implementation of RAHT as a benchmark for future low-complexity/latency proposals. It is important to say, however, that this scenario would lead to an awkward situation in case agree that any other proposal is acceptable. Having two different coders is not fundamentally better than having two implementations of the same coder, if their behavior is equivalent.
3. Optimizations of TMC13v10 RAHT implementation.

- Given that there is an encoding and decoding time gap between the implementations of RAHT in TMC13v6 and in TMC13v10, the proposal is to optimize the implementation of RAHT in TMC13v10.

The suggested products of this EE are:

1. Integration of TMC13v6 RAHT into the TMC13v10 framework.
2. Comparison between RAHT implementations in TMC13v6 and TMC13v10 regarding encoding and decoding time for automotive and mapping point clouds.
3. Extension of the inherent low-complexity capabilities of RAHT TMC13v6 to a potential low-latency model using the slicing tools present in TMC13v10.
4. Optimizations of RAHT implementaion in TMC13v10.

5. Timeline

- 2020-04-24 MPEG 130th meeting ends.
- 2020-05-08 Expected date for release of finalized CE description
- 2020-05-08 G-PCCv10 software
- 2020-05-15 Expected date for release of cross-verified G-PCCv10.0
- 2020-05-29 CE/EE Software and results are released to cross-checkers
- 2020-06-06 Preliminary feedback from cross-checkers to proponents
- 2020-07-01 MPEG document upload deadline

References

[1] "[G-PCC][New proposal] Predictive Geometry Coding," ISO/IEC JTC1/SC29 WG11 (MPEG) Input Document m51012, Geneva, CH, October 2019.
[2] "G-PCC EE13.8 report on low-latency coding for automotive/mapping applications," ISO/IEC JTC1/SC29 WG11 (MPEG) Input Document m53391, Online, April 2020.
[3] "[G-PCC] [EE13.8] Test Model and Exploratory Model behaviour on 3D maps and Lidar sequences in a low-latency framework," ISO/IEC JTC1/SC29 WG11 (MPEG) Input Document m52981, Online, April 2020.
[4] "[G-PCC] TMC13v6 Implementation as a Low-complexity Point Cloud Coder for Category 3," ISO/IEC JTC1/SC29 WG11 (MPEG) Input Document m53446, Online, April 2020.
[5] "[G-PCC] [Crosscheck] CE13.22 Predictive Geometry Coding," ISO/IEC JTC1/SC29 WG11 (MPEG) Input Document m52703, Brussels, BE, January 2020.
[6] "PCC Requirements," ISO/IEC JTC1/SC29 WG11 (MPEG) Input Document w17353, Gwangju, KR, January 2018.