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| **Source** | Samsung Electronics |
| **Status** | Input contribution |
| **Title** | [V-PCC] Report on CE 2.20 on improved point cloud compression through filtering of occupancy map |
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# Introduction

The V-PCC codec encodes geometry information (x, y, z coordinates) by projecting the 3D points of the input point cloud onto 2D planes, known as geometry images, and then, encodes the geometry images by using a video encoder such as HEVC. The occupancy map in V-PCC consists of a binary map that indicates whether a cell on the grid belongs to the empty space (i.e. no point projected onto it, the value is 0) or the point cloud (i.e. point projected onto it, the value is 1).

In order to reduce the bitrates used for coding occupancy map, the occupancy map is padded for each N×N block, where N is the occupancy map precision. This means that all the pixels in an N×N block will be set as occupied if at least one of them is occupied. The encoder codes a single occupancy map value for each N×N block. On the decoder side, if occupancy map value of 1 is received, the each pixel in the corresponding N×N block is marked as occupied. This results in an increase in the number of projected points represented in the occupancy map when the N is greater than 1. Due to this, the compressed sizes of the geometry 2D image and the texture 2D image increase. We proposed up-sampling and 2D filtering of the occupancy map [1] in order to remove added points in the occupancy map.

This method [1] sometimes generated artifacts due to removing original points in occupancy map. To overcome this drawback, we propose the combination of this method and constrained occupancy map trimming [2].

# Proposal of up-sampling and 2D filtering of occupancy map

The concept of the up-sampling and 2D filtering of occupancy map shows in Fig 1.



Figure 1 – Two times Oversampling and 2D filtering on occupancy map.

This method of up-sampling and 2D filtering is repeated until an occupancy map with occupancy precision of 1 is obtained.

# Objective results

The objective results for C2 lossyG, lossyA, all-intra conditions and for C2 lossyG, lossyA, interRA conditions are shown in Table 1 and Table 2, respectively. The experimental results show that 2.3%, 6.7% improvement in the geometry in terms of BDBR can be achieved, respectively

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| Table 1: C2 lossyG, lossyA, intra (test results compared against the anchor) |
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| Table 2: C2 lossyG, lossyA, inter-RA (test results compared against the anchor) |
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# Visual results

Table 3 shows a sample of the visual results.

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| --- | --- | --- |
| Table 3: Sample of visual tests | | |
| Sequence, Condition | Anchor (TMC2 6.0) | m46370 + m47593 |
| Queen  0054, rp3,  all intra |  |  |
| Queen  0055, rp3,  all intra a |  |  |
| Queen  0094, rp3,  all intra |  |  |
| Redandblack  1487, rp3,  all intra |  |  |
| Redandblack  1541, rp3,  all intra |  |  |

These results show that the overall quality is similar.

# Complexity considerations

## Run times

The run times observed are reported in the spreadsheet included with this contribution. The run time of the decoder is increased by about 2.3%, but the complexity of encoder slightly decreased.

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| --- | --- | --- | --- | --- |
| AI mode | **Encoder runtime [s]** | | **Decoder runtime [s]** | |
| **Self** | **Child** | **Self** | **Child** |
| Avg. time [%] | 95.2% | 100.0% | 102.3% | 100.0% |
| RA mode | **Encoder runtime [s]** | | **Decoder runtime [s]** | |
| **Self** | **Child** | **Self** | **Child** |
| Avg. time [%] | 98.1% | 99.5% | 102.2% | 97.7% |

# Conclusion

From the results of this core experiments, Samsung recommends the following adoptions in V-PCC:

* Adding “Improved point cloud compression through filtering of occupancy map” [1] in lossy mode
* Adding “Constrained occupancy map trimming using a ternary occupancy map“ [2] in lossy mode

# References

[1] [V-PCC] Improved point cloud compression through filtering of occupancy map, m46370, January 2019, Marrakesh, Morocco.

[2] [V-PCC][New Proposal] Constrained occupancy map trimming using a ternary occupancy map, m47593, Geneva, Switzerland.