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| *Title:* | **3D-CE3 related: Motion data buffer reduction for 3D-HEVC** | | |
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# Abstract

In the HEVC-based 3D video coding, HTM-7.0, it requires larger buffers and causes a bandwidth issue to store and access the motion data at full resolution when coding the pictures within an access unit (AU). In this contribution, two different schemes are proposed to store the motion data of each picture at lower resolution during the coding of the pictures within an AU. The first scheme is to compress the motion data into 1/4 resolution after encoding/decoding of each picture and then compress the motion data again into 1/16 resolution after encoding/decoding of all the pictures within the same AU. The second scheme is to directly compress the motion data into 1/16 resolution right after encoding/decoding of each picture. With the proposed two schemes, the motion data buffer and the memory access bandwidth for writing and reading motion data can both be reduced. The experimental results reportedly show that 0.0% and 0.4% BD-rate increases for overall results are observed for the first and second schemes, respectively.

The second scheme has been already integrated into SHM-2.0, and the first scheme is being investigated under CE in SHVC. It is recommended that unified scheme be adopted both with SHVC and 3DV.

# Introduction

In the HEVC-based 3D video coding, HTM-7.0 [1], motion information is used for motion vector prediction. Therefore, the motion data of each coded picture needs to be stored in a motion data buffer. To reduce the size of the motion data buffer, the motion compression process is applied to store the decoded motion data of each picture at a lower resolution. It uses decimation to store motion vectors on a larger granularity instead of 4x4.

Fig. 1 shows the decimation of motion data in HTM-7.0, motion data of each picture is stored at full resolution during the coding of the pictures within the access unit (AU). After all the pictures within the same AU are coded, the motion data compression is conducted for each 16x16 block, and all the 4x4 blocks within each 16x16 unit share the motion vectors, reference picture indices and prediction mode of the representative block. Currently, the top left 4x4 block is used as the representative block for the entire 16x16 block.



**Fig. 1. The motion data buffer reduction in HTM-7.0**

# Proposed methods

In this contribution, as shown in Fig. 2 and Fig. 3, we propose two schemes to store the motion data of each picture at lower resolution during the coding of the pictures within the AU. The details of the proposed two schemes are elaborated as follows.

## Progressive motion compression

In this scheme, for each 8x8 unit, the motion parameters of the top-left 4x4 block are used as the representative motion parameters. Therefore, the motion data are stored in a motion data buffer of quarter size after each picture is coded. After all pictures within the same AU are coded, the same procedure is then performed to the motion parameters that are already compressed. After the second motion data buffer reduction, motion data are stored in a motion data buffer of 1/16 size, which leads to the same decimation results as the current HTM. As can be seen in Fig. 2, since the storage is reduced, the bandwidth for writing and reading motion data can also be reduced by the proposed scheme.



**Fig. 2. Progressive motion compression for motion data buffer reduction**

## Immediate motion compression

In this scheme, as shown in Fig. 3, for each 16x16 unit, the motion parameters of the top-left 4x4 block are used as the representative motion parameters. Therefore, the motion data could be stored in a motion data buffer of 1/16 size after each picture is coded. Compared to the scheme of progressive motion compression, this scheme could further reduce the storage required to store the motion data during the coding within the AU, and thus the bandwidth for writing and reading motion data can also be further reduced.



**Fig. 3. Immediate motion compression for motion data buffer reduction**

# Experimental results

The proposed MV decimation methods are conducted based on HTM-7.0r1 [1] under the common test conditions [2]. The results are shown in Table 1 and Table 2, respectively. The experiments results show that the proposed progressive motion compression scheme for motion data buffer reduction brings almost no overall BD-rate change, while the internal motion data buffer during the coding of the pictures within the AU can be reduced to 1/4.

The performance loss caused by the proposed immediate motion compression scheme for motion data buffer reduction is about 0.4% BD-rate increase for coded and synthesized results, while the internal motion data buffer during the coding of the pictures within the AU can be reduced to 1/16.

**Table 1. Experimental results of the progressive motion compression scheme**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Video 1 | Video 2 | video/Video bitrate | video/total bitrate | synth / total bitrate | Enc time | Dec time | Ren time |
| Balloons | 0.1% | 0.1% | 0.0% | 0.0% | 0.0% | 99.9% | 110.1% | 101.9% |
| Kendo | 0.1% | 0.1% | 0.0% | 0.0% | 0.1% | 99.9% | 97.9% | 99.2% |
| Newspapercc | 0.1% | 0.0% | 0.0% | 0.0% | -0.1% | 99.5% | 96.5% | 99.2% |
| GhostTownFly | 0.3% | 0.1% | 0.0% | 0.0% | 0.0% | 99.8% | 100.6% | 98.7% |
| PoznanHall2 | -0.1% | -0.1% | 0.0% | 0.0% | 0.0% | 99.1% | 109.4% | 98.3% |
| PoznanStreet | 0.1% | 0.1% | 0.0% | 0.0% | 0.0% | 99.8% | 99.2% | 98.6% |
| UndoDancer | 0.0% | 0.1% | 0.0% | 0.0% | 0.1% | 99.5% | 104.8% | 100.6% |
| 1024x768 | 0.1% | 0.1% | 0.0% | 0.0% | 0.0% | 99.8% | 101.5% | 100.1% |
| 1920x1088 | 0.1% | 0.1% | 0.0% | 0.0% | 0.0% | 99.6% | 103.5% | 99.0% |
| **average** | **0.1%** | **0.1%** | **0.0%** | **0.0%** | **0.0%** | **99.7%** | **102.6%** | **99.5%** |

**Table 2. Experimental results of the immediate motion compression scheme**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Video 1 | Video 2 | video/Video bitrate | video/total bitrate | synth / total bitrate | Enc time | Dec time | Ren time |
| Balloons | 1.2% | 1.3% | 0.5% | 0.5% | 0.4% | 98.2% | 101.0% | 100.2% |
| Kendo | 0.9% | 0.9% | 0.4% | 0.4% | 0.4% | 97.5% | 99.0% | 98.8% |
| Newspapercc | 0.8% | 0.7% | 0.3% | 0.3% | 0.7% | 97.2% | 101.4% | 97.3% |
| GhostTownFly | 0.8% | 0.5% | 0.2% | 0.2% | 0.3% | 99.0% | 99.2% | 98.9% |
| PoznanHall2 | 0.2% | 0.2% | 0.1% | 0.1% | 0.3% | 98.8% | 98.9% | 98.9% |
| PoznanStreet | 0.4% | 0.7% | 0.2% | 0.2% | 0.2% | 97.3% | 99.1% | 97.3% |
| UndoDancer | 0.8% | 0.9% | 0.3% | 0.3% | 0.4% | 98.6% | 99.7% | 101.6% |
| 1024x768 | 1.0% | 1.0% | 0.4% | 0.4% | 0.5% | 97.7% | 100.5% | 98.8% |
| 1920x1088 | 0.5% | 0.6% | 0.2% | 0.2% | 0.3% | 98.4% | 99.2% | 99.2% |
| **average** | **0.7%** | **0.8%** | **0.3%** | **0.3%** | **0.4%** | **98.1%** | **99.8%** | **99.0%** |

# Conclusion

This contribution proposed two motion data decimation schemes, which stores the motion data in a larger granularity instead of 4x4 blocks during the coding of the pictures within the access unit (AU). In the progressive compression scheme, the internal motion data buffer during the coding of the pictures within the AU can be reduced to1/4 with no coding efficiency loss. As for the immediate compression scheme, the internal motion data buffer during the coding of the pictures within the AU can be reduced to1/16 with 0.4% BD-rate increase.

The second scheme has been already integrated into SHM-2.0, and the first scheme is being investigated under CE in SHVC. It is recommended that unified scheme be adopted both with SHVC and 3DV.

# Patent rights declaration(s)

**MediaTek Inc. may have current or pending patent rights relating to the technology described in this contribution and, conditioned on reciprocity, is prepared to grant licenses under reasonable and non-discriminatory terms as necessary for implementation of the resulting ITU-T Recommendation | ISO/IEC International Standard (per box 2 of the ITU-T/ITU-R/ISO/IEC patent statement and licensing declaration form).**

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# References

1. HTM-7.0r1, <https://hevc.hhi.fraunhofer.de/svn/svn_3DVCSoftware/tags/HTM-7.0r1/>
2. D. Rusanovskyy, K. Müller, A. Vetro, “Common test conditions of 3DV Core Experiments,” Document of Joint Collaborative Team on 3D Video Coding Extension Development, JCT3V-D1100, April, 2013.
3. K. Sato, C. Gisquet, “HEVC Scalable Extensions Core Experiment 2 (SCE2): Combination of inter-layer syntax prediction and motion data compression”, JCTVC-M1102, April, 2013