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| *Title:* | **3D-CE4: Summary Report on Residual Prediction** | | |
| *Status:* | Input Document | | |
| *Purpose:* | Core Experiment Report | | |
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# Abstract

This document summarizes the activities of the Core Experiment CE4 on Residual Prediction. During the 2nd JCT-3V meeting, contributions have been proposed to solve the parsing issue and further improve the coding efficiency of residual prediction in 3D-HEVC. Two of them were considered for further study in a Core Experiment (JCT3V-B0051 and JCT3V-B0093). The goal of this CE is to evaluate them in the context of the 3D-HTM 5.0.1 under the common test conditions. In addition, one more mandate of this CE is to investigate the loss of coding efficiency when inter-view residual prediction (IVRP) flag is always transmitted for each coding unit, without other changes of the current design.

All of the experiments are related to 3D-HTM only. 8 companies were involved in the CE with 2 CE proposals and 2 CE-related proposals.

# Participants

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(P = proponent, C = cross checker)

# Tools under investigation

## Coding loss of removal of the parsing issues in IVRP

In current IVRP design, the IVRP flag of each coding unit (CU) is signaled only when both of the following conditions are satisfied:

* At least one of the prediction units (PUs) within the corresponding block is inter-coded and the values of cbf\_luma, cbf\_cb or cbf\_cr are unequal to 0. (dependency on the reference view)
* At least one of the PUs within current CU is predicted from a temporal reference picture in at least one picture reference list. (dependency on the decoded reference picture types)

The coding loss compared to HTM5.0.1 anchor is listed as follows:

**Table 1. Summary of simulation results compared to HTM anchor**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | With only the first condition removed | | | | | With both conditions removed | | | | |
|  | Video 1 | Video 2 | Video only | Synthesized only | Coded & synthesized | Video 1 | Video 2 | Video only | Synthesized only | Coded & synthesized |
| Balloons | 2.2% | 2.4% | 0.9% | 0.8% | 0.8% | 2.1% | 2.1% | 0.8% | 0.7% | 0.7% |
| Kendo | 2.0% | 2.2% | 0.8% | 0.8% | 0.8% | 1.6% | 1.9% | 0.7% | 0.6% | 0.6% |
| Newspapercc | 1.5% | 1.4% | 0.6% | 0.5% | 0.5% | 1.2% | 1.1% | 0.5% | 0.4% | 0.4% |
| GhostTownFly | 0.5% | 0.4% | 0.1% | 0.1% | 0.1% | 0.4% | 0.3% | 0.1% | 0.0% | 0.0% |
| PoznanHall2 | 1.3% | 1.3% | 0.6% | 0.4% | 0.4% | 1.1% | 1.0% | 0.4% | 0.3% | 0.3% |
| PoznanStreet | 0.6% | 0.9% | 0.3% | 0.2% | 0.2% | 0.4% | 0.8% | 0.2% | 0.1% | 0.1% |
| UndoDancer | 0.9% | 1.0% | 0.3% | 0.2% | 0.2% | 0.8% | 0.8% | 0.2% | 0.2% | 0.2% |
| 1024x768 | 1.9% | 2.0% | 0.8% | 0.7% | 0.7% | 1.6% | 1.7% | 0.7% | 0.6% | 0.6% |
| 1920x1088 | 0.9% | 0.9% | 0.3% | 0.2% | 0.2% | 0.7% | 0.7% | 0.2% | 0.2% | 0.2% |
| **average** | **1.3%** | **1.4%** | **0.5%** | **0.4%** | **0.4%** | **1.1%** | **1.1%** | **0.4%** | **0.3%** | **0.3%** |

It is also noted that the parsing issue caused by the dependency on decoded reference picture types also exists in current illumination compensation design of 3D-HEVC.

## Advanced residual prediction for multiview coding [[JCT3V-C0049](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=487)]

This proposal is a follow-up of JCT3V-B0051. Inter-view residual prediction is enabled in the current HTM design to code the residue of dependent texture views more efficiently. In this proposal, an advanced residual prediction (ARP) is proposed to further improve the coding efficiency of inter-view residual prediction. In ARP, to ensure high correlation between residues of two views, motion of the current block of picture in current view is applied to the corresponding block in a reference view picture to generate residual in the base view to be used for inter-view residual prediction. Moreover, an adaptive weighting factor is applied to the residue signal so that the prediction error is further reduced. Meanwhile, the parsing issue of current inter-view residual prediction is solved. In this method, inter-view residual prediction is always explicitly signalled, thus there is no parsing dependency to the base view. The proposed ARP is applied to CUs with partition modes equal to 2Nx2N and bi-linear interpolation is applied to generate the residual predictor.

This proposal was crosschecked by LG and detail information can be referred to [JCT3V-C0110](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=549).

## Results on removal of the parsing dependency of inter-view residual prediction [[JCT3V-C0138](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=579)]

This proposal is a follow-up of JCT3V-B0093. In this contribution, parsing dependency to the base view is also removed in a way that the inter-view residual prediction flag is never signaled and whether inter-view residual prediction is used or not is derived after parsing. Two methods are proposed to improve the inter-view residual prediction in HTM.

* Method #1: a method to derive at the decoding process whether the current block utilizes inter-view residual prediction. When current block utilizes a temporal motion vector candidate derived from a reference view, inter-view residual prediction is applied. Otherwise, inter-view residual prediction is disabled.
* Method #2: bi-linear interpolation in inter-view residual prediction is further removed and replaced by rounding the disparity vector to a nearest integer pixel.

This proposal was crosschecked by Sharp and detail information can be referred to [JCT3V-C0196](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=645).

# Experiments and results

**Table 2. Summary of simulation results for CE proposals**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Test cases | Algorithm summary |  |  | | Simulation Results | | | | | |
| Video  1 | | Video  2 | | Video  only | Synthesized only | Coded & synthesized | Enc  time | Dec  time |
| JCT3V-C0049 |  | -2.7% | | -2.4% | | -0.9% | -0.6% | -0.7% | 99% | 92% |
| JCT3V-C0138 | Method #1 | -0.1% | | -0.2% | | 0.0% | 0.0% | 0.0% | 94% | 100% |
| Method #2 | 0.2% | | 0.2% | | 0.1% | 0.0% | 0.0% | 99% | 99% |
| Method #1 and #2 | 0.0% | | 0.0% | | 0.0% | 0.0% | 0.0% | 94% | 100% |

# Related proposals

## Results on simplification of residual prediction ([JCT3V-C0098](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=537))

This proposal introduces simplification of inter-view residual prediction. Two methods are proposed:

* Method #1: The residual prediction is disabled when both temporal and inter-view predictions are utilized for one prediction unit in B slices. In the original inter-view residual prediction, the residual prediction may be applied for the above case where the residual predictor is multiplied by ½ (i.e., shifted by 1). It is reported that there is no coding loss.
* Method #2: bi-linear interpolation for residual predictor generation is removed, which is the same as the second method in JCT3V-C0138.

This proposal was crosschecked by NTT and detail information can be referred to [JCT3V-C0185](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=634).

## Mode dependent advanced inter-view residual prediction ([JCT3V-C0139](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=580))

This contribution proposes a method to take advantage of both concept in JCT3V-B0093 and JCT3V-B0051 to enable the Inter-View Residual Prediction (IVRP) only when the temporal inter-view merging candidate in merge or skip mode is selected with 2Nx2N partition and the advanced residual generation is used. With such proposed method, it is reported there is 0.4% coding gain for coded and synthesized views. Furthermore, it is also proposed that not only the motion information, but also the IVRP information (IVRP flag and DV) is merged, if a spatial merging candidate is selected for a 2Nx2N PU. Combined the two aspects together, it is reported that 0.5% bit rate reduction could be achieved for coded and synthesized views.

This proposal are due to be crosschecked by Sharp in [JCT3V-C0214](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=663), but it hasn’t been uploaded yet.