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Status	**Report**
Title	**3D-CE2h results on Nonlinear Depth Representation**
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1   Introduction

This documents presents Core Experiment results attained by Poznan University of Technology. The goal of this Core Experiment (CE) was to further investigate and develop depth representation tools applied HEVC-compatible 3D video coding (3D-HTM). This core experiment CE was defined in [N12561, Section 2a].

2   Experiment conditions

Software

The 3D-HTM-Test Model under Consideration 0.4 was used in the experiments.

3   Non-linear Depth Representation tools [M22697] description

M22697 describes a normative tool named non-linear depth representation. The depth is internally represented in such a way that the closer objects are represented more accurately than distant ones.

In the original proposal, internal depth sample values were defined by the following power-law expressions, similar as in the case of well known gamma correction:

$$depth\ value\ internal = \left(\frac{depth\ value\ external}{maximum\ value\ external}\right)^{exponent} \cdot maximum\ value\ internal$$

Where "maximum value" field represents range of used disparity values.

Such approach unfortunately cannot be seamlessly implemented with integer-only operations. The exact shape of curves for non-linear representation is defined by means of line-segment-approximation. The first (0,0) and the last (255,255) nodes are predefined. Additional nodes can be transmitted in SPS in form of deviations from straight-line curve (linear representation).

Nodes are defined in configuration file with "NonlinearDepthModel" parameter.
Additionally, this allows experimentation with other non-linear curves that the above-mentioned exp-based curve.

In most of places, linear-to-non-linear conversion is done through LUT tables, and in some cases (view synthesis etc) non-linearity has been incorporated into existing LUT tables.
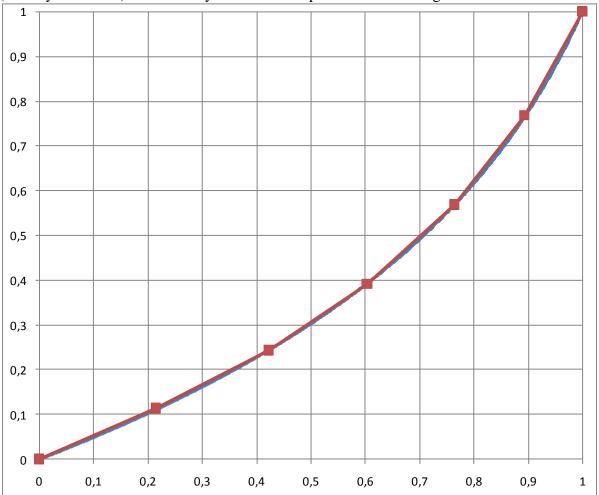

Fig 1. An exemplary approximation of non-linear curve with 5 values being sent in SPS.

As previous experiments has shown, Non-linear Depth Representation gives subjective gains but sometimes imposes objective losses.
We have performed some experiments that shown, that the objective losses can be reduced if this tool is turned off in some sequences. Specifically, this tools is turned off, if weighted average of depth map of the center view (the center of the scene) is in low disparity ranges. Experimentally, we have found, that selection can be automatically done with use of the following value:

$$center\_disparity = \frac{\sum_{i=0..255} disparity\_histogram(i) \cdot i}{\sum_{i=0..255} disparity\_histogram(i)}$$

where $disparity\_histogram(i)$ is a histogram of the first frame of depth map in center view.

If *center_disparity* is lesser that some threshold (in this CE set to 100), then Non-linear Depth Representation tool is turned off.
The rationale behind such approach is that low disparity values are highly distorted.

4   Tool configuration

The tools was tested in two configurations:
  a) 7-node approximation
NonlinearDepth=1
NonlinearDepthModel="10;19;24;27;26;22;13"'
NonlinearDepthThreshold=100

  b) 7-node approximation, which was introduced as an update during the last CE experimentation phase

NonlinearDepth=1
NonlinearDepthModel="2;4;7;8;10;12;14;16;17;19;20;21;22;23;24;25;26;26;27;27;27;27;27;27;26;
26;25;24;23;22;20;19;17;15;13;11;9;6;3"'
NonlinearDepthThreshold=100

5   Results

Unfortunately the results are not yet available due to system crash. The test has been rerun and will finish in the first days of the meeting.

6   Subjective evaluation
Due to time shortage, subjective evaluation in HEVC category has been abandoned.

7   Test Platform
The simulations results was generated on a ~80 core cluster system. This cluster platform's processing units have the following specifications:
- •   Processor: Intel Xeon X5675
- •   Clock Speed: 3.06 GHz
- •   Memory: approx. 4 GB per Core
- •   OS: 64-bit Windows Server 2008
- •   Compiler: Microsoft Visual Studio 2008 (64 bit)

8   Conclusions and recommendations

- Already implemented in 3D-HTM tag0.5 (also 0.3-Poznan branch), which are based on tag0.4.
- The results are not yet available due to system crash.
- To wait until middle of the week for results.
- Decide upon comparison of results and cross-check.
- Continue experimentation with subjective viewing if results in AVC are promising.