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Title:	**3D-HEVC with reduced resolution of depth**
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Abstract

This contribution presents a proposal of enhancement of 3D-HTM test model software allowing encoding with reduced resolution of depth. Experimental results are provided and show gains of about 7% related to current CTC.

1 Introduction

The current 3D-HEVC Test Model [1] allows coding of texture and depth data only at the same spatial resolution.

As investigated in [2, 3] downsampling of the depth maps has negligible impact on virtual view quality. At the same time 3D-AVC Test Model [4] successfully exploits possibility of subsampling depth data by the factor of 2, which substantially increase compression efficiency. The same concept can be applied to 3D-HTM

This paper presents simulation results of reduced depth map coding in 3D-HTM. Presented results downsamples the depth by the factor of 2 but other factor can be applied (up to 8) The reduced resolution depth maps are the same as in case of 3D-ATM CTC [5]. The depth is **not** upsampled inside the loop. It is **only** upsampled before the rendering.

2 Affected tools

In order to allow coding with reduced resolution of depth in 3D-HTM several modifications to the software must be done. Most of them are pretty straight forward and concern accommodating different resolutions of the pictures in the depth sub-codec.

In particular, the following coding tools are affected:

- Depth model modes dependent on texture (DMM)
- Motion parameter inherence from texture picture for depth map coding (MPI)
- Inter-view residual prediction
- Depth map generator tool
- View Synthesis Optimization (VSO)

Some of more interesting details of those modifications are described below.

2.1 Depth model modes dependent on texture (DMM)

The basic principle of depth model mode dependent on texture (Wedgelet and Contour partitioning) is to predict shape of the depth partitioning based on already coded texture from co-located block.

Texture co-located block should represent the same region on the texture image and processed depth block. In case of different resolution of depth and texture component co-located block has different size and pixel coordinates.

In proposed coding with reduced resolution of depth, co-located texture block is down-sampled on-the-fly in order to align with resolution of the depth block (Fig. 1). To maintain low complexity simple average filter is used.

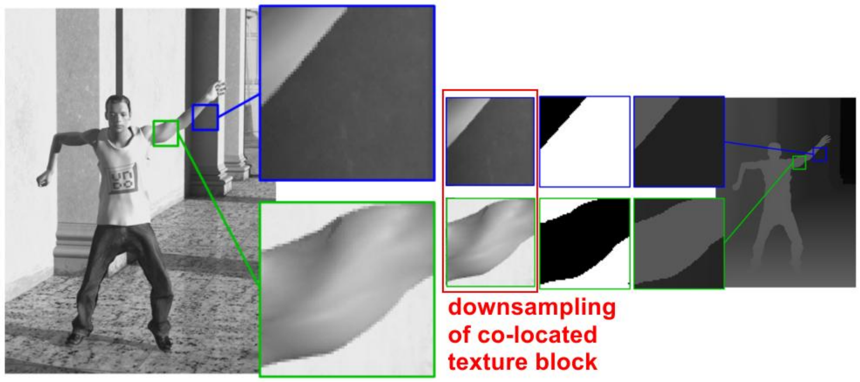

Fig. 1. Prediction of Wedgelet (blue) and Contour (green) partition information from texture co-located block.

2.2 Motion parameter inheritance from texture picture for depth map coding (MPI)

The basic idea of the motion parameter inherence is to reuse motion field of texture component in depth map coding at the same spatial position and temporal instant.

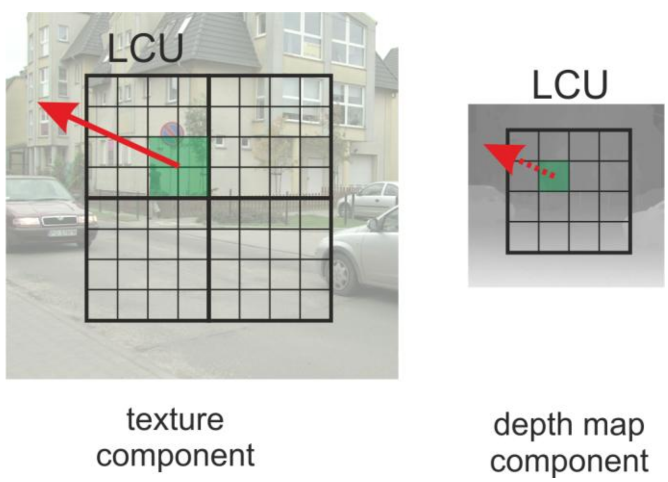

Fig. 2. Correspondent area of the texture and depth component.

The Largest Coding Unit (LCU) of the texture component represent less image area that LCU of the depth component. For example, LCU of depth data subsampled by the factor of 2, represents 4 LCU units from correspondent texture component (Fig. 2). Thus, in the proposal, the procedure of motion information inherence is adjusted accordingly. Also motion vectors are scaled by the sub-sampling factor.

2.3 View synthesis optimization (VSO)

Adjustment of VSO tool to allow synthesis with depth maps at lower resolution than the texture is a straight forward implementation issue. This has been solved by implicit separation of variables related to depth and texture.

3 Simulation results

The proposal has been implemented on top of the current 3D-HTM - version 3.0. The experiments has been performed according to the current Common Test Conditions [5] without VSO.

For the simulation, decimated depth data (2 times), same as for 3D-ATM, has been used. Before rendering of the virtual view depth data has been upsampled with the nearest neighbor algorithm (Fig. 3).

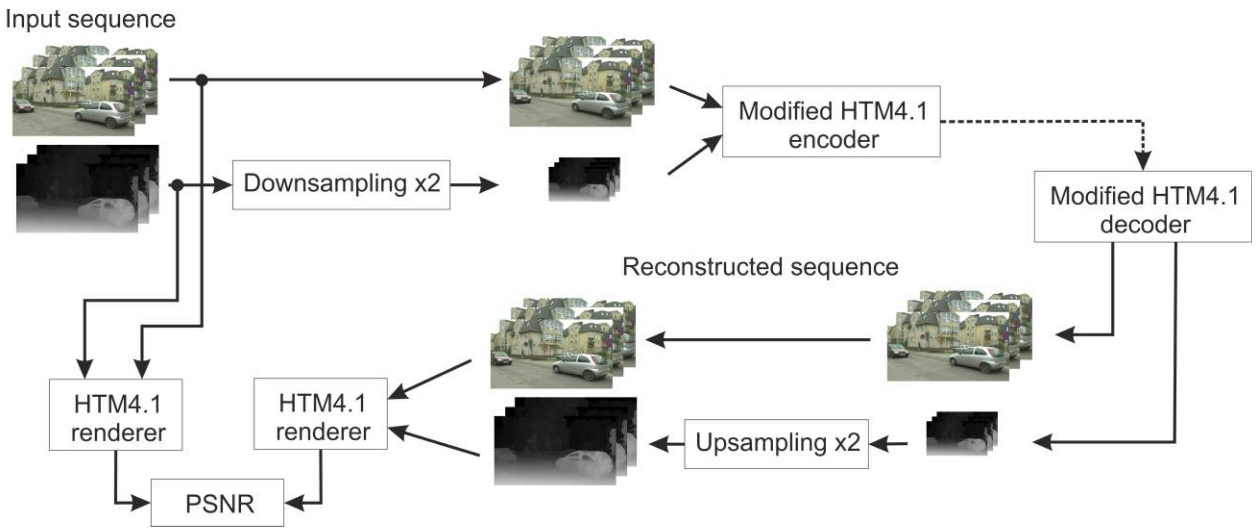

Fig. 3. Evaluation tool chain

The simulations results were generated on a ~80 core cluster system. The 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)

Overview of the results is shown in Table 1. All simulation results are attached to this document in excel sheet.

Table 2 Overview of simulation results for 3-view case

	Texture Coding		Synthesized Views	
	BD-rate (piecewise cubic)	BD-rate (cubic)	BD-rate (piecewise cubic)	BD-rate (cubic)
S01	0,00%	0,00%	-1,90%	-2,15%
S02	-0,02%	-0,02%	-16,68%	-16,70%
S03	0,00%	0,00%	8,84%	8,69%
S04	-0,01%	-0,01%	-7,95%	-8,00%
S05	0,00%	0,00%	-8,43%	-8,52%
S06	0,02%	0,02%	-11,15%	-11,23%
S08	-0,01%	-0,01%	-15,01%	-15,12%
Average	0,00%	0,00%	-6,87%	-6,58%

4 Conclusion

The experiments show that coding of reduced resolution depth maps in 3D-HTM provides a gain of about 7%. Also, the complexity of both the encoder and the decoder are vastly reduced (depth is coded at half-resolution). Moreover, because depth is represented at half-resolution, the data volume requirement (3.1.3 from [6]) is satisfied.

The proposed modifications of 3D-HTM software are fixes to software issues, that disallowed coding with reduced resolution of depth. The changes do not affect coding with full resolution of depth maps.

We recommend to adopt the proposed modifications into 3D-HTM software, and open Core Experiment on reduced resolution depth map coding.

5 Patent rights declaration

Poznań University of Technology 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).

References

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