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1 Introduction

During 115th MPEG Meeting in Geneva, Ad-Hoc Group on FTV (Free-viewpoint TeleVision) has analyzed further the responses to "Call for Evidence on Free-Viewpoint Television: Super-Multiview and Free Navigation" [1] and summarized the results obtained [2]. The current mandates of this AfG are to develop and improve the 3D framework available within the MPEG in order to possibly allow the issue of "Call for Proposals" in future. During the evaluation of the responses to the CfE, it was noticed that some of the compression tools are common in the technologies proposed by different proponents. Therefore it seems beneficial for future work to have a common software as a starting point for the next work items. This software should be built on top of the 3D-HEVC software (HTM 13.0) and would include those common tools.

With this in mind, we provide an experimental software package for 3D video coding for usage within MPEG activities. The software is based on HTM 13.0 [7] and adds the coding tools that have been proposed both by Poznań University of Technology and Zhejiang University in their responses to the CfE [2][3][4][5][6]. Next, this software may be used by any party within MPEG to include other tools into an experimental model of the 3D video coding technology for Free Navigation applications.

2 Selection of the tools

The tools from the proposals provided by Poznań University of Technology and Zhejiang University are listed in Table 1. Among them some tools have been identified as common in the both responses in the Free Navigation category. The set of such tools has been selected to be included in the proposed common software. Moreover, the software comprises also the tool for encoding of the camera parameters that is needed for future work on video coding for the Free Navigation applications.

Table 1. Comparison of the tools submitted in the responses to the CfE in FN category. The tools that are common are marked in dark gray. Additionally selected tool (camera parameter coding) is marked in light gray.

Tools	Poznan University	Zhejiang University
Color correction: preprocessing.	Y	-
Camera parameter transmission extension: extrinsic and intrinsic parameters, like rotation matrices, translation and distortion parameters.	Y	-
Disparity-Compensated Prediction: depth-based compensation, 2D disparity.	Y	Y
Neighboring Block Disparity 2D-Vector	Y	Y
Modification of Depth-oriented NBDV (DoNBDV): disparity is half of the maximum depth sample value and the position of selected corner of the block.	Y	-
2D disparity based View Synthesis Prediction (VSP).	Y	Y
Adjustment of DV borrowed from neighboring block: according to position of blocks.	-	Y
Adjustment of depth from neighboring block: according to position of blocks.	-	Y
Projection of motion vector as Inter-view MV predictor	Y	Y
Depth RDO for non-linear camera arrangement View Synthesis Optimization for non-linear camera arrangement	-	Y
Proprietary view synthesis software: e.g. based on multiple views, higher precision, hole filling, color correction	Y	-

Note: The response from Hasselt University was provided for only one sequence and thus it is omitted.

3 Description of the technology

As mentioned, the software comprises the coding tools proposed both in the responses to the CfE provided by Poznań University of Technology [3][4] and Zhejiang University [5][6]. The software implements an extension of the 3D-HEVC technology. The implementation is based on HTM 13.0 [7]. However, the software it is not compatible with 3D-HEVC standard, e.g. proposed bitstreams cannot be decoded with the use of a 3D-HEVC decoder. The bitstream syntax modifications (with respect to HM 13.0) are mostly at the high-level syntax, but there are also some minor adjustments at the low level.

The most important improvement is related to the supported arrangements of the cameras. In HTM software, a number of specific tools was introduced in their simplified versions with the explicit assumption that the cameras are located on a line and that they all have parallel optical axes. Such a simplification implies that the views are linearly aligned. Therefore, disparity vectors are restricted only to the horizontal direction, and they can be very simply derived from depth data. This simplifies various processes in both encoders and decoders, e.g. view synthesis/depth-based prediction.

Therefore, the technology allows coding of materials acquired with the use of non-linear camera arrangements (e.g. with cameras located on an arc). For that, the codec is extended for a generic scenario, thus removing the restriction of the horizontal disparity only. The general derivation of disparity vectors is applied that exploits fully the depth data. For that, several syntax elements and tools were modified with respect to the HTM:

- Transmission of the camera parameters in VPS. Full camera parameters are transmitted, including the extrinsic and intrinsic parameters, like the rotation matrices, the translation and distortion parameters.
- Modification of Disparity-Compensated Prediction (DCP). Instead of the disparity (along the horizontal direction only) we use the depth-based compensation.
- Modification of Neighboring Block Disparity Vector (NBDV). Instead of the disparity restricted to the horizontal direction, we use a vector with possibly two non-zero components.
- Modification of View Synthesis Prediction (VSP). In 3D-HEVC, the view synthesis in prediction is restricted to the horizontal translation only. Therefore, full DIBR scheme is performed in the software proposed.
- Modification of Inter-view Motion Prediction (IvMP). In 3D-HEVC, the motion vectors are purely two-dimensional. Because the other views lay on the same plane, the motion vectors remain the same after the projection to another view. In the proposed software, during the prediction, we accordingly rotate a motion vector in the 3D space.

4 Availability of the software

The proposed software is available at **svn://multimedia.edu.pl/FNS**. User credential will be provided upon request.

5 Licensing

The software is provided to MPEG and the scientific community in general for the research and standardization purposes only. Of course, some words of acknowledgement are **appreciated** if the software is to be used in research and are **required** if the software is to be used in publications. In particular, reference to this document or other relevant future documents must be listed in all documents that report any usage of the materials.

Any **commercial use is prohibited** unless an explicit permission is given by Poznań University of Technology, Chair of Multimedia Telecommunications and Microelectronics, Poland.

In the case of adopting this software as a reference software, Poznan University of Technology is willing to provide more open license.

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References

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[7] 3D HEVC reference codec online https://hevc.hhi.fraunhofer.de/svn/svn_3DVCSoftware/tags/HTM-13.0