INTERNATIONAL ORGANISATION FOR STANDARDISATION
ORGANISATION INTERNATIONALE DE NORMALISATION
ISO/IEC JTC1/SC29/WG11
CODING OF MOVING PICTURES AND AUDIO

ISO/IEC JTC1/SC29/WG11
MPEG/M23788
February 2012, San Jose, USA

Title	**3D-AVC-CE3 results on Nonlinear Depth Representation & Coding**
Sub group	**Video**
Authors	**Olgierd Stankiewicz** (ostank@multimedia.edu.pl), Krzysztof Wegner, Maciej Kurc Poznań University of Technology, Chair of Multimedia Telecommunications and Microelectronics, Poznań, Poland

1 Introduction

This documents presents results attained by Poznan University of Technology in experiments on Non-linear depth representation [1] as a part of core experiment CE defined in [2].

2 Description of the tool

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. Internal depth sample values are defined by the following power-law expressions, similar as in the case of well known gamma correction:

$$depth\ value\ internal = \left(\frac{depth\ value\ external}{maximum\ value\ external}\right)^{exponent} \cdot maximum\ value\ internal \quad (1)$$

Exponent is automatically chosen by the encoder with use of base QP for the depth and sent to decoder in the encoded bitstream (one parameter is added to i.e. SPS):

$$\text{exponent} = \text{clip}\left(\left(\text{QP}_{\text{depth}} - 30\right) \cdot 0.0125 + 1.25\ ;\ 1.0\ ;\ 1.66\right) \quad (2)$$

Depth map samples are represented on increased number of bits with use of IBDI (Internal Bit Depth Increase) tool. Finally, in the decoder the original depth is reconstructed with inverse expression:

$$depth\ value\ external = \left(\frac{depth\ value\ internal}{maximum\ value\ internal}\right)^{1/exponent} \cdot maximum\ value\ external \quad (3)$$

This tool is designed to improve subjective quality of the synthesized views and thus assessment by PSNR is not adequate and should be done subjectively instead.

The parameter *exponent* is transmitted to the decoder in order decode depth.

3 Configuration applicability

- The tools is applicable for HP (High Profile) configuration, because in this configuration no interpretation of depth values is done in loop the encoder, and thus no changes at macroblock level are required. The only required operations are pre- and post-processing of the coded depth.

- The tools is also applicable for EHP (Extended High Profile) configuration. In this configuration some tools make use of depth values in loop the encoder and thus those tools have to be modified accordingly to correctly interpret non-linearly coded depth values e.g. view synthesis, joint view filter. In all of those cases this can be done by implementing Look-Up Table (LUT) or even by modification of existing LUT (view synthesis in VISBD).

4 Implementation

The source code with non-linear depth representation has been attached.
Macro definition for this tool: in: defines.h (x2), header.h
POZNAN_NONLINEAR_DEPTH
New config options: * in 3dv_enc_###_depth_###.cfg
DepthPower - power coefficient. typically from 1.0 (nochange,turned off) to about 1.6
selects power automatically depending on QP following equation (2).

This tool transmits DepthPower coefficient in SPS in form of a single byte (8-bit) value.

5 Experiment conditions

The experiment has been performed with respect to Common Test Conditions [3].
Unfortunately, some detailed concerning the view synthesis methodology have not been strictly settled.
Therefore, apart from experimental results we provide anchor results attained with the same synthesis scheme.
In particular:

- the whole experiment was performed on Windows platform,
- default VSRS software (special version for dynamic z_{near}-z_{far} range by Nokia, the same for all sequences)
- default configuration files, same as on your SVN (with exception for 1920x1080 to 1920x1088 change)
    - original sequences (color-corrected version of newspaper, as in coding)
      original full resolution depth maps
    - left reference view ("LeftViewImageName") was always set to the "base view" (center one in C3), and Right reference view ("RightViewImageName") was set to the other view, the nearest one to the currently being synthesized.

  Such approach provides slightly better quality, because "LeftViewImageName" is the primary view in VSRS. This scheme has been identified during the last Geneva meeting as the best one by many companies participating in CfP.

6 Results

The tool changes allocation of bits in the compressed depth representation - between the foreground and the background - **to obtain higher quality of subjective results**.
The objective rate-distortion (PSNR) curve should **approximately be unchanged** or be little worse than the anchors due to errors in the background that are higher than in the foreground.
The results of this core experiment confirm that assumption. Indeed there is a little loss of PSNR (about 0.02dB) which corresponds to increase of bitrate by about 0.25% - both for HP and EHP configurations and both C2 and C3 case.
The complexity of encoder and decoder is similar to the anchor with about 10% (both positive and negative) deviations, which results from imperfections of measurements.
We suggests to perform subjective evaluation of this tool and if positive results are attained, to include this tools into 3D-ATM software.

7 Conclusions and recommendations

Experiments show almost no impact on rate-distortion (PSNR) curve as expected - it is proposed to perform subjective evaluation of this tool.

8 References

[1] Marek Domański, Tomek Grajek, Damian Karwowski, Krzysztof Klimaszewski, Jacek Konieczny, Maciej Kurc, Adam Łuczak, Robert Ratajczak, Jakub Siast, Olgierd Stankiewicz, Jakub Stankowski, Krzysztof zWegner, “Technical description of Poznan University of Technology proposal for Call on 3D Video Coding Technology”, ISO/IEC JTC1/SC29/WG11 document M22697, Geneva, Switzerland, November 2011.

[2] Description of Core Experiments for 3D-AVC ", ISO/IEC JTC1/SC29/WG11 N12353, December 2011, Geneva, Switzerland.

[3] Heiko Schwarz, Dmytro Rusanovskyy, "Common Test Conditions for HEVC- and AVC-based 3DV", ISO/IEC JTC1/SC29/WG11 MPEG2011/N12352, December 2011, Geneva, Switzerland.