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| **Joint Collaborative Team on 3D Video Coding Extensions**  **of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29/WG 11**  12th Meeting: Warsaw, PL, 20–26 June 2015 | Document: JCT3V-L1002 |

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| *Title:* | **MV-HEVC / 3D-HEVC Verification Test Plan** | | |
| *Status:* | Output Document | | |
| *Purpose:* | Testing | | |
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| *Source:* | JCT-3V | | |

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# Abstract

This document describes the verification

test plan for MV-HEVC and 3D-HEVC including test conditions, evaluation methodology and timeline.

# Introduction

The primary usage scenario for 3D video is to support 3D video applications, where 3D depth perception of a visual scene is provided by a 3D display system. There are many types of 3D display systems including classic stereo systems that require special-purpose glasses to more sophisticated multiview auto-stereoscopic displays that do not require glasses.

A new generation of 3D Video Coding technology that goes beyond the capabilities of existing standards to enable both advanced stereoscopic display processing and improved support for auto-stereoscopic multi-view displays has been the primary subject of work by the JCT-3V group. A new data format and associated compression technology to enable the high-quality reconstruction of synthesized views for 3D displays have been developed for both AVC and HEVC-based coding frameworks. As part of this work, two amendments of the HEVC standard have been developed as outlined below.

* Multi-view extension (MV-HEVC): The main target of this extension is to enable coding multi-view video sequences. Depth maps can be coupled with multi-view video stream using auxiliary pictures, which are one of the features in the range extension of HEVC. There are no change to the CU-level syntax, semantics and decoding processes of HEVC. The specification of this extension (ISO/IEC 23008-2:201x) has included in the 2nd edition of HEVC, which has reached FDIS status in October 2014.
* 3D video extension (3D-HEVC): This extension has been developed that aims for higher compression efficiency by jointly compressing texture and depth data. The specification of this extension (ISO/IEC 23008-2:2013/Amd.4) has reached FDAM status in February 2015.

As the standardization of both specifications is nearing completion, verification tests are planned to assess the improvement of the coding performance. MV-HEVC is planned to be compared with simulcast coding of HEVC as well as MVC in terms of stereo video coding. 3D-HEVC will be compared to MV-HEVC. In the following sections, the timeline of these tests, the test conditions and evaluation procedure are described.

# MV-HEVC Verification Test Plan

## Timeline

12th JCT-3V Meeting: Made test bitstreams and viewing material available

Transferred viewing material to Vittorio

2015/07-10: Perform subjective viewing test

13th JCT-3V Meeting: Provide the subject viewing result as an input document

## Test Conditions

### Input Test Sequences

The multiview test sequences with associated depth data, and corresponding input views to be used for experiments are specified in the table below.

|  |  |  |
| --- | --- | --- |
| **Seq. ID** | **Test Sequence** | **left-right** |
| S03 | Undo\_Dancer | 3-5 |
| S04 | GT\_Fly | 5-3 |
| S13 | Band06 | 0-1 |
| S14 | BMX | 0-1 |

The followings are spare sequences which will be used when the clear quality differences among quality points are not visible.

|  |  |  |
| --- | --- | --- |
| **Seq. ID** | **Test Sequence** | **left-right** |
| S11 | Musicians | 0-1 |
| S10 | Shark | 5-6 |

### Encoder Configuration

Three coding frameworks are considered for the subjective test:

* MVC: AVC-based multiview video coding (non-base view is coded using inter-view prediction)
* Simulcast HEVC: each view is coded independently
* MV-HEVC: HEVC-based multiview video coding (non-base view is coded using inter-view prediction)

The encoder configuration settings for both codec are consistent with the CTC as given in JCT3V-G1100, which are also outlined below:

* Inter-view coding structure
* 2 view case: left-right (in coding order)
* Temporal prediction structure: GOP 8, intra every 24 frames (random access at ~1sec)
* Full resolution texture coding
* Software: JM v18.6, 3D-HTM v14.1 (to be used in Simulcast and MV-mode)
* Encoder configurations for 3D-HTM are provided as part of the “Starter-kit” (./cfg/MV-HEVC)

Bit rates/QP settings:

* Target 4 rate points
* HEVC Independent view texture QP values: 25, 30, 35, 40
* MV-HEVC Dependent view texture QP values: Started with same QP offset values defined in the CTC and adjusted QP values to approximately match PSNR
* MVC QP values: Found QP values that approximately match PSNR

The table below summarizes the QP settings obtained for each sequences.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | **QP values (Independet view/dependent view)** | | |
| **Seq. ID** | **Test Sequence** | **MVC** | **Simulcast HEVC** | **MV-HEVC** |
| S03 | Undo\_Dancer | 23/25, 28/29, 32/35, 37/39 | 25, 30, 35, 40 | 24/27, 30/33, 35/38, 40/43 |
| S04 | GT\_Fly | 23/24, 27/30, 32/33, 36/37 | 25, 30, 35, 40 | 24/27, 29/32, 35/38, 39/42 |
| S10 | Shark | 23/24, 28/29, 32/33, 36/37 | 25, 30, 35, 40 | 25/28, 30/33, 35/38, 40/43 |
| S11 | Musicians | 23/24, 27/29, 32/33, 36/39 | 25, 30, 35, 40 | 24/27, 29/32, 34/37, 39/42 |
| S12 | Poker | 22/25, 27/28, 31/33, 35/38 | 25, 30, 35, 40 | 24/27, 29/32, 34/37, 39/42 |
| S13 | Band06 | 23/25, 28/29, 32/34, 36/39 | 25, 30, 35, 40 | 24/27, 29/32, 34/37, 39/42 |
| S14 | BMX | 22/24, 26/28, 30/32, 34/37 | 25, 30, 35, 40 | 24/27, 29/32, 34/37, 39/42 |

# 3D-HEVC Verification Test Plan

## Timeline (tentative)

2015/07-10: Prepare viewing materials and bitstreams with various bitrate

2015/10: Decide target bitrate for testing

Perform expert viewing test with at least 9 experts and prepare the report

## Test Conditions

### Input Test Sequences

The multiview test sequences with associated depth data, and corresponding input views to be used for experiments are specified in the table below.

|  |  |  |
| --- | --- | --- |
| **Seq. ID** | **Test Sequence** | **left-center-right** |
| S01 | Poznan\_Hall2 | 7-6-5 |
| S02 | Poznan\_Street | 5-4-3 |
| S03 | Undo\_Dancer | 1-5-9 |
| S04 | GT\_Fly | 9-5-1 |
| S05 | Kendo | 1-3-5 |
| S06 | Balloons | 1-3-5 |
| S08 | Newspaper | 2-4-6 |
| S10 | Shark | 1-5-9 |

S10 will be a spare sequence which is used when the other sequences are not appropriate for subjective viewing in terms of quality differences

### Encoder Configuration

Three coding frameworks are considered for the subjective test:

* MV-HEVC: HEVC-based multiview video coding (ISO/IEC 23008-2:201x, Annex G)
  + Depth maps are coded as auxiliary pictures using VSO
* 3D-HEVC: HEVC-based 3D video coding (ISO/IEC 23008-2:2013/Amd.4, Annex I)

The encoder configuration settings for both codec are consistent with the CTC as given in JCT3V-G1100 [4], which are also outlined below:

* Inter-view coding structure:
  + center-left-right (in coding order)
  + P-I-P inter-view prediction
* Temporal prediction structure: GOP 8, intra every 24 frames (random access at ~1sec)
* Software:
  + 3D-HTM v15.0 with VSO support for auxiliary picture coding
* Encoder configurations:
  + For 3D-HTM, configuration files are provided with the source codes (./cfg/3D-HEVC or ./cfg/MV-HEVC)
* Bit rates/QP settings:
  + Independent texture view:
    - 3D-HEVC: QPs: 25, 30, 35, 40 (according to CTC)
    - MV-HEVC: Find QP values that approximately match PSNR values achieved by 3D-HEVC
  + Dependent texture view:
    - 3D-HEVC: According to CTC
    - MV-HEVC: Adjust QP to find the offset values that approximately match PSNR values achieved by 3D-HEVC
  + Depth maps:
    - 3D-HEVC: According to CTC
    - MV-HEVC: Adjust QP to find the offset values that approximately match PSNR values of synthesized views achieved by 3D-HEVC

### Output Views

Based on the reconstructed multiview video and associated depth data, which have been encoded according to the test conditions specified in this section, two sets of stereo pairs shall be generated as given in the below table. The first stereo pair consists of 2 synthesized views, while the second stereo pair consists of one original and one synthesized view. Horizontal parallax adjustment will be applied to each test sequence according to the shift parameter given in the below table.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Seq. ID** | **Test Sequence** | **Input Views** | **Output Stereo #1**  **(2 synthesized views)** | **Output Stereo #2**  **(1 original, 1 synthesized)** | **Shift parameter** |
| S01 | Poznan\_Hall2 | 7-6-5 | (6.25-5.75) | (6-5.5) | 12 |
| S02 | Poznan\_Street | 5-4-3 | (4.25-3.75) | (4-3.5) | 16 |
| S03 | Undo\_Dancer | 1-5-9 | (4-6) | (5-7) | 20 |
| S04 | GT\_Fly | 9-5-1 | (6-4) | (7-5) | 8 |
| S05 | Kendo | 1-3-5 | (3-4) | (2.5-3.5) | ? |
| S06 | Balloons | 1-3-5 | (3-4) | (2.5-3.5) | ? |
| S08 | Newspaper | 2-4-6 | (3-4) | (3.5-4.5) | ? |
| S10 | Shark | 1-5-9 | (4-6) | (5-7) | 10? |

The view synthesis algorithm to be used for generating synthesized views is the “VSRS-1D-Fast” software included in 3D-HTM software.

# Expert Viewing Protocol

The visual evaluation provided by the three coding schemes will be made by means of an “Expert Viewing Protocol” (EVP), as used for two previous MPEG subjective evaluation experiments [2] [3].

The EVP is based on the participation of MPEG experts, who were not directly involved in the activities related to the tested video materials.

The EVP is a variation of the “Double-Stimulus Impairment Scale” (DSIS) test method (as described by the ITU-R Recommendation BT-500 [1]) where the modifications introduced are:

1. Only 9 experts participate as viewers in each EVP session,
2. The “unimpaired” Source video Clip (SRC) is shown once, every two Processed Video Clips (PVS).

Therefore, the viewing timing of an EVP Basic Test Cell (BTC) is set up as shown in *Figure 1*.

*“BTC N” SRC video “A” PVS video A “B” PVS video B “Vote A and B”*

*(1 sec.) (10 sec.) (1 sec.) (10 sec.) (1 sec.) (10 sec.) (5 sec.)*

*Figure 1 – Time scale of EVP Basic Test Cell*

Here, the captions “BTC N” “A” “B” Vote A and B” represent messages that are displayed on the screen.

This BTC timing allows to save a considerable amount of time in relation to a standard DSIS test protocol, since the experts have more habit in viewing images and can remember much better the details of a reference video clip.

The time required by EVP to evaluate two PVSs is 38 seconds, against a total of 54 seconds required by the DSIS method, thus saving approximately 30% of viewing time.

Furthermore an EVP does not requires a stabilization phase as well as the insertion of one or more SRC vs SRC test cells, dueto the high ability of experts to create their own evaluation scale and to be reliable in a way that no SRC vs. SRC check is required. Thus, the overall session length can further be reduced by more than 15%.

## Viewing area set-up

A 3D display of diagonal size equal or higher than 40” is used.

Three viewers are seated in front of the HD 3D monitor (or high quality TV set), at a distance of 3 H (3 times the screen height), taking care that, in any case, the widest viewing angle does not exceed 60° from the center axis of the screen. The position of viewers has to be recorded, to allow a post experiment verification of the influence of the viewing position (i.e. center, left, right) on the MOS value.

The testing area has to be completely dark and any visible and audible pollution has to be avoided.

A low power (e.g. 25 Watts or less) light source is placed behind the monitor and directed to the wall behind the monitor in a way, that no direct light points to the viewers. The distance between display and viewers shall be ≥ 1m in order to avoid distraction of the viewers.

The light behind the monitor has two functions: to allow the viewers to see their scoring sheets and to mitigate any sudden light changes on the monitor.

## Test design

The test will consist of as many test sessions as necessary to evaluate all the PVSs.

The orders of presentation of the PVSs inside a BTC are randomly changed (to avoid any bias in the judgment) in a way hidden to the viewers.

A 10-grade impairment scale is used to assess the visual quality of the coded video clips.

### 10 grades impairment scale and viewers’ training

Even if the viewers are all “experts” in the area of video processing, they need a short training about:

* Timing of presentation of the video clips on the screen,
* How to fill out the scoring sheet,
* Meaning and use of the 10 grade impairment scale.

The 10-grade impairment scale allows viewers to express a judgement of the degradation (if any) between the “SRC” and the processed video clips (PVS).

A short training session (namely 6 BTCs) is run to let the viewers understand when to look at the screen and when to look at the scoring sheet, and how and when to express their opinion.

The BTCs of the training session must include PVSs equally representing the overall impairment range of a test session.

The viewers are explained to carefully look at the video clips shown immediately after the message “A” and “B”, to notice if they were able to see any difference with the video clip shown after the message “BTC N”.

The following guidance about the meaning of the numerical scoring will be given to the viewers:

* should the viewer not be able to see any difference between the source and video clip “A”, a score of 10 is written in box “1” of a BTC (see Figure 2). Similar, if no difference between the source and video clip “B” occurs, a score of 10 is written in box “2”.
* in the case any, even very small, impairments are visible, a score of “9” is given, if the impairment is just in one area of the image, or “8” if the difference is noted in many areas of the screen.
* Scores 7 and 6 are given, if the impairment are clearly visible.
* Scores 5 and 4 are given, if impairments are evident at first sight.
* Scores 3 and 2 are given, when impairments are annoying.
* Scores 1 and 0 are given, when the image is severely corrupted, in some area or everywhere.

### Scoring Sheet

An example of the scoring sheet for an EVP session is shown below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | BTC 1 | | | | |  | BTC 2 | | | | |  |  |  |  | BTC n/2 | | | | |  |
|  |  | 1 |  | 2 |  |  |  | 3 |  | 4 |  |  | … | |  |  | n-1 |  | n |  |  | |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |

*Figure 2 – Scoring Sheet*

## Data analysis

At least nine subjects must participate in each session. This means that, when more than one session has to be run to complete the evaluation, each session must be run with nine viewers, however it is not mandatory that the same viewers run all the sessions.

The obtained viewing results will be statistically analyzed, computing the mean-opinion score (MOS) and the confidence interval (CI) for each test. It is noted that with nine scores the computation of the CI already provides a good indication of when two coding condition are assumed to be different in visual quality.

## Usability and stability of the expert viewing procedure

In other EVP tests [2] [3] the ranking of the video clips was excellent and stable, providing a very good discrimination of the different qualities both in term of relative and absolute values. This encourages the use of EVP also for this Verification test.

1. International Telecommunication Union – Radio Communication Sector; Recommendation ITU-R BT.500-13.
2. WG11, “Results of Call for Evidence on High-Performance Video Coding (HVC)”, ISO/IEC JTC1/SC29/WG11 N10721, London, UK, July 2009.
3. WG11, “Report of IVC visual quality evaluation” ISO/IEC JTC1/SC29/WG11 N14989, Strasbourg, FR, October 2014.

Appendix A: Test Sequences

**S01: Poznan\_Hall2**

**S02: Poznan\_Street**

**Poznan University of Technology**

<ftp://multimedia.edu.pl/3DV/>  
username: 3DV / password: ftvftv

directory: CFP

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Owners: Poznan University of Technology, Poznañ, Poland.

**S03: Undo\_Dancer**

**S04: GT\_Fly**

**Nokia**

<ftp://mpeg3dv.research.nokia.com>

username: mpegmember / password: S9"12#sHD)3

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Owners: Nokia, Finland.

**S05: Kendo**

**S06: Balloons**

**Nagoya University**

<http://www.tanimoto.nuee.nagoya-u.ac.jp/~mpegftv/mpeg3dv/CfP/>

username: mpegftv / password: fngOyfTv

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Owners: Nagoya University, Japan.

## S08: Newspaper

**GIST**

<ftp://203.253.128.142>

username: 3DV / password: 3dvkr

directory: /GIST\_Test\_Sequence/Newspaper

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Owners: Gwangju Institute of Science and Technology (GIST), Republic of Korea.

## S10: Shark

**NICT**

ftp://ftp.merl.com

username: anonymous password: <email>

directory: /pub/tian/NICT-3D/Shark

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