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Title: **Description of Exploration Experiments on Free-viewpoint Television (FTV)**
Editors: **Krzysztof Wegner, Takanori Senoh, Gauthier Lafruit**

1 Introduction

The aim of this exploration experiment is to evaluate currently available depth estimation, view synthesis and coding technology in the context two specific applications:

A) super multiview – where a very dense set of more than 100 views are being displayed to viewer, and
B) free viewpoint navigation – where user has the ability to freely navigate around and through the scene which was registered by sparse set of more than 10 cameras, arbitrarily arranged, with wide baseline.

This document describes the conditions of the experiment and the evaluation procedures under consideration. Experiments are performed to get more insight into quality of depth estimation algorithms, view synthesis algorithms, and currently available compression technology, that can be in use for FTV applications.

2 Description of Exploration Experiments

In this experiment, depth estimation, view synthesis and current MPEG multiview coding technology will be evaluated. Several contributions were received about these essential building blocks of FTV systems. The goal is to start experimental evaluation of currently available building blocks and proposed algorithms in a structured, defined and comparable way.

2.1 Reference Software

Poznan University of Technology kindly agreed to provide enhanced software for depth estimation (DERS 6.1) as well as for view synthesis (VSRS 6.0) to be used as reference in this EE. It is available a MPEG SVN (http://wg11.sc29.org/svn/repos/Explorations/FTV).

For coding efficiency evaluation last version of HTM v.11.2 software shall be used.
This is available at https://hevc.hhi.fraunhofer.de/svn/svn_3DVCSoftware/tags/HTM-11.2.

2.2 Test data

Test data will be selected from the test sequences summarized in Table 1 which contain super-multiview video and, if available, corresponding depth data.
There are currently four types of the materials available (11 test materials in total, highlighted green in Table 1):

- Linear camera arrangement still images– 2 test materials
- Linear camera arrangement sequences – 6 test materials
- Arc camera arrangement sequences – 2 test materials
- 2D parallel camera arrangement sequence – 1 test material

This data can be used for depth estimation experiments and comparison with reference depth data when available. These sequences can also be used directly for encoding/decoding and view synthesis experiments using the available depth data.

From all available views for each test sequence, subsets of input views are carefully selected in order to create similar disparity ranges and angular resolutions between the so-obtained newly assigned successive input views over all test sequences.

There are still a strong need for additional test data which has one or, if possible, all of the following features:

- Was capture by non-linear camera arrangements (arc, 2D, others)
- Are not computer generated graphics
- Depth data are available and if possible directly acquired by means of depth sensing camera
- Have additional supplementary information (like specular information, etc.)
- Are provided in light field representation.

Additional test materials will be added as soon as they become available.

Table 1. Summary of the test sequence to be used in the exploration experiments.

No.	Provider's Name	Seq. Name	Number of Views	Resolution (pel)	Frame rate (fps)	Length	Cam Arrangement (1D parall, 1D arc, 2D parall, 2D arc, Sphere, Arbitrary)	Ground Truth Depth Available	Depth Data Avaiable	Contents	condition to use (if any)	URL of sequence (ID, PW)
1	NICT	Little world (Bee)	185	1920x1088	Still Image	1 frame	1D parallel	Yes	Yes	CG: Sun flowers and bee	See M32201	http://fujii.nuee.nagoya-u.ac.jp/NICT/NICT.htm
2	UHasselt	San Miguel	200	1920x1080	Still image	1 frame	1D parallel	Yes	Yes	CG, Raytraced	See M33162	https://wg11.sc29.org/content/MPEG-04/Part02-Visual/FTV_AhG/UHasselt_San_Miguel
3	Nagoya University	Champagne Tower	80	1280 x 960	29.4114	10 sec 300 frames	1D parallel	No	Only for views 37, 39,41	Glass tower	See M15378 and provider webpage	http://www.fujii.nuee.nagoya-u.ac.jp/multiview-data no password required
4	Nagoya University	Pantomime	80	1280 x 960	29.4114	10 sec 300 frames	1D parallel	No	Only for views 37, 39,41	Two clowns	See M15378 and provider webpage	
5	Nagoya University	Dog	80	1280 x 960	29.4114	10 sec 300 frames	1D parallel	No	No	Dog and person	See M15378 and provider webpage	
6	UHasselt	Soccer-linear 1	8	1600x1200	25	22 sec 550 frames	1D parallel	No	Yes	Soccer game with cameras ca 1m apart	Provided to MPEG community acknowledgement to Hasselt University.	http://wg11.sc29.org/content//MPEG-04/Part02-Visual/FTV_AhG/UHasselt_Soccer
7	UHasselt	Soccer-linear 2	8	1600x1200	25	22 sec 550 frames	1D parallel	No	Yes	Soccer game with cameras ca 1m apart		

8	NICT	Shark	185	1920x1088	30	2 sec 60 frames	1D parallel	Yes	Yes	CG: See and shark	See M32201	http://fujii.nuee.nagoya-u.ac.jp/NICT/NICT.htm
9	Poznan University of Technology	Poznan Blocks	10	1920x1080	25	40 sec 1000 frames	100deg. on arc around the scene	No	Yes	gaming scene	See M32243	ftp://multimedia.edu.pl/ftv Password provided upon request please email kwegner@multimedia.edu.pl
10	UHasselt	Soccer-corner	7	1920x1080	25	22 sec 550 frames	120 deg. corner, 1D arc	No	Yes	Soccer game with cameras ca 10m apart	Provided to MPEG community acknowledgement to Hasselt University.	https://wg11.sc29.org/content/MPEG-04/Part02-Visual/FTV_AhG/UHasselt_Soccer
11	Nagoya University	Akko & Kayo	15	640x480	29.4114	10 sec 300 frames	2D parallel	No	Yes	Two persons	See M12338 and provider webpage	http://www.fujii.nuee.nagoya-u.ac.jp/multiview-data no password required
12	NHK	CGIP_nhk	Approx. 300	Approx. 200x120 (3840x2160)	TBD		2D lens-array			TBD	TBD	TBD

2.3 Experiments

2.3.1 EE1 Depth estimation

Both FTV applications relay very strongly on the quality of the depth data. So far several depth estimation algorithms have been presented. Poznan University of Technology have kindly provide improved and extended Depth Estimation Reference Software that allows to estimate the depth maps in case of any arbitrary camera arrangement.

The goal of this EE is to further improve quality of the depth estimation algorithms by improving Depth Estimation Reference Software (DERS). The secondary goal is to prepare a test set with high quality depth maps.

Table 1. Specification of view position for depth estimation

Sequence name	**View position number**
Poznan Blocks	0,1,2,3,4,5,6,7,9
Champagne_tower	23,25,27,29,31,33,35,37,*39*,41,43,45,47,49,51,53,55
Pantomime	23,25,27,29,31,33,35,37,*39*,41,43,45,47,49,51,53,55
Dog	23,25,27,29,31,33,35,37,*39*,41,43,45,47,49,51,53,55
Bee	58,62,66,70,74,78,82,86,*90*,94,98,102,106,110,114,118,122

Participants shall generate depth data for the views indicated in table 1 by running the DERS with optimized configurations. Participants are encourage to create any supplementary information require by semi-automatic depth estimation process leading to improvements of resultant depth maps. Please note that there are currently three kinds of supplementary information, a rough depth map, edge-map and static-map, for further information please see DERS Software Manual m34302.

In order to obtain high quality depth maps, further improvements of automatic tools or through manual efforts are also encouraged.

Table 2. List of participants and work allocation for EE1

Data set	**Participant**
Poznan Blocks	Poznan
Bee	UPM
Soccer-linear 1	Uhasselt
Pantomime	LZ Associates

2.3.2 EE2 View synthesis

User experience of current FTV technology is dependent on view synthesis algorithm. A few view synthesis algorithms have been presented so far as well. In particular there are two view synthesis algorithms available: VSRS – extended and improved by Poznan University of Technology, and VSRS-1D-Fast provided by HHI and developed as a part of 3D-HEVC project. Each of this software's have its own limitations. The goal of this EE is to discover these limitations and, as a results, to improve view synthesis algorithm implemented in VSRS.

The goal of this EE is to asses quality distribution of virtual view over a fixed range of views. In particular, it is to check how many views are necessary (what subset of views) to reconstruct (by means of view synthesis) all of the views necessary for a given display.

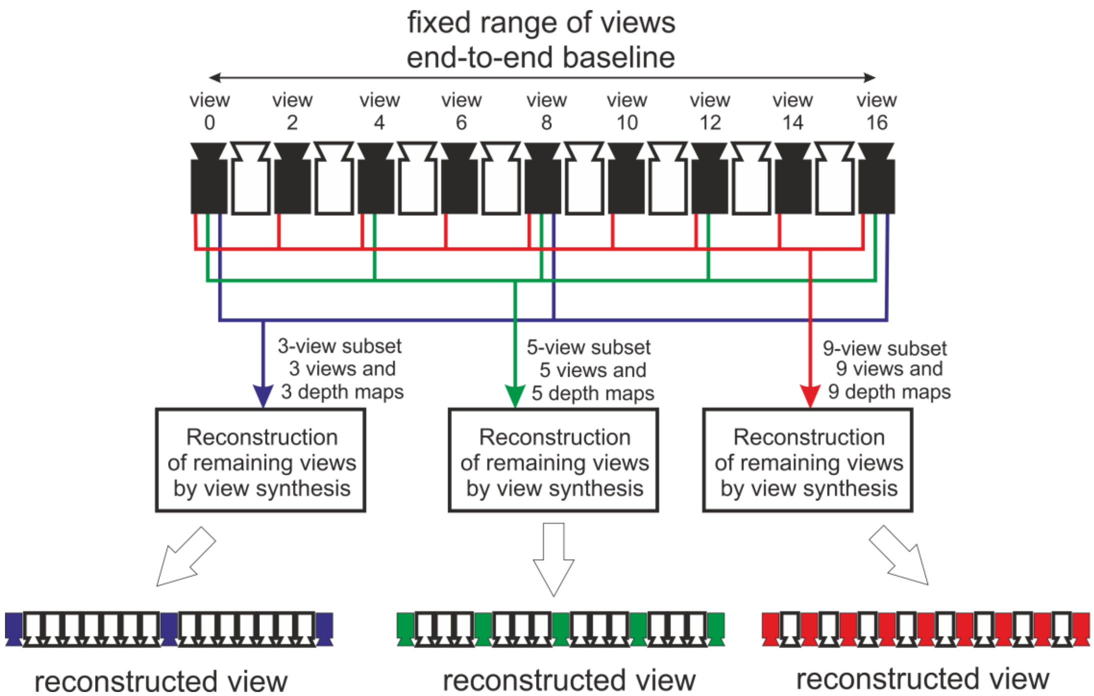

Figure 1. Overview of the EE2.

Table 3. Specification of reference view position and virtual view position.

Sequence name	Subset	Positions of reference view to synthesize from	Positions of virtual views to be generated
Bee	3-views	Every 32rd view, from 58 to 122, 3 views in total 58,90,122	Every view from 59-89 and from 91-121
	5-views	Every 16th view from 58 to 122, 5 views in total 58,74,90,106,122	Every view from 59-73, 75-89,91-105 and 107-121
	9-views	Every eighth view from 58 to 122, 9 views in total 58,66,74,82,90,98,106,114,122	Every view from 59-65, 67-73, 75-81, 83-89, 91-97, 99-105, 107-113 and 115-121
	17-views	Every forth view from 58 to 122, 17 views in total 58,62,66,70,74,78,82,86,90, 94,98,102,106,110,114,118,122	Every view from 59-61, 63-65, 67-69, 71-73, 75-77, 79-81, 83-85, 87-89, 91-93, 95-97, 99-101, 103-105, 107-109, 111-113, 115-117, 119-121
	33-views	Every second view from 58 to 122, 33 views in total 58,60,62,64,66,68,70,72,74, 76,78,80,82,84,86,88,90,92, 94,96,98,100,102,104,106,108, 110,112,114,116,118,120,122	Views 59, 61, 63, 65, 67, 69, 71, 73, 75, 77, 79, 81, 83, 85, 87, 89, 91, 93, 95, 97, 99, 101, 103, 105, 107, 109, 111, 113, 115, 117, 119, 121
San Miguel	3-views	Every 32rd view, from 94 to 158, 3 views in total 94, 126, 158	Every view from 95-125 and 127-157
	5-views	Every 16th view from 94 to 158, 5 views in total 94, 110, 126, 142, 158	Every view from 95-109, 111-125, 127-141, 143-157
	9-views	Every eighth view from 94 to 158, 9 views in total 94, 102, 110, 118, 126, 134, 142 150, 158	Every view from 95-101, 103-109, 111-117, 119-125, 127-133, 135-141, 143-150, 151-157

	17-views	Every forth view from 94 to 158, 17 views in total 94, 98, 102, 106, 110, 114, 118, 122, 126, 130, 134, 138, 142, 146, 150, 154, 158	Every view from 95-97, 99-101, 103-105, 107-109, 111-113, 115-117, 119-121, 123-125, 127-129, 131-133, 135-137, 139-141, 143-145, 147-149, 151-153, 155-157
	33-views	Every second view from 94 to 158, 33 views in total 94, 96, 98, 100, 102, 104, 106, 108, 110, 112, 114, 116, 118, 120, 122, 124, 126, 128, 130, 132, 134, 136, 138, 140, 142, 144, 146, 148, 150, 152, 154, 156, 158	Every view: 95,97,99,101,101,103,105, 107, 109 111,113, 115, 117, 119, 121, 123, 125, 127, 129, 131, 133, 135, 137, 139, 141, 143, 145, 147, 149, 151, 153, 155, 157

Participants shall synthesize a number of virtual views with use of VSRS and/or VSRS-1D-Fast from a texture and ground truth depth data of reference views. Exact positions, numbers of views to be synthesized, and exact number and positions of reference views to be used are provided in table 3.

Participants shall report virtual view quality in terms of PSNR against real view at the same spatial position for each virtual view separately in the provided template sheet.

Participants shall analyze influence of density of reference views onto distribution of the virtual view quality (see m31365, m34494 for example).

Participants are also encouraged to provide the results obtained by other view synthesis algorithms.

Table 4. List of participants and work allocation for EE2

Sequence name	**Participant**
Bee	NICT, Zhejiang University
San Miguel	UPM, UHasselt

2.3.3 EE3 Compression

The second phase of FTV MPEG has developed a number of multiview coding technologies, i.e MV-HEVC and 3D-HEVC.

The goal is to investigate the coding efficiency of the best of currently available coding technologies in the context of FTV third phase video.

For the compression in case of application A there are currently two competitive approaches:

A1) all the views can be transmitted directly with use of MV-HEVC or 3D-HEVC, or

A2) only a subset of the views which cover selected range of views and corresponding depth maps are transmitted directly. Then after decoding, the remaining (not transmitted) views are reconstructed through view synthesis.

In both A1 and A2 cases we would like to analyze the following:
- Whether it is feasible to use currently available MPEG compression technology.
- What are the missing part?
- What is the coding performance compared to simulcast?
- What is the coding performance of case A2 compared to case A1?
- Study of necessary number of views to be transmitted in case A2?

2.3.3.1 EE3 A1 Direct transmission of the views

The goal of the EE is to evaluate of feasibility of direct transmission of all of the views needed to be displayed to the viewer in application case A by means of currently available MPEG compression technology. EE focuses on a case of direct transmission of 33 input views acquired by the camera system.

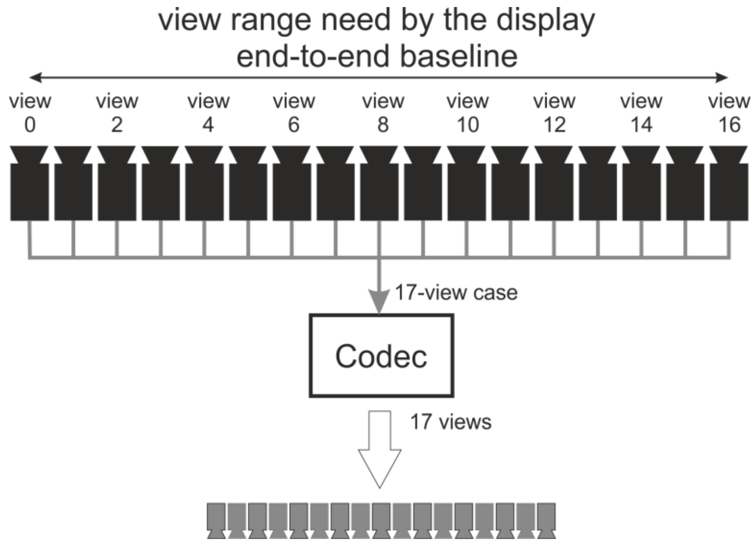

Figure 2. Overview of EE3 A1

Table 5. Specification of views to be transmitted.

Sequence name	**View position**
Champagne Tower	All of the views from 23 to 55 in total 33 views 23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39, 40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,55
Pantomime	All of the views from 23 to 55 in total 33 views 23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39, 40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,55
Dog	All of the views from 23 to 55 in total 33 views 23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39, 40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,55
Bee	Every second view from 58 to 122 in total 33 views 58,60,62,64,66,68,70,72,74,76,78,80,82,84,86,88,90,92, 94,96,98,100,102,104,106,108,110,112,114,116,118,120,122
San Miguel	Every second view from 94 to 158 in total 33 views 94,96,98,100,102,104,106,108,110,112,114,116,118,120,122, 124,126,128,130,132,134,136,138,140,142,144,146,148,150, 152,154,156,158

Proponents shall compress all 33 input views according to table 5 with use of 3D-HEVC, MV-HEVC, and HEVC (simulcast approach).

Template configuration files for 3D-HEVC, MV-HEVC and HEVC will be provided over the reflector. UPM have kindly volunteer to prepare such a template configuration files. Proponents are encourage to test other view structure configuration from provided ones.

Proponents shall include total bitrate and quality in terms of PSNR of coded views for each case. Moreover proponents are encourage to compute BR-rate of direct-view-transmission approach versus simulcast.

All of the result should be provided with attached template sheet.

Configuration of the codecs.

In order to be compared fairly, the configurations of HEVC, MV-HEVC and 3D-HEVC need to be somewhat aligned. The table below summarizes the alignment.

	HEVC	MV-HEVC	3D-HEVC
Basis configuration	As reported in JCT-	JCT3V CTCs	JCT3V CTCs

	VC CTCs (JCTVC-L1100), RA configuration		
Intra Period	24 (suggested change – was 32)	24	24
Search Range	96	96 (suggested change – was 64)	96 (suggested change – was 64)

Table 4. List of participants and work allocation for EE3 A1

Coding	**Sequence name**	**Participant**
HEVC Simulcast	Bee	Orange Labs
	San Miguel	Orange Labs
	Champagne Tower	Orange Labs
	Pantomime	Orange Labs
	Dog	Orange Labs
MV-HEVC	Bee	
	San Miguel	
	Champagne Tower	
	Pantomime	
	Dog	
3D-HEVC	Bee	
	San Miguel	
	Champagne Tower	
	Pantomime	
	Dog	

2.3.3.2 EE3 A2 Depth based view transmission

Direct transmission of large number of views can be not feasible. The main concern is bitrate requirement for such a transmission. Recently MPEG have developed technology for efficient depth based transmission of multiview sequences namely 3D-HEVC.

In this EE only a subset of the views and corresponding depth maps which covers whole range of views, needed to be displayed to the viewer in application case A, are transmitted. The remaining (not transmitted) views are reconstructed through view synthesis at the decoder side from decoded ones. As EE3 A1, EE3 A2 focuses on a case of 33 input view case and its 17, 9, 5, 3 view subsets.

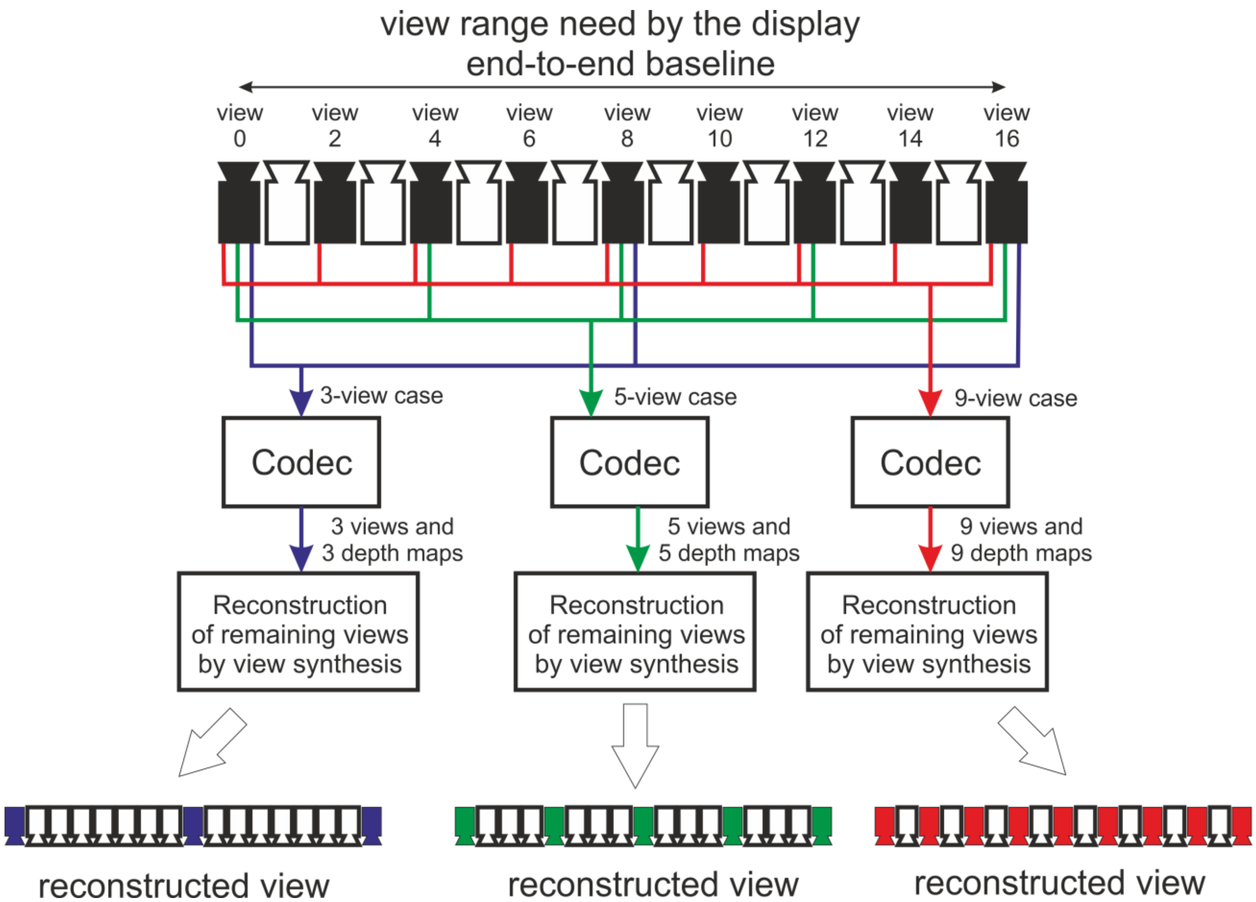

Figure 3. Overview of EE3 A2 experiments

The goal of the EE is to evaluate of feasibility of depth based transmission of subsets views and depth maps that are needed for high quality super multiview experience. In particular questions have been raised, about density of the views that need to be transmitted. Participants shall compress input views and corresponding depth maps of selected n-view case according to table 6 with use of 3D-HEVC. Template configuration files for each n-view case of 3D-HEVC will be provided over the reflector. UPM have kindly volunteer to prepare such a template configuration files.

Participants shall include total bitrate, quality of the coded views, in terms of PSNR of each reconstructed view through view synthesis according to table 6 and average virtual view quality in terms of PSNR. Synthesized virtual views should be compared with real cameras at exactly the same spatial positions as well with views synthesized from uncompressed data at the same spatial positions. For view synthesis participants should use both VSRS 6.0 and VSRS-1D-Fast (from 3D-HEVC software version 11.2).

Participants should investigate the number and density of the input views to be coded that provide highest and equally distributed quality of all reconstructed views at given bitrate.

For the purpose of comparison, participants shall compress all views and corresponding depth maps with 3D-HEVC, according to EE3 A1 condition, and additionally with use of simulcast approach with HEVC.

Participants are encourage to compute BR-rate of depth-based approach versus simulcast and EE3 A1 condition.

All of the result should be provided with the attached template sheet.

Table 6. Specification of reference view position and virtual view position.

Sequence name	**Subset**	**Positions of reference view to be transmitted and that are**	**Positions of virtual views to be generated**

		used to synthesize from	
Bee	3-views	Every 32rd view, from 58 to 122, 3 views in total 58,90,122	Every view from 59-89 and from 91-121
	5-views	Every 16th view from 58 to 122, 5 views in total 58,74,90,106,122	Every view from 59-73, 75-89,91-105 and 107-121
	9-views	Every eighth view from 58 to 122, 9 views in total 58,66,74,82,90,98,106,114,122	Every view from 59-65, 67-73, 75-81, 83-89, 91-97, 99-105, 107-113 and 115-121
	17-views	Every forth view from 58 to 122, 17 views in total 58,62,66,70,74,78,82,86,90, 94,98,102,106,110,114,118,122	Every view from 59-61, 63-65, 67-69, 71-73, 75-77, 79-81, 83-85, 87-89, 91-93, 95-97, 99-101, 103-105, 107-109, 111-113, 115-117, 119-121
San Miguel	3-views	Every 32rd view, from 94 to 158, 3 views in total 94, 126, 158	Every view from 95-125 and 127-157
	5-views	Every 16th view from 94 to 158, 5 views in total 94, 110, 126, 142, 158	Every view from 95-109, 111-125, 127-141, 143-157
	9-views	Every eighth view from 94 to 158, 9 views in total 94, 102, 110, 118, 126, 134, 142 150, 158	Every view from 95-101, 103-109, 111-117, 119-125, 127-133, 135-141, 143-150, 151-157
	17-views	Every forth view from 94 to 158, 17 views in total 94, 98, 102, 106, 110, 114, 118, 122, 126, 130, 134, 138, 142, 146, 150, 154, 158	Every view from 95-97, 99-101, 103-105, 107-109, 111-113, 115-117, 119-121, 123-125, 127-129, 131-133, 135-137, 139-141, 143-145, 147-149, 151-153, 155-157
Champagne Tower	3-views	Evert 16^{th} view from 23-55, 3 views in total 23,39,55	24-38, 40-54
	5-views	Evert eighth view from 23-55, 5 views in total 23,31,39,47,55	24-30, 32-38, 40-46, 48-54
	9-views	Evert fourth view from 23-55, 9 views in total 23,27,31,35,39,43,47,51,55	24-26, 28-30, 32-34, 36-38, 40-42, 44-46, 48-50, 52-54
	17-views	Every second view from 23-55, 17 views in total 23,25,27,29,31,33,35,37,39, 41,43,45,47,49,51,53,55	24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54
Pantomime	3-views	Every 16^{th} view, From 23-55, 3 views in total 23,39,55	24-38, 40-54
	5-views	Every eight view From 23-55. 5 views in total 23,31,39,47,55	24-30, 32-38, 40-46, 48-54
	9-views	Every forth view from 23-55, 9 views in total 23,27,31,35,39,43,47,51,55	24-26, 28-30, 32-34, 36-38, 40-42, 44-46, 48-50, 52-54
	17-views	Every second view from 23-55, 17 views in total 23,25,27,29,31,33,35,37,39,	24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54

		41,43,45,47,49,51,53,55	
Dog	3-views	Every 16th view, From 23-55, 3 views in total 23,39,55	24-38, 40-54
	5-views	Every eight view From 23-55. 5 views in total 23,31,39,47,55	24-30, 32-38, 40-46, 48-54
	9-views	Every forth view from 23-55, 9 views in total 23,27,31,35,39,43,47,51,55	24-26, 28-30, 32-34, 36-38, 40-42, 44-46, 48-50, 52-54
	17-views	Every second view from 23-55, 17 views in total 23,25,27,29,31,33,35,37,39, 41,43,45,47,49,51,53,55	24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54

Table 8. List of participants and work allocation for EE3 A2

Experiment	Sequence name	Participant
EE3 A2	Bee	Zhejiang University

2.3.3.3 EE3 B FTV transmission

In order to provide realistic FTV experience certain number of views is required. But in opposition to super multiview application, those views need to cover as much of scene content as possible with minimum overlapping. Typically, it means arbitrary view arrangement, large baseline distances, and heavily view perspective change form viewpoint to viewpoint. This cause challenged task for currently available coding technology.

The goal of this EE is to assess coding performance of MV-HEVC and 3D-HEVC in case of arc or arbitrary view setup, and compare it with coding performance attained by JCT-3V group during development of 3D-HEVC.

Table 7. Specification of the views to be encoded

Sequence name	Position of the view to be transmitted	Position of the virtual view to be synthesized
Poznan Blocks	0,1,2,3,4,5,6,7,8,9	0.5, 1.5, 2.5, 3.5, 4.5, 5.5, 6.5, 7.5, 8.5, 9.5
Soccer-corner	0,1,2,3,4,5,6	0.5, 1.5, 2.5, 3.5, 4.5, 5.5

Participants shall compress the input views and corresponding depth maps according to table 7 with MV-HEVC and 3D-HEVC and report the PSNR of all views (input and synthesized views) vs. the total bitrate over all input views. The coding conditions should follow the JCT-3V Common Test Condition (JCT3V-H1100), except for the number of views. Virtual views under evaluation should be synthesized with used of VSRS 6.0 at the positions according to table 7. Necessary camera parameters for virtual view positons will be provide over the reflector (see timeline section).

Quality of the synthesized views should be compared with the results of view synthesized from uncompressed data at the same spatial positions in terms of PSNR.

Table 8. List of participants and work allocation for EE3 B

Experiment	Sequence name	Participant
EE3 B	Poznan Blocks	Poznan

2.4 Evaluation

Evaluation in this round of EE shall be mainly based on assessment of the data reported at the 110th meeting. PSNR evaluation shall be complemented by view quality assessment on the decoded and synthesized output views. Especially the views with lowest PSNR obtain in EE2 and EE3 shall be judged by expert viewing.

Nevertheless, it is not expected that very strong conclusions can be drawn at that stage, however, first initial insights can be obtained already in several ways:

- Monoscopic viewing of a synthesized view.
- PSNR comparisons shall be made for view synthesis experiments with the real view at the same spatial position.
- Results of depth estimation for other data shall be inspected visually and compared.
- Results of depth estimation shall be evaluated by view synthesis and visual inspection.

It is expected that by the next meeting the group will have established a running experimental framework for further FTV testing, including depth estimation, view synthesis and multiview compression. Experiment will help to identify the missing parts of the current MPEG standards and allows to develop objective means to assets quality of the FTV system.

Discussion of the results at the 110th meeting will provide insights about how to improve, extend, and refine experiments and algorithms during the next period.

3 Time line

2014/08/10	Template configuration file for EE3 A1 and A2 ready and announced over the reflector.
2014/08/22	Camera parameters for virtual views ready and distributed over the reflector.
2014/09/01	Template Excel Sheet for reporting the EE results provided over the reflector.
2014/10/01	EE3 A1 results available
2014/10/13	Strasburg MPEG meeting document registration deadline.

4 Participants

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UPM	Francisco Morán Burgos, fmb@gti.ssr.upm.es Pablo Carballeira López, pcl@gti.ssr.upm.es Sergio García Lobo, sgl@gti.ssr.upm.es
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