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Title	Newspaper sequence - Results of 3DV/FTV Exploration Experiments with depths and view synthesis
Sub group	Video
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1 Introduction

This document presents results of Exploration Experiment (EE4) performed on “Newspaper” sequence [2] and is in response to W10925 “Description of Exploration Experiments in 3D Video Coding” [1].

2 Experiments conditions

Experiments were performed basing on W10925 [1] guidelines:

2.1 EE1

- Select stereo pair from data set, i.e. an original left view OL and an original right view OR (OL=2, OR=4).
- Estimate depth corresponding to neighboring original views OL (left) and OR (right), from neighboring cameras with use of semi-automatic mode.

2.2 EE2

Two view case:

- Original reference texture data for views 4 and 6 of “Newspaper” sequence were compressed using JMVM software version 5.0.6 with different QP values. GOP length was set to 16 frames, to comply with the requirement of at least 0.5 second GOP length (Newspaper is a 30 fps sequence).

- Depth maps for views 4 and 6, provided for the purpose of this experiment, were compressed using JMVM software version 5.0.6 with different QP values. GOP length was set to 16 frames.
- Appropriate depth and texture data were selected to meet the 0.375, 0.75, 1.25, 2 Mbps stream requirements.
- Reconstructed texture and depth data were fed to the view synthesis software VSRS version 3.0.1, together with camera system parameters and Znear, Zfar values to recreate view 5.
- Synthesized view 5 was compared in terms of PSNR and PSPNR with original view 5 as well as with view 5 synthesized using uncompressed data. For PSPNR calculation, default settings were used – borders of 30 pixels width were excluded from both sides of synthesized frames for purpose of quality calculation.

The tests were performed on ‘Newspaper’ [2] sequence with following views selected as O and NL-NR.

Table 1. The specification of views for EE experiment.

Data set	Two cameras case	
	O	NL-NR
Newspaper	3	2 - 4

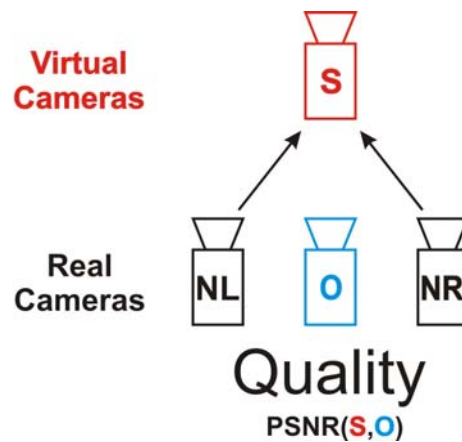


Figure 1. Two cameras case – test setup.

3 Semi-automatic data

In order to estimate the depth in semi-automatic DERS mode, an additional data has been created and provided.



Figure 2. Example of new key frame (10 and 80) used to estimated depth with semi-automatic mode in DERS 5.0

4 Results

4.1 EE 1:

The new depth map for view 2 and our previously estimated depth maps for views 4 and 6 are available on our FTP site <http://multimedia.edu.pl/3DV> in *newspaper* directory.

4.2 EE 4 - Two view case:

To meet the requirements imposed on bitstream size, the following pairs of QP and QD (QP index for depth encoding) were selected:

Table 2. Selected QP-QD pairs for synthesis

Bitrate	QP-QD pairs selected
375 kbps	44-43, 44-42, 43-44, 44-41, 43-43, 43-43, 42-44, 44-40, 42-43, 43-41
750 kbps	43-31, 37-36, 35-41, 38-34, 40-32, 39-33, 36-37, 35-40, 42-31, 44-30, 37-35
1.25 Mbps	40-26, 30-40, 32-32, 31-35, 30-39, 37-27, 44-25, 34-29, 30-38, 33-30
2 Mbps	44-21, 28-29, 27-32, 29-27, 26-37, 31-25, 34-23, 43-21, 32-24, 37-22, 26-36, 42-21

With selected pairs, view 5 was synthesized and its quality was measured:

Table 3. Quality of synthesized views, 375 kbps case

Bitrate [kbps]	QP	QD	against uncompressed synthesis				against original view			
			PSNR [dB]	PSNR (psnr) [dB]	PSPNR temporal [dB]	PSPNR spatial [dB]	PSNR [dB]	PSNR (psnr) [dB]	PSPNR temporal [dB]	PSPNR spatial [dB]
353	44	43	30.36	30.54	44.55	32.54	29.00	29.14	44.17	30.59
364	44	42	30.40	30.58	44.57	32.58	29.03	29.17	44.17	30.62
366	43	44	30.91	31.09	45.09	33.40	29.42	31.09	45.09	33.40
378	44	41	30.45	30.62	44.58	32.63	29.05	30.62	44.58	32.63
379	43	43	30.97				29.46	29.60	44.73	31.23
390	43	42	31.02	31.20	45.13	33.52	29.49	29.63	44.74	31.27
391	42	44	31.36	31.55	45.65	34.10	29.70	29.85	45.30	31.59
395	44	40	30.48	30.65	44.59	32.66	29.06	29.20	44.18	30.66
403	42	43	31.44	31.62	45.68	34.19	29.74	29.89	45.32	31.64
404	43	41	31.08	31.25	45.15	33.58	29.52	29.66	44.76	31.29
	- the best result for given bitrate						- the worst result for given bitrate			

Table 4. Quality of synthesized views, 750 kbps case

Bitrate [kbps]	QP	QD	against uncompressed synthesis				against original view			
			PSNR [dB]	PSNR (pspnr) [dB]	PSPNR temporal [dB]	PSPNR spatial [dB]	PSNR [dB]	PSNR (pspnr) [dB]	PSPNR temporal [dB]	PSPNR spatial [dB]
730	43	31	31.33	31.49	45.31	33.82	29.62	29.74	44.8	31.38
733	37	36	34.29	34.49	48.43	38.64	31.39	31.56	48.09	34.02
737	35	41	34.59	34.87	49.23	39.4	31.65	31.87	49.12	34.54
747	38	34	33.83	34.01	47.91	37.85	31.17	31.31	47.47	33.65
752	40	32	32.94	33.1	46.92	36.35	30.59	30.72	46.43	32.8
753	39	33	33.46	33.63	47.49	37.19	30.93	31.07	46.99	33.3
753	36	37	34.61	34.84	48.92	39.23	31.6	31.79	48.6	34.36
754	35	40	34.69	34.97	49.27	39.5	31.69	31.9	49.12	34.57
755	42	31	31.86	32.01	45.89	34.6	29.93	30.04	45.36	31.81
762	44	30	30.67	30.83	44.71	32.83	29.14	29.26	44.2	30.72
764	37	35	34.34	34.54	48.45	38.7	31.41	31.58	48.08	34.03
	- the best result for given bitrate						- the worst result for given bitrate			

Table 5. Quality of synthesized views, 1250 kbps case

Bitrate [kbps]	QP	QD	against uncompressed synthesis				against original view			
			PSNR [dB]	PSNR (pspnr) [dB]	PSPNR temporal [dB]	PSPNR spatial [dB]	PSNR [dB]	PSNR (pspnr) [dB]	PSPNR temporal [dB]	PSPNR spatial [dB]
1 236	40	26	33.09	33.24	47.04	36.51	30.59	30.71	46.43	32.80
1 236	30	40	36.22	36.61	51.51	42.08	32.38	32.64	51.82	35.75
1 242	32	32	36.45	36.73	50.95	42.24	32.35	32.55	50.73	35.50
1 246	31	35	36.63	36.94	51.35	42.61	32.46	32.67	51.33	35.71
1 256	30	39	36.37	36.75	51.62	42.25	32.44	32.69	51.87	35.78
1 267	37	27	34.67	34.86	48.67	39.10	31.44	31.59	48.07	34.06
1 268	44	25	30.72	30.87	44.78	32.88	29.12	29.24	44.22	30.70
1 270	34	29	35.90	36.12	50.16	41.22	32.04	32.20	49.69	34.97
1 275	30	38	36.53	36.91	51.64	42.55	32.49	32.74	51.86	35.87
1 277	33	30	36.27	36.52	50.64	41.89	32.25	32.43	50.25	35.31
	- the best result for given bitrate						- the worst result for given bitrate			

Table 6. Quality of synthesized views. 2000 kbps case

Bitrate [kbps]	QP	QD	against uncompressed synthesis				against original view			
			PSNR [dB]	PSNR (psnr) [dB]	PSPNR temporal [dB]	PSPNR spatial [dB]	PSNR [dB]	PSNR (psnr) [dB]	PSPNR temporal [dB]	PSPNR spatial [dB]
1 978	44	21	30.74	30.89	44.82	32.90	29.10	29.22	44.22	30.69
1 982	28	29	38.10	38.45	53.02	45.05	32.78	33.00	52.92	36.27
1 982	27	32	38.06	38.44	53.26	44.87	32.86	33.09	53.51	36.48
1 993	29	27	37.99	38.31	52.80	44.92	32.70	32.91	52.46	36.10
1 995	26	37	37.68	38.11	53.26	44.28	32.81	33.08	54.00	36.56
1 996	31	25	37.41	37.69	51.81	43.87	32.48	32.68	51.29	35.72
2 001	34	23	36.19	36.40	50.39	41.62	32.00	32.18	49.66	34.95
2 004	43	21	31.45	31.59	45.42	33.93	29.59	29.70	44.80	31.36
2 006	32	24	37.00	37.25	51.33	43.11	32.34	32.53	50.69	35.47
2 007	37	22	34.82	34.99	48.78	39.28	31.42	31.56	48.06	34.04
2 021	26	36	37.83	38.24	53.36	44.41	32.84	33.10	54.06	36.59
2 029	42	21	31.99	32.13	46.02	34.74	29.89	30.00	45.36	31.78
	- the best result for given bitrate						- the worst result for given bitrate			

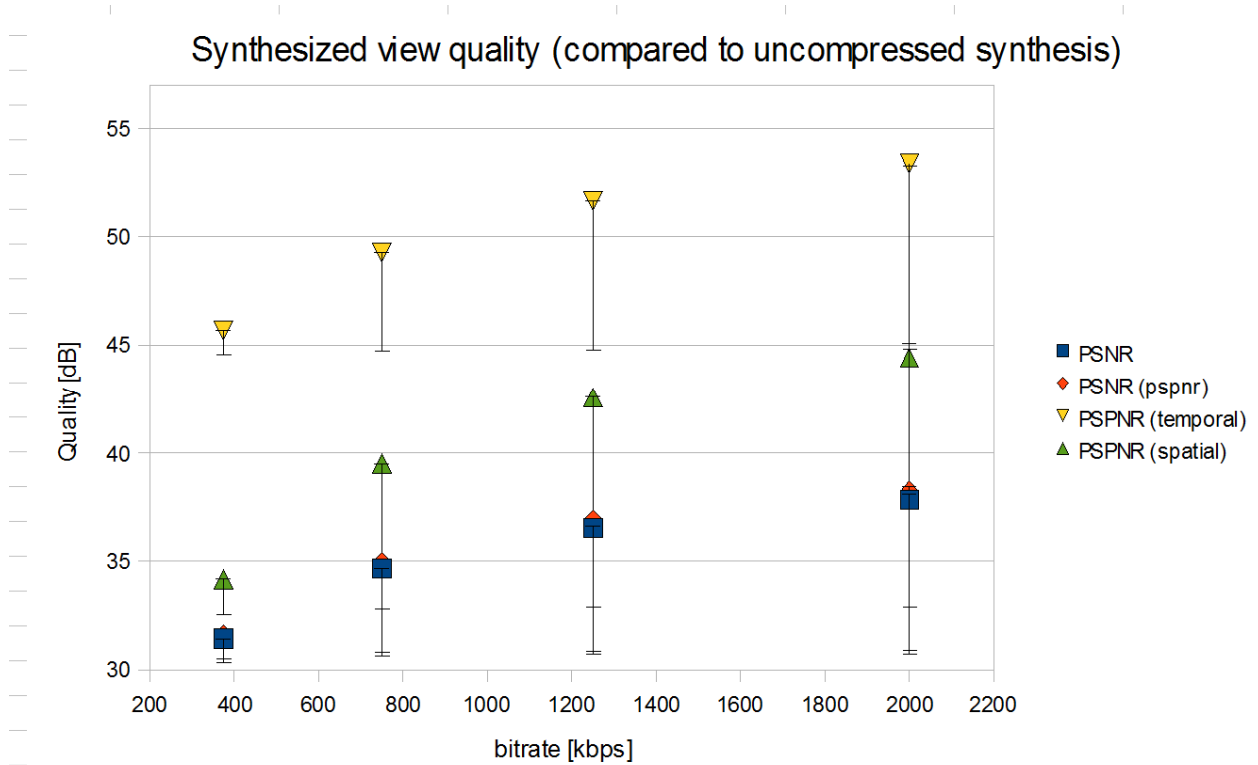


Figure 4. Quality of synthesized view as defined in [1] for 2 camera case. View synthesized with uncompressed data is used as reference. Points mark results for the pairs with minimal QP (and minimal QD, if more than one pair has the same QP). The bars show quality range from the best to the worst pair for each bitrate.

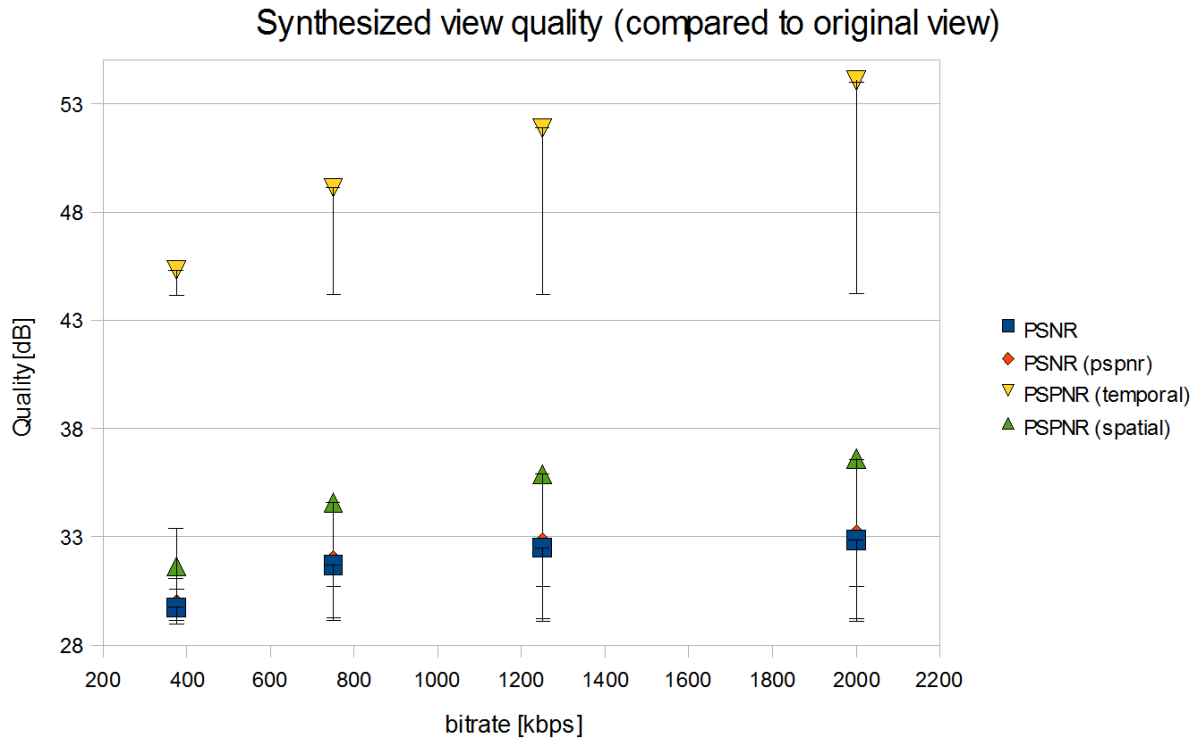
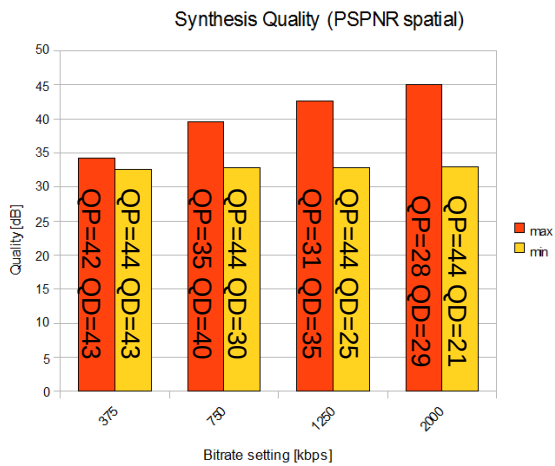
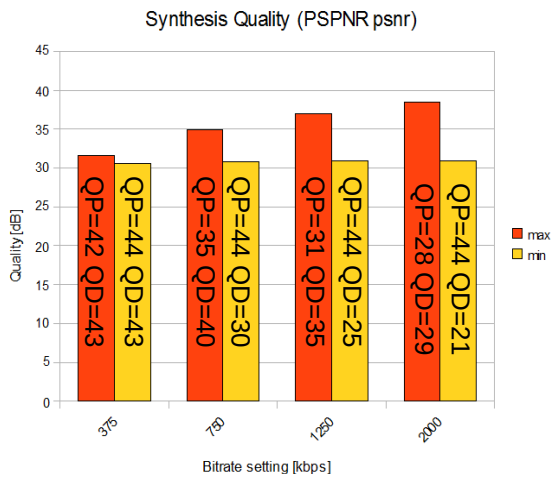
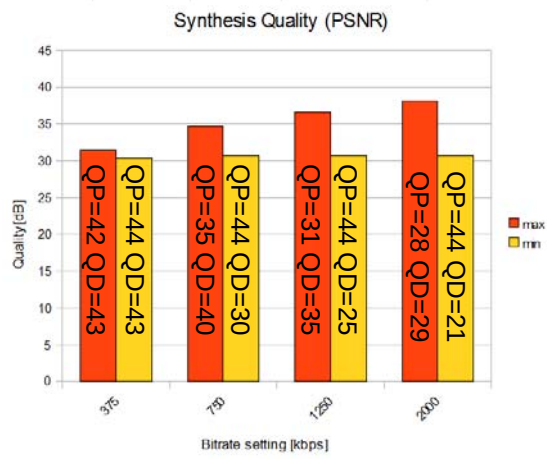
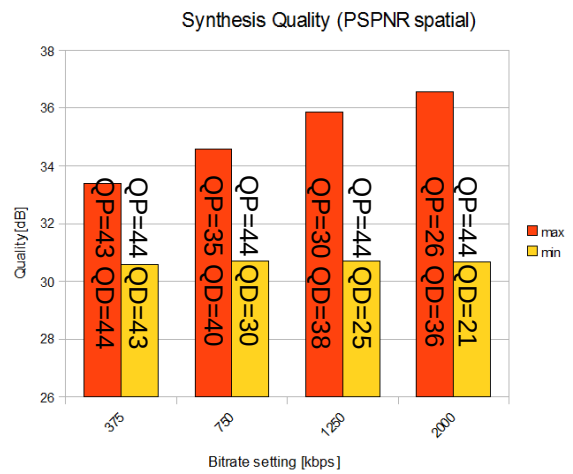
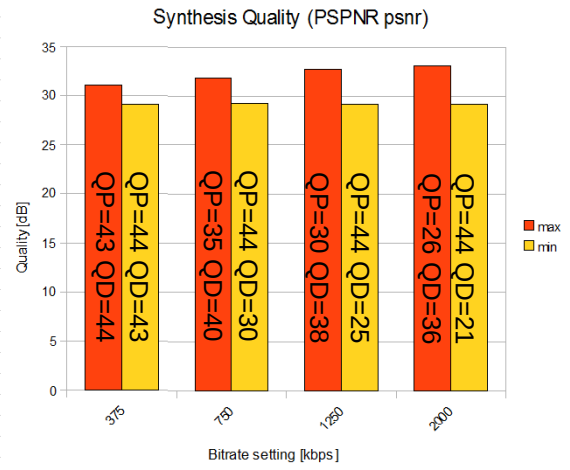
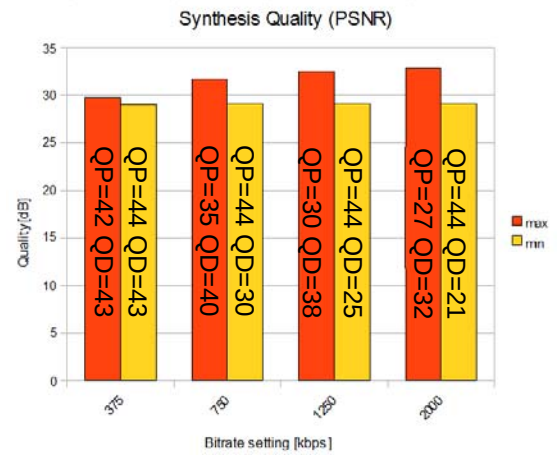


Figure 5. Quality of synthesized view as defined in EE4 for 2 camera case. Real view from camera 5 is used as a reference. Points mark results for the pairs with minimal QP (and minimal QD, if more than one pair has the same QP). The bars show quality range from the best to the worst pair for each bitrate.

Against uncompressed synthesis



Against original view



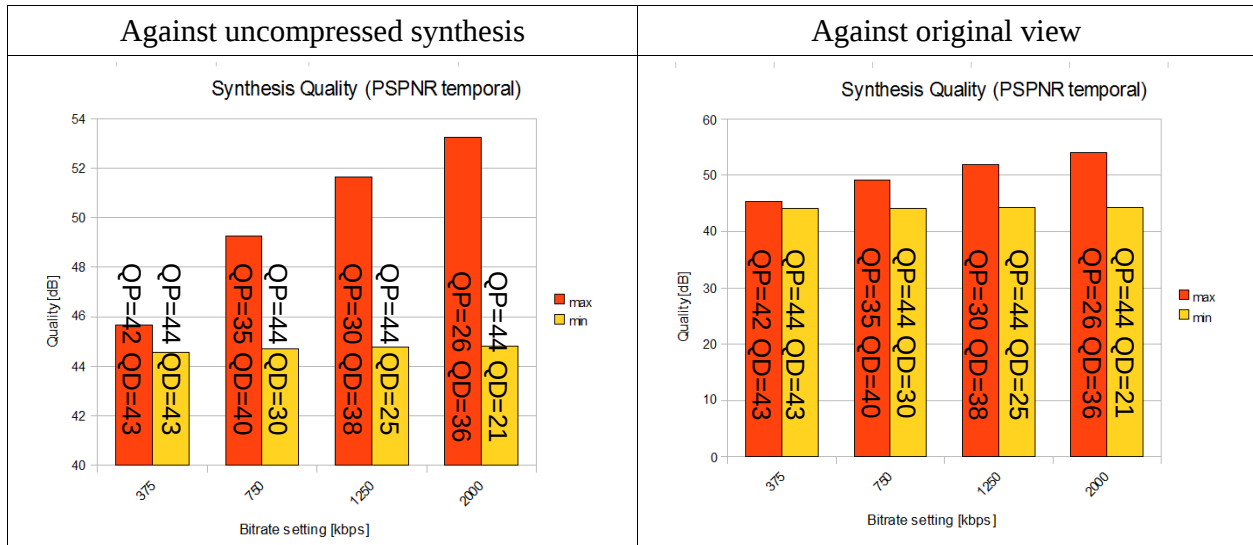


Figure 6. Best and worst results of synthesis for different measures and cases.

5 Conclusions

The conclusions are as follows:

4.1. EE 4 - Two view case

- Quality of synthesized view depends more on quality of compressed/decompressed image (QP parameter) than on quality of compressed/decompressed depth (QD).
- The usual approach of choosing the minimal QP does not give the best results in some cases, but the differences of quality measures are negligible.
- Quality of synthesized views in coding experiments is almost equally distributed over quality axes for reference bitrates.

6 References

- [1] "Description of Exploration Experiments in 3D Video Coding" MPEG 2009/ W10925. Xian, China. October 2009.
- [2] Yo-Sung Ho, Eun-Kyung Lee, and Cheon Lee . „Multiview Video Test Sequence and Camera Parameters". MPEG 2008/M15419. Archamps, France. April 2008.