

# **JCT3V-I0078:**

## **Memory Complexity for DBBP and VSP**

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# Memory Complexity Analysis

- ❖ Worst case memory bandwidth for DBBP and VSP
  - DBBP and VSP can be compared to HEVC worst case
    - HEVC worst case: bi-predictive 8x8 PU
  - DBBP
    - 2 depth block fetches
    - Worst case memory bandwidth is 120% ~ 128%
  - VSP
    - 1 depth block fetch, no vertical interpolation, no bi-prediction
    - Worst case memory bandwidth is 50% ~ 81%

	Memory Pattern (1x1)	Memory Pattern (4x2)	Memory Pattern (8x2)
HEVC	100%	100%	100%
DBBP	120%	125%	128%
VSP	50%	66%	81%

# Proposed Method for DBBP

- ❖ To reduce the memory complexity of DBBP, two methods are proposed
- ❖ **Method 1:** Using NBDV instead of DoNBDV
  - Number of depth fetches can be reduced
  - Worst case memory bandwidth: 128% → 114% (in 8x2 memory pattern)
- ❖ **Method 2:** Disallowing in 8x8 CU
  - Worst case memory bandwidth: 128% → 69% (in 8x2 memory pattern)

	Memory Pattern (1x1)	Memory Pattern (4x2)	Memory Pattern (8x2)	Coding Gain (Synthesized View)
DBBP	120%	125%	128%	n/a
Method 1	110%	113%	114%	0.06%
Method 2	79%	71%	69%	0.00%

# Proposed Method for VSP

- ❖ As doing in DBBP, VSP can use DoNBDV to identify the depth block (**Method 3**)
- ❖ Therefore, it needs to fetch 2 depth blocks
  - Worst case memory complexity: 81% → 94% (in 8x2 memory pattern)
  - This gives a minor coding benefit: 0.05% bit-saving on synthesized views

	Memory Pattern (1x1)	Memory Pattern (4x2)	Memory Pattern (8x2)	Coding Gain (Synthesized View)
VSP	50%	66%	81%	n/a
Method 3	59%	78%	94%	-0.05%

# Simulation Results – Method 1

## ❖ **Method 1:** Using NBDV instead of DoNBDV for DBBP

- Based on CTC and HTM 11
- 0.06% loss on coded and synthesized views

	video 0	video 1	video 2	video PSNR / video bitrate	video PSNR / total bitrate	synth PSNR / total bitrate	enc time	dec time	ren time
Balloons	0.00%	0.02%	0.37%	0.06%	0.06%	0.01%	100.0%	97.6%	99.8%
Kendo	0.00%	-0.08%	0.07%	-0.01%	-0.03%	-0.03%	100.4%	95.4%	99.9%
Newspaper_CC	0.00%	-0.03%	0.06%	0.00%	0.00%	0.00%	99.2%	91.6%	98.2%
GT_Fly	0.00%	0.20%	0.15%	0.05%	0.05%	-0.01%	100.1%	101.7%	103.5%
Poznan_Hall2	0.00%	-0.14%	-0.01%	0.00%	0.02%	0.11%	99.8%	95.5%	103.3%
Poznan_Street	0.00%	0.47%	0.40%	0.10%	0.10%	0.11%	99.9%	94.2%	101.5%
Undo_Dancer	0.00%	0.61%	0.78%	0.16%	0.16%	0.15%	99.3%	98.2%	102.4%
Shark	0.00%	0.52%	0.69%	0.12%	0.11%	0.10%	99.8%	99.3%	103.5%
1024x768	0.00%	-0.03%	0.16%	0.02%	0.01%	-0.01%	99.9%	94.9%	99.3%
1920x1088	0.00%	0.33%	0.40%	0.09%	0.09%	0.09%	99.8%	97.8%	102.8%
<b>average</b>	<b>0.00%</b>	<b>0.20%</b>	<b>0.31%</b>	<b>0.06%</b>	<b>0.06%</b>	<b>0.06%</b>	<b>99.8%</b>	<b>96.7%</b>	<b>101.5%</b>

# Simulation Results - Method 2

## ❖ Method 2: Disallowing DBBP in 8x8 CU

- Based on CTC and HTM 11
- No coding loss

	video 0	video 1	video 2	video PSNR / video bitrate	video PSNR / total bitrate	synth PSNR / total bitrate	enc time	dec time	ren time
Balloons	0.00%	-0.10%	0.13%	0.01%	0.01%	-0.04%	100.0%	100.5%	98.9%
Kendo	0.00%	-0.09%	0.00%	-0.03%	-0.05%	-0.06%	99.5%	98.8%	100.3%
Newspaper_CC	0.00%	-0.04%	0.14%	0.02%	0.02%	0.02%	99.2%	91.9%	99.1%
GT_Fly	0.00%	0.04%	0.09%	0.01%	0.01%	-0.02%	100.3%	102.7%	104.1%
Poznan_Hall2	0.00%	-0.09%	-0.07%	-0.01%	0.01%	0.07%	99.0%	100.8%	102.7%
Poznan_Street	0.00%	0.16%	0.07%	0.03%	0.03%	0.05%	99.7%	101.3%	102.5%
Undo_Dancer	0.00%	-0.04%	0.03%	0.01%	0.01%	0.02%	98.9%	106.4%	101.7%
Shark	0.00%	-0.13%	0.01%	-0.02%	-0.02%	0.00%	100.0%	99.3%	104.0%
1024x768	0.00%	-0.08%	0.09%	0.00%	-0.01%	-0.03%	99.6%	97.1%	99.4%
1920x1088	0.00%	-0.01%	0.03%	0.00%	0.01%	0.02%	99.6%	102.1%	103.0%
<b>average</b>	<b>0.00%</b>	<b>-0.03%</b>	<b>0.05%</b>	<b>0.00%</b>	<b>0.00%</b>	<b>0.00%</b>	<b>99.6%</b>	<b>100.2%</b>	<b>101.6%</b>

# Simulation Results - Method 3

## ❖ **Method 3:** Using DoNBDV instead of NBDV in VSP

- Based on CTC and HTM 11
- 0.05% bit-saving on synthesized views

	video 0	video 1	video 2	video PSNR / video bitrate	video PSNR / total bitrate	synth PSNR / total bitrate	enc time	dec time	ren time
Balloons	0.00%	-0.09%	-0.03%	-0.02%	-0.02%	-0.05%	100.2%	96.6%	102.1%
Kendo	0.00%	-0.16%	-0.08%	-0.03%	-0.08%	-0.09%	99.5%	98.1%	100.1%
Newspaper_CC	0.00%	-0.15%	-0.11%	-0.05%	-0.02%	-0.08%	98.4%	95.1%	98.0%
GT_Fly	0.00%	-0.25%	-0.27%	-0.04%	-0.04%	-0.03%	100.4%	110.2%	104.6%
Poznan_Hall2	0.00%	0.10%	-0.37%	-0.04%	-0.02%	-0.02%	98.7%	97.1%	102.2%
Poznan_Street	0.00%	-0.19%	-0.05%	-0.04%	-0.04%	-0.01%	99.6%	99.5%	102.2%
Undo_Dancer	0.00%	-0.14%	-0.54%	-0.07%	-0.06%	-0.06%	99.3%	99.0%	102.9%
Shark	0.00%	-0.17%	-0.31%	-0.06%	-0.04%	-0.03%	100.2%	98.4%	105.4%
1024x768	0.00%	-0.13%	-0.07%	-0.04%	-0.04%	-0.07%	99.4%	96.6%	100.1%
1920x1088	0.00%	-0.13%	-0.31%	-0.05%	-0.04%	-0.03%	99.6%	100.9%	103.4%
<b>average</b>	<b>0.00%</b>	<b>-0.13%</b>	<b>-0.22%</b>	<b>-0.05%</b>	<b>-0.04%</b>	<b>-0.05%</b>	<b>99.5%</b>	<b>99.3%</b>	<b>102.2%</b>

# Conclusion

- ❖ We analyzed the memory complexity for DBBP and VSP
  - To reduce the memory complexity DBBP, two methods are proposed
    - Option 1: Using NBDV instead of DoNBDV
      - ⊕ 128% → 114% in 8x2 memory pattern
    - Option 2: Disallowing DBBP in 8x8 CU
      - ⊕ 128% → 69% in 8x2 memory pattern
  - Additionally, to align with DBBP and to improve the coding performance, it is proposed to use DoNBDV for VSP
    - 0.05% bit-saving on synthesized views
- ❖ We recommend to adopt the proposed method into next 3D-HEVC WD

**Thanks Sharp for the cross check (JCT3V-I0160).**



