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Parametric Non-local In-loop Filter for Future Video Coding

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Outline

- Introduction
- Parametric Non-local In-loop Filter (PNLF)
- Experimental Results
- Conclusion

Introduction

- Loop filters in VVC
  - LMCS、DBF、SAO、ALF

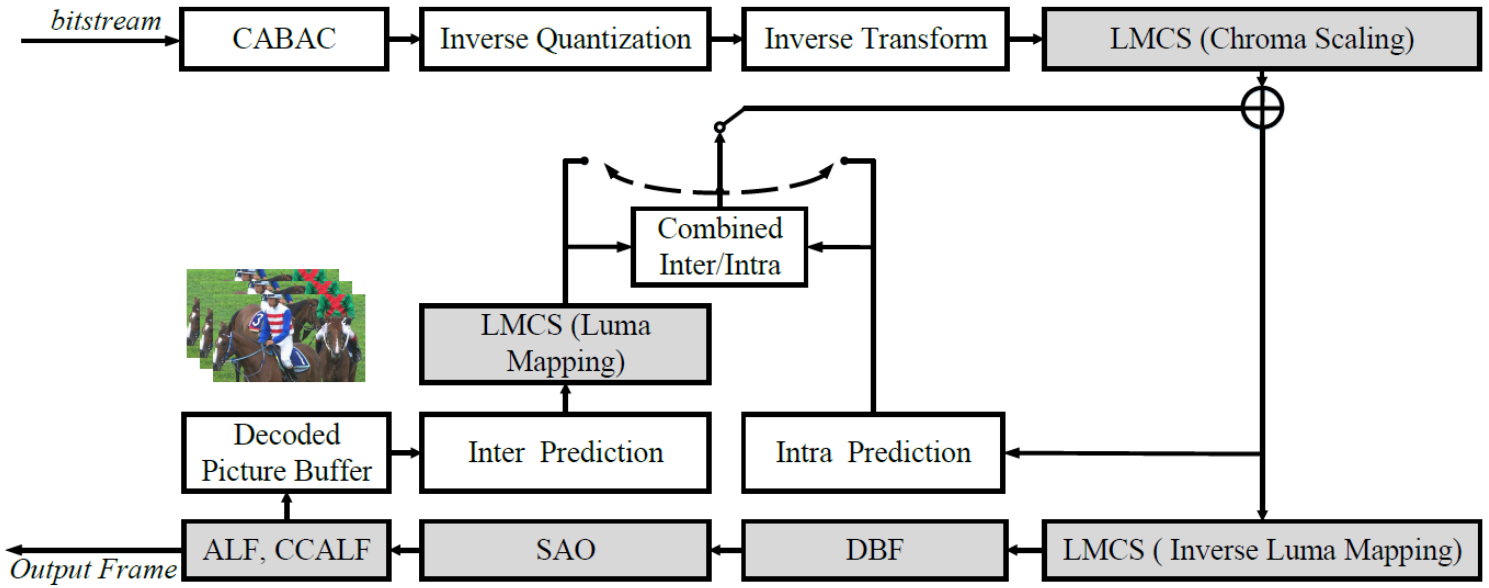


Figure 1: Illustration of the VVC decoder block diagram, with the gray boxes corresponding to in-loop filters.

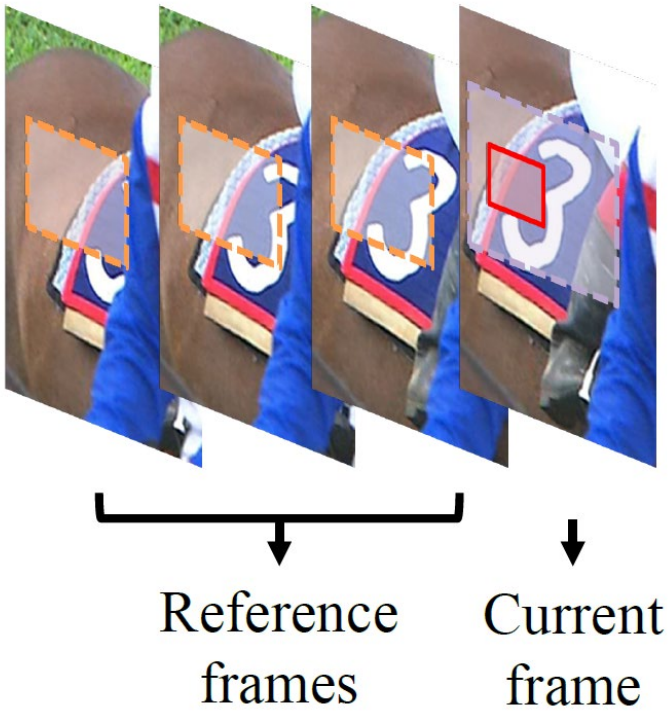
Introduction

- Features of local filters
  - Low complexity
  - The non-local self-similarity is not fully considered.

- Features of non-local filters
  - Non-local similarity
  - High complexity → block matching, SVD process
  - Unsupervised non-local methods with the off-line trained parameters limit content adaptability and coding performance

Parametric Non-local In-loop Filter (PNLF)

- Reference sample derivation



- Filtering operation

$$f(x,y) = \sum_{j=0}^{N-1} w_j \times r_j$$

Parameter selection

- The influence of the block matching scheme on PNLF

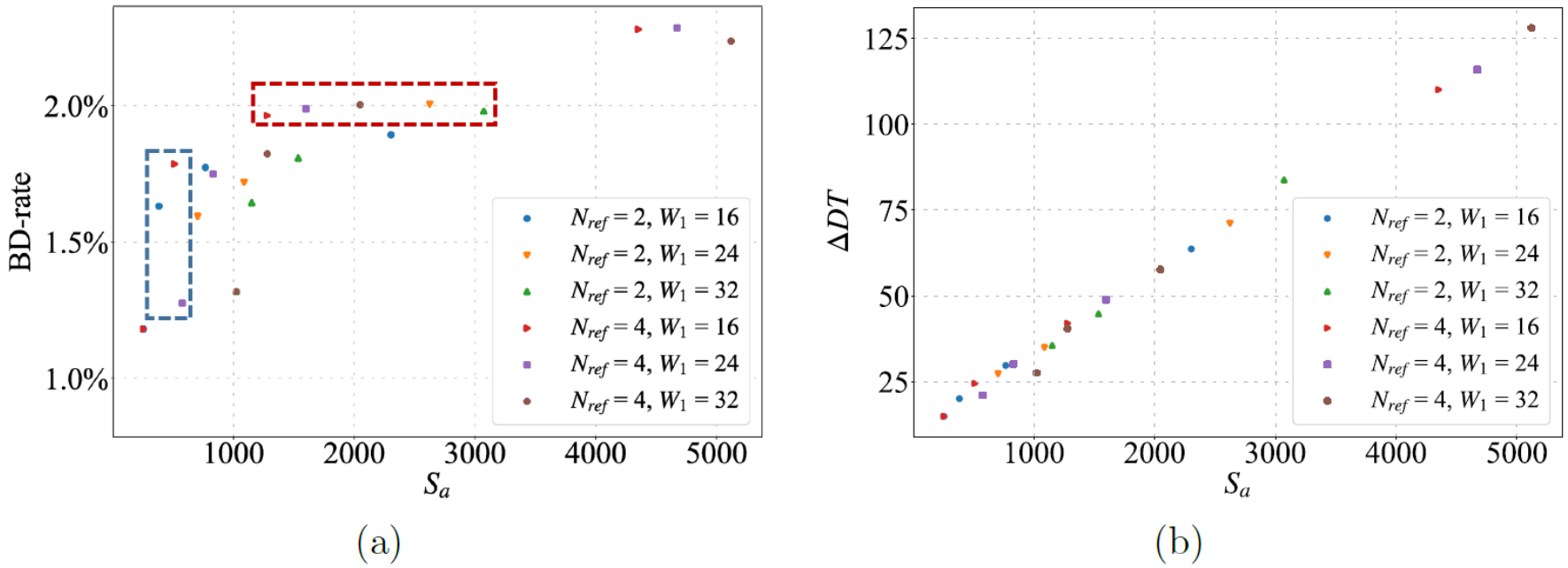


Figure 2: The influence of block matching scheme (search window on the current frame W_1, search window on reference frames W_2, and reference frame number N_{ref}) on PNLF under RA configuration. The y-axis of (a) is the absolute value of BD-rate, for better visualization. The x-axis is the search area S_a.

Parameter selection

- The influence of the block matching scheme on NLSF [1]

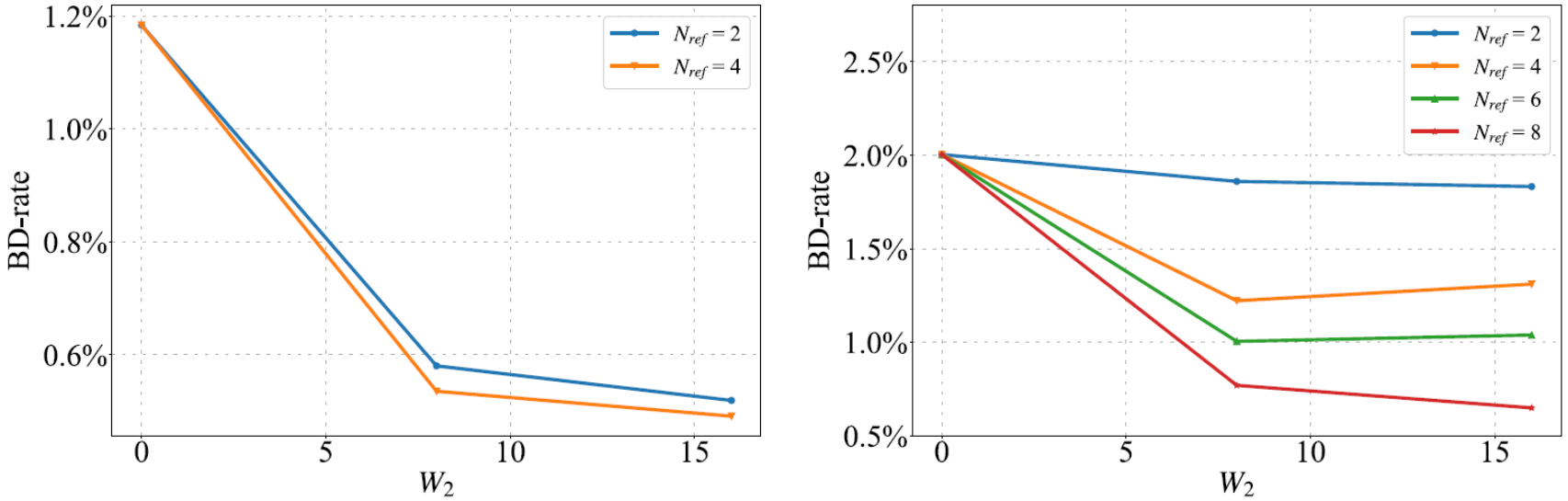


Figure 3: The influence of block matching scheme (search window on reference frames W_2, and reference frame number N_{ref}) on NLSF under RA and LDB configurations. The y-axis is the absolute value of BD-rate, for better visualization.

[1] X. Meng, C. Jia, S. Wang, S. Ma, and X. Zheng, CE2: Non-local structure-based filter, Joint Video Experts Team (JVET), doc. JVET-K0160, Jul. 2018.

Parameter setting

PNLF

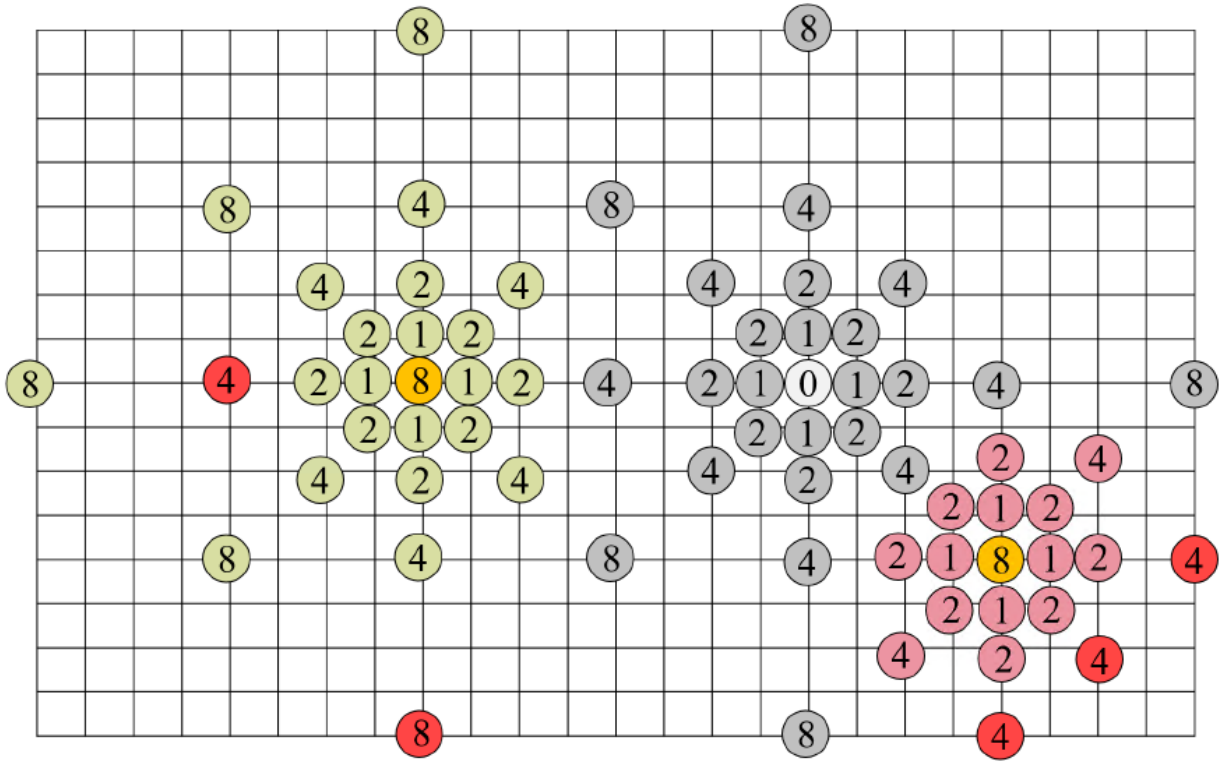
	I-frame	B-frame (RA)	B-frame (LDB)
W_1	32	24	24
W_2	-	16	16
N_{ref}	-	4	8

NLSF

	I-frame	B-frame (RA)	B-frame (LDB)
W_1	32	32	32
W_2	-	-	-
N_{ref}	-	-	-

Fast algorithm

- Two-step fast algorithm [2]



0 Reference block Searched block in step1

Searched block in step2

Similar block selected in step1

Similar block selected in step2

[2] X. Meng, C. Jia, S. Wang, X. Zheng, and S. Ma, Optimized non-local in-loop filter for video coding, in Picture Coding Symposium (PCS). IEEE, 2018, pp. 233-237.

Experimental Results

- Test condition
  - Anchor: VTM-11.0
  - Test: the proposed PNLF
  - QP: 22, 27, 32, 37

Table 2: Experimental results of the proposed PNLF with fast algorithm, Anchor: VTM-11.0.

Class	AI		RA		LDB	
	BD-Rate	ΔDT	BD-Rate	ΔDT	BD-Rate	ΔDT
Class A1	-0.40%	956%	-0.70%	652%	-	-
Class A2	-0.45%	1465%	-0.74%	756%	-	-
Class B	-0.51%	1001%	-1.01%	1954%	-1.51%	1126%
Class C	-0.41%	658%	-1.16%	1120%	-1.35%	1658%
Class D	-0.12%	521%	-1.58%	1952%	-1.85%	1369%
Class E	-0.87%	2023%	-	-	-2.35%	865%
Class F	-0.85%	1489%	-1.16%	1023%	-1.41%	569%
Class TGM	-1.90%	2011%	-2.84%	2463%	-2.97%	1823%
Average (CTC)	-0.52%	1276%	-0.93%	1232%	-1.67%	1238%
Average (All)	-0.70%	1325%	-1.34%	1434%	-1.84%	1246%

Experimental Results

- Test condition
  - Anchor: VTM-11.0
  - Test: NLSF
  - QP: 22, 27, 32, 37

Table 3: Experimental results of NLSF [16], Anchor: VTM-11.0.

Class	AI		RA		LDB	
	BD-Rate	ΔDT	BD-Rate	ΔDT	BD-Rate	ΔDT
Class A1	-0.74%	2185%	-0.63%	2936%	-	-
Class A2	-0.63%	2161%	-0.52%	1522%	-	-
Class B	-0.73%	2102%	-0.88%	1448%	-1.22%	1854%
Class C	-0.92%	3169%	-0.72%	1857%	-1.08%	2394%
Class D	-0.73%	3301%	-0.06%	1158%	-0.42%	1654%
Class E	-1.79%	3304%	-	-	-1.65%	1664%
Class F	-0.74%	2630%	-0.50%	1361%	-1.28%	1646%
Class TGM	-0.65%	2939%	-0.91%	2029%	-0.83%	2362%
Average (CTC)	-0.93%	2509%	-0.71%	1797%	-1.28%	1964%
Average (All)	-0.84%	2574%	-0.61%	1503%	-1.07%	1810%

Conclusion

- Parametric Non-local In-loop Filter
- Compared to the SVD-based non-local filter (NLSF)
  - Better coding performance, especially for screen content videos
  - Lower software and hardware complexity
- Meaningful for the investigation of further video coding standards

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THANKS