INTERNATIONAL ORGANISATION FOR STANDARDISATION
ORGANISATION INTERNATIONALE DE NORMALISATION
ISO/IEC JTC1/SC29/WG11
CODING OF MOVING PICTURES AND AUDIO

ISO/IEC JTC1/SC29/WG11 MPEG130/M53701
April 2020, Online

Source	**Electronics and Telecommunications Research Institute (ETRI)** **Poznań University of Technology (PUT)**
Status	**Input**
Title	**CE3-related: Additional patch dilation in temporal patch redundancy removal**
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1 Introduction

This document describes the results of applying additional patch dilation in temporal patch redundancy removal procedure. The main aim of this procedure is to improve the rendering quality of natural sequences.

2 Overview of the proposed technique

The shape of patches does not change during entire GOP (Group of Pictures). However, if there is any movement in the scene, some pixels are redundant and do not have to be copied to all frames but only to the frames that they are needed. Based on this consensus, a temporal patch redundancy removal was adopted in MPEG 129 meeting, since it achieved significant bit rate reduction. During evaluating the subjective quality of rendered viewport generated by TMIV 4.0, some artifacts were observed. To compensate such artifacts and improve the subjective quality, simple dilation is applied to non-empty area during the procedure of determining temporal removal area. Throughout this contribution, the results will be presented.

2.1 Dilation of non-empty region in temporal redundancy removal

In TMIV 4.0, only the blocks that contain pixels belonging to the cluster for the current frame are copied from source views to atlases (Fig. 1 left). This creates occupied region within patch, while most of patch's area is unoccupied through temporal redundancy removal. Our approach is to let non-empty areas have some amount of redundancy over consecutive frames to improve image quality of rendered viewport. Thus, applied current dilation of the hierarchical pruner to only non-empty region, while maintaining the clusters that are independently determined by the mask aggregator (Fig. 1 right). Therefore, there is no alteration of original patch shape but expansion of non-empty region in CU (Coding Unit). To align with non-empty region in CU, both 8x8 and 16x16 block expansion were evaluated and it was confirmed that the latter choice could achieve better performance.

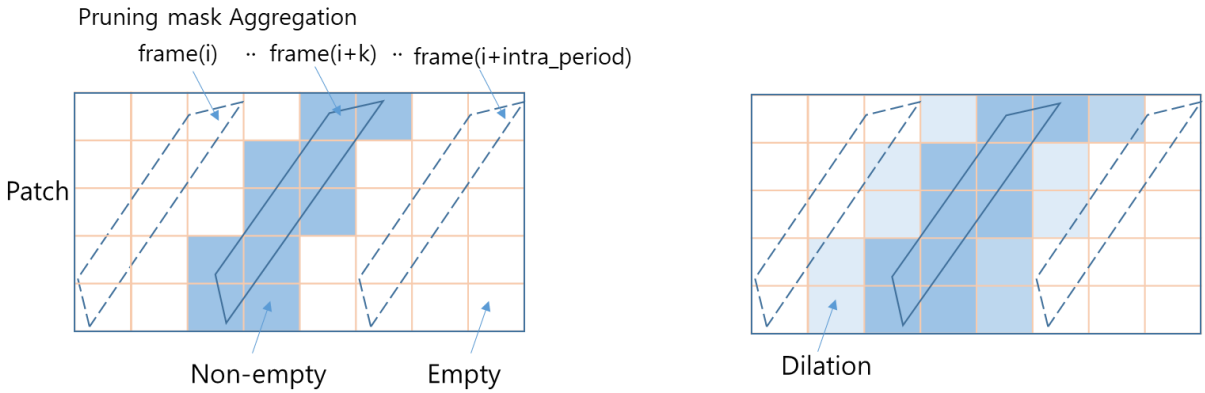

Fig. 1. Temporal redundancy reduction in TMIV4.0 (left) vs. proposed method (right).

3 Experimental results

The comparison between TMIV 4.0 (left) and proposed method (right) is presented in Fig. 2. At TMIV4.0, most of the patch's area is empty by temporal patch redundancy removal procedure. At proposed approach, 16x16 blocks were dilated in non-empty region. Table 1 shows the summary of objective evaluation result.

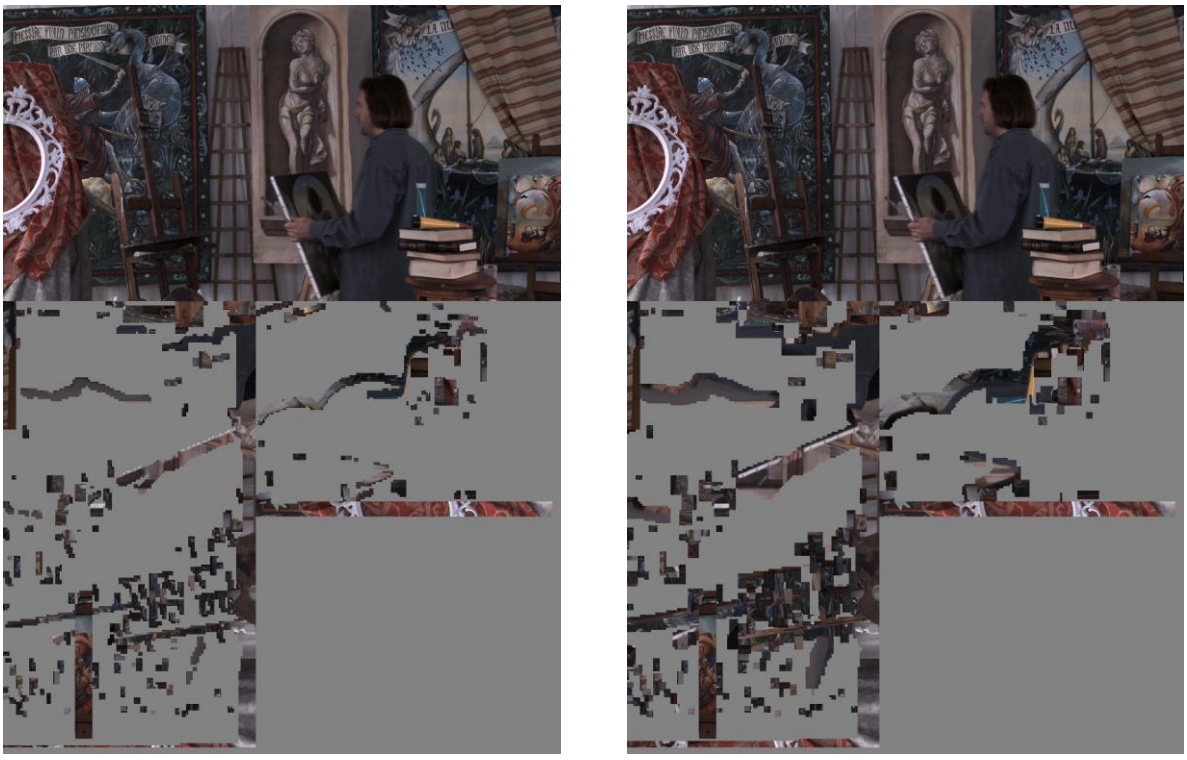

Fig. 2. TMIV 4.0 (left) vs. proposed method (right).

Table 1. Objective evaluation result

Test class	Sequence	Anchor (ff)	High-BR BD rate Y-PSNR	Low-BR BD rate Y-PSNR	Max delta Y-PSNR	High-BR BD rate VMAF	Low-BR BD rate VMAF	High-BR BD rate IV-PSNR	Low-BR BD rate IV-PSNR	Pixel rate ratio
CG	ClassroomVideo	AA97 (MIV)	-2.4%	-0.9%	3.23	-0.3%	-0.9%	4.9%	2.1%	0.59
	TechnicolorMuseum	BA97 (MIV)	-0.7%	-2.0%	13.88	-1.3%	-2.7%	-0.6%	-2.0%	0.59
	InterdigitalHijack	CA97 (MIV)	4.8%	1.2%	12.28	3.1%	0.4%	4.5%	0.6%	0.59
	OrangeKitchen	JA97 (MIV)	4.8%	3.9%	14.67	3.3%	3.9%	6.4%	4.9%	0.70
	NokiaChess (*)	NA97 (MIV)	#VALUE!	#VALUE!	0.00	#VALUE!	#VALUE!	#VALUE!	#VALUE!	0.59
		All MIV Anchor	1.6%	0.6%	14.67	1.2%	0.2%	3.8%	1.4%	
NC	TechnicolorPainter	DA97 (MIV)	3.3%	2.5%	7.99	0.0%	0.0%	-28.0%	-9.8%	0.63
	IntelFrog	EA97 (MIV)	-18.2%	-6.5%	10.69	-10.9%	-0.8%	-12.3%	-3.0%	0.70
	PoznanFencing	LA97 (MIV)	-16.5%	-9.7%	13.88	6.5%	4.3%	-9.6%	-6.1%	0.49
	PoznanCarpark (*)	PA97 (MIV)	-18.5%	-13.3%	11.14	-17.4%	-11.3%	-15.3%	-11.1%	0.49
	PoznanHall (*)	TA97 (MIV)	-36.9%	-28.4%	11.10	-27.0%	-19.0%	-27.1%	-22.3%	0.49
	PoznanStreet (*)	UA97 (MIV)	-3.1%	-0.6%	10.14	-7.6%	-1.3%	1.9%	2.6%	0.49
		All MIV Anchor	-10.4%	-4.6%	13.88	-1.5%	1.1%	-16.6%	-6.3%	

Test class	Sequence	Anchor (ff)	High-BR BD rate Y-PSNR	Low-BR BD rate Y-PSNR	Max delta Y-PSNR	High-BR BD rate VMAF	Low-BR BD rate VMAF	High-BR BD rate IV-PSNR	Low-BR BD rate IV-PSNR	
All		**All MIV Anchor**	-3.5%	-1.6%	10.94	0.1%	0.6%	-4.9%	-1.9%	

The results of the proposed enhancement of viewport are presented in the figures below

Fig. 2. TMIV 4.0 (left) vs. proposed method (right).

4 Conclusions and Recommendations

In objective and subjective evaluation aspect,

- Proposal achieves much better performance for most NC test sequences on almost objective metrics
- Proposal improves the viewport quality for most NC test sequences.

It is recommended to:

- Adopt the proposed method into TMIV 5.0 for NC sequences. One new parameter option “Dilate” may need to be added at “Packer” part of TMIV json file.

5 References

[1] A. Dziembowski, D. Mieloch, A. Grzelka, J. Stankowski, M. Domański, G. Lee “Immersive Video CE3.2: Temporal patch redundancy removal”, ISO/IEC JTC1/SC29/ MPEG2019/M51603 January 2020, Brussels, Belgium.