

JVET-AF0173

Weighted Filtering for Picture Upscaling and RPR

Tim Claßen, Mathias Wien

Lehrstuhl für Bildverarbeitung

RWTH Aachen University

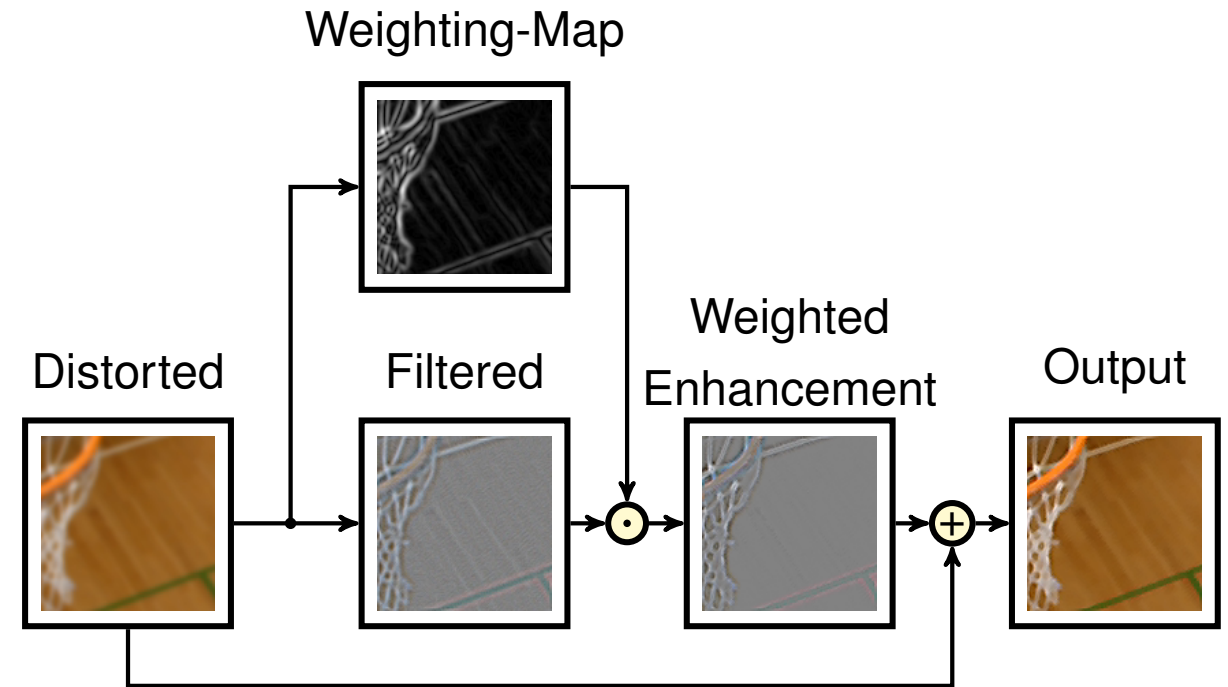
Background

- Upsampled video content in RPR is usually blurred
 - High-frequency components are lost in the downsampling operation
 - Structural content such as edges is degraded
- Pre-defined linear upsampling filters are currently applied for picture upscaling
- Adaptive filter for edge enhancement without ringing or overshoot and amplification of noise desirable
 - Sharpening of edges and blurred content

Weighted Edge Enhancement Filtering

Filter Setup

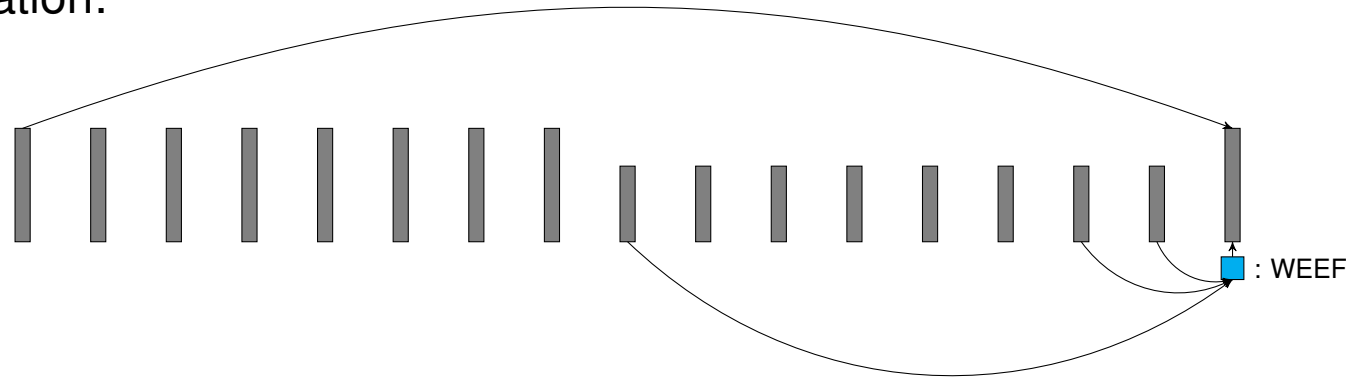
1. Weighting map is computed based as function of the input picture
 2. Filtered picture is computed based on input picture
 3. Multiplication of weighting map and filtered picture
 4. Result of multiplication is added to the input picture
- Filter is applied to luma and chroma components separately
 - Weighting map: Magnitude of the local gradient (e.g. Sobel-operator)
 - Diamond shaped filters similar to ALF



Exploration Experiment

Test 4.2a

- Test description:
 - Filtering applied after motion compensation of low-resolution blocks
- Illustration of configuration:



- Current implementation:
 - Filter is optimized for high-resolution frame
 - Filter is applied to all referenced low-resolution blocks in inter-prediction
 - Filter is not used if low-resolution reference block area $< 2\%$

Exploration Experiment

Test 4.2a (Experimental Implementation)

Trial encode slice

if Low-resolution picture in refPicList **then**

if Referenced low-resolution area $< 2\%$ **then**

 Return

end if

 Optimize and assign WEEF

 Trial encode slice

if RD-costs with WEEF $>$ RD-costs without WEEF **then**

 Remove WEEF

 Encode slice

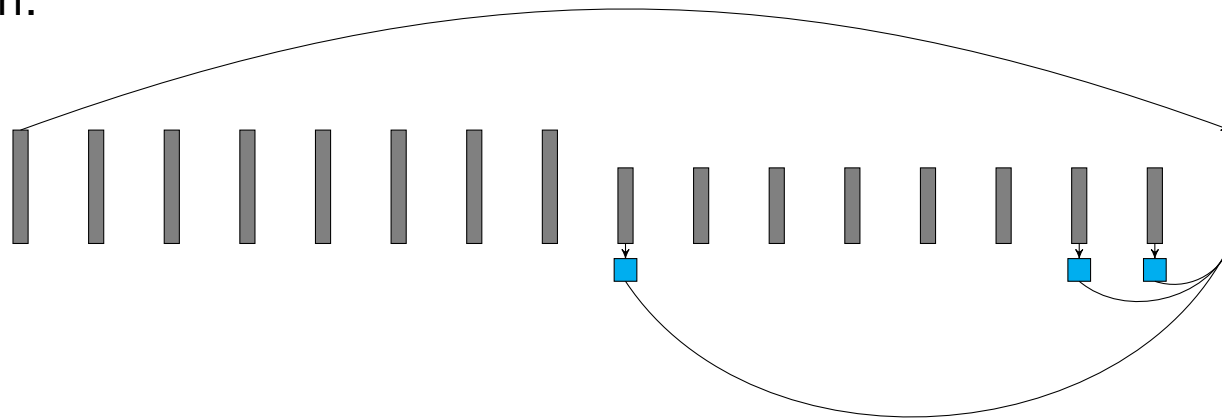
end if

end if

Exploration Experiment

Test 4.2b

- Test description:
 - Filtering applied after motion compensation of low-resolution blocks and as post-processing of upscaled output pictures
- Illustration of configuration:



- Current implementation:
 - Filter is optimized for each low-resolution frame
 - Filter is applied to the upscaled output picture and to blocks referenced by a high-resolution picture

Test 4.2b

```
if Current picture is low-resolution picture then
    Optimize and assign WEEF
    if RD-costs with WEEF > RD-costs without WEEF then
        Remove WEEF
    end if
end if
```

Simulation Results

Test 4.2a: 1.5x (left) and 2.0x (right)

	Low delay B Main 10				
	Experiment 4.2a over ECM-10.0 (RPR 1.5x)				
	Y	U	V	EncT	DecT
Class A1					
Class A2					
Class B	#WERT!	#WERT!	#WERT!	#DIV/0!	#DIV/0!
Class C	0.00%	0.00%	0.01%	131%	117%
Class E	-0.02%	0.05%	-0.02%	126%	114%
Overall	#WERT!	#WERT!	#WERT!	#DIV/0!	#DIV/0!
Class D	0.00%	-0.03%	0.00%	115%	104%
Class F	#WERT!	#WERT!	#WERT!	#DIV/0!	#DIV/0!
Class TGM	#WERT!	#WERT!	#WERT!	#DIV/0!	#DIV/0!

	Low delay B Main 10				
	Experiment 4.2a over ECM-10.0 (RPR 2.0x)				
	Y	U	V	EncT	DecT
Class A1					
Class A2					
Class B	#WERT!	#WERT!	#WERT!	#DIV/0!	#DIV/0!
Class C	-0.02%	-0.05%	-0.02%	129%	117%
Class E	0.00%	0.00%	0.00%	129%	116%
Overall	#WERT!	#WERT!	#WERT!	#DIV/0!	#DIV/0!
Class D	0.00%	0.00%	0.00%	116%	105%
Class F	#WERT!	#WERT!	#WERT!	#DIV/0!	#DIV/0!
Class TGM	#WERT!	#WERT!	#WERT!	#DIV/0!	#DIV/0!

Simulation Results

Unfinished Classes of Test 4.2a: 1.5x (top) and 2.0x (bottom)

Class	Sequence	Y	U	V	EncT	DecT
F	BasketBallDrillText	0.00%	0.00%	0.00%	138%	118%
F	SlideEditing	0.00%	0.00%	0.00%	105%	107%
F	SlideShow	-0.10%	-0.16%	0.04%	126%*	95%*

Class	Sequence	Y	U	V	EncT	DecT
F	BasketBallDrillText	0.01%	0.03%	-0.01%	139%	119%
F	SlideEditing	0.00%	0.00%	0.00%	105%	106%
F	SlideShow	0.00%	0.00%	0.00%	140%*	149%*
TGM	ChineseEditing	0.00%	0.00%	0.00%	197%*	219%*

*:Run-time data unreliable

Simulation Results

Test 4.2b: 1.5x (left) and 2.0x (right)

	Low delay B Main 10				
	Experiment 4.2b over ECM-10.0 (RPR 1.5x)				
	Y	U	V	EncT	DecT
Class A1					
Class A2					
Class B	#WERT!	#WERT!	#WERT!	#DIV/0!	#DIV/0!
Class C	-3.12%	-0.42%	-0.43%	132%	151%
Class E	-6.21%	0.29%	0.89%	129%	143%
Overall	#WERT!	#WERT!	#WERT!	#DIV/0!	#DIV/0!
Class D	-2.85%	0.89%	-0.44%	113%	125%
Class F	#WERT!	#WERT!	#WERT!	#DIV/0!	#DIV/0!
Class TGM	#WERT!	#WERT!	#WERT!	#DIV/0!	#DIV/0!

	Low delay B Main 10				
	Experiment 4.2b over ECM-10.0 (RPR 2.0x)				
	Y	U	V	EncT	DecT
Class A1					
Class A2					
Class B	#WERT!	#WERT!	#WERT!	#DIV/0!	#DIV/0!
Class C	-4.03%	-0.69%	-0.70%	135%	148%
Class E	-12.58%	-1.11%	0.65%	134%	152%
Overall	#WERT!	#WERT!	#WERT!	#DIV/0!	#DIV/0!
Class D	-2.78%	1.32%	-1.44%	116%	122%
Class F	#WERT!	#WERT!	#WERT!	#DIV/0!	#DIV/0!
Class TGM	#WERT!	#WERT!	#WERT!	#DIV/0!	#DIV/0!

Simulation Results

Unfinished Classes of Test 4.2b: 1.5x (top) and 2.0x (bottom)

Class	Sequence	Y	U	V	EncT	DecT
F	BasketBallDrillText	-5.75%	-14.55%	-10.66%	133%	155%
F	SlideEditing	-3.23%	-2.21%	-2.31%	119%	158%
F	SlideShow	-6.46%	-6.06%	-6.28%	125%*	119%*

Class	Sequence	Y	U	V	EncT	DecT
F	BasketBallDrillText	-6.94%	-7.51%	-6.61%	142%	160%
F	SlideEditing	-1.51%	-0.54%	-1.14%	125%	185%
F	SlideShow	-15.67%	-7.32%	-6.58%	143%*	187%*

*:Run-time data unreliable

Simulation Results

Number of referenced low-resolution blocks by high-resolution pictures 1.5x (left) and 2.0x (right)

Sequence	QP	Anchor	Test 4.2b	Test 4.2b in %
BQSquare	22	2174	2227	102.4%
BQSquare	27	1344	1411	105.0%
BQSquare	32	864	940	108.8%
BQSquare	37	654	656	100.3%
RaceHorsesD	22	6152	6386	103.8%
RaceHorsesD	27	4668	4675	100.1%
RaceHorsesD	32	3278	3327	101.5%
RaceHorsesD	37	2136	2099	98.3%
BasketballDrill	22	9960	10020	100.6%
BasketballDrill	27	6734	6925	102.8%
BasketballDrill	32	4788	4976	103.9%
BasketballDrill	37	3335	3376	101.2%
		46087	47018	102.0%

Sequence	QP	Anchor	Test 4.2b	Test 4.2b in %
BQSquare	22	1462	1408	96.3%
BQSquare	27	936	929	99.3%
BQSquare	32	514	528	102.7%
BQSquare	37	319	377	118.2%
RaceHorsesD	22	4260	4273	100.3%
RaceHorsesD	27	3063	3089	100.8%
RaceHorsesD	32	2045	2147	105.0%
RaceHorsesD	37	1340	1372	102.4%
BasketballDrill	22	5826	5812	99.8%
BasketballDrill	27	4335	4307	99.4%
BasketballDrill	32	3320	3291	99.1%
BasketballDrill	37	2311	2324	100.6%
		29720	29857	100.5%

Conclusion

- Proposed method shows promising results for Test 4.2b and marginal gains for Test 4.2a
- Test 4.2a:
 - It was observed that the filter shows small gains for selected pictures
 - Next steps are the study of an optimized filter derivation and encoding for Test 4.2a
- Test 4.2b:
 - Promising gains can be observed for the upscaled low-resolution pictures
 - It is proposed to study run-time optimizations for Test 4.2b
- It is proposed to consider dynamic resolution encoding with constant output resolution as a mode of operation in ECM