

Cross-channel techniques to improve intra chroma prediction

JCTVC-F502

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Summary of JCTVC-F502

- **Two techniques to improve intra chroma prediction**

- Technique 1: A 3x2 Luma downsampling filter for LM mode (1x2 for when left luma are not available)
- Technique 2: A new coding mode: Local adaptive prediction selection (LAPS) based on local analysis on reconstructed luma pixels,
- Combination of above two techniques

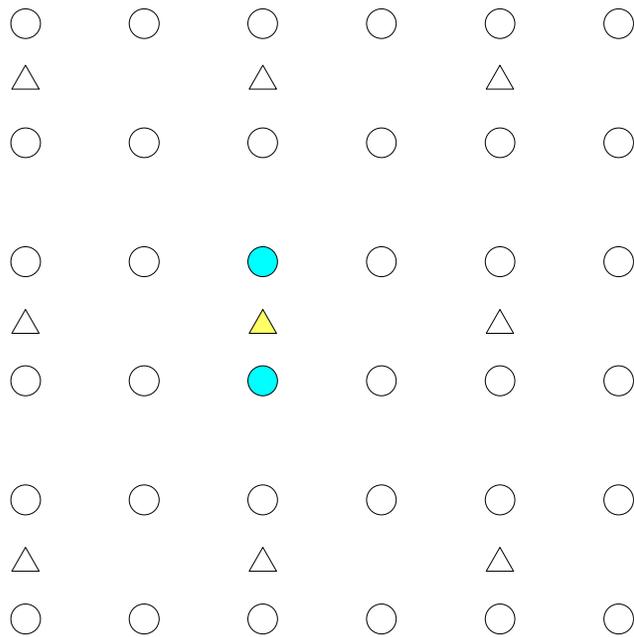
AI/HE		Y	U	V	Best	Enc T	Dec T
	3x2	-0.1%	-0.5%	-0.3%	-2.0%, -1.7%	100%	99%
	LAPS	-0.0%	-0.3%	-0.3%	-0.9%, -0.9%	103%	99%
	Combo	-0.2%	-0.7%	-0.6%	-2.3%, -2.0%	103%	100%

- AI/LC

3x2	-0.1%	-0.8%	-0.6%	99%	99%
LAPS	-0.0%	-0.2%	-0.2%	103%	97%
Combo	-0.1%	-1.0%	-0.8%	103%	99%

3x2 luma down-sampling filter for LM mode

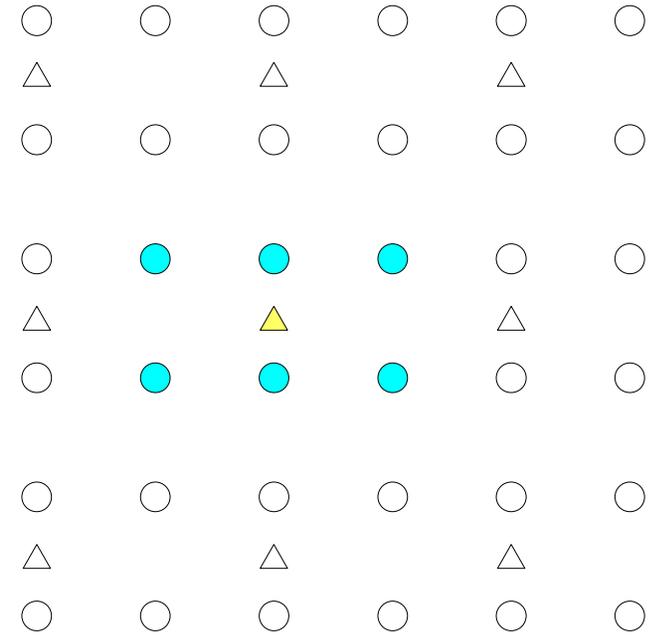
HM3.0 filter



○ : Luma position

△ : Chroma position

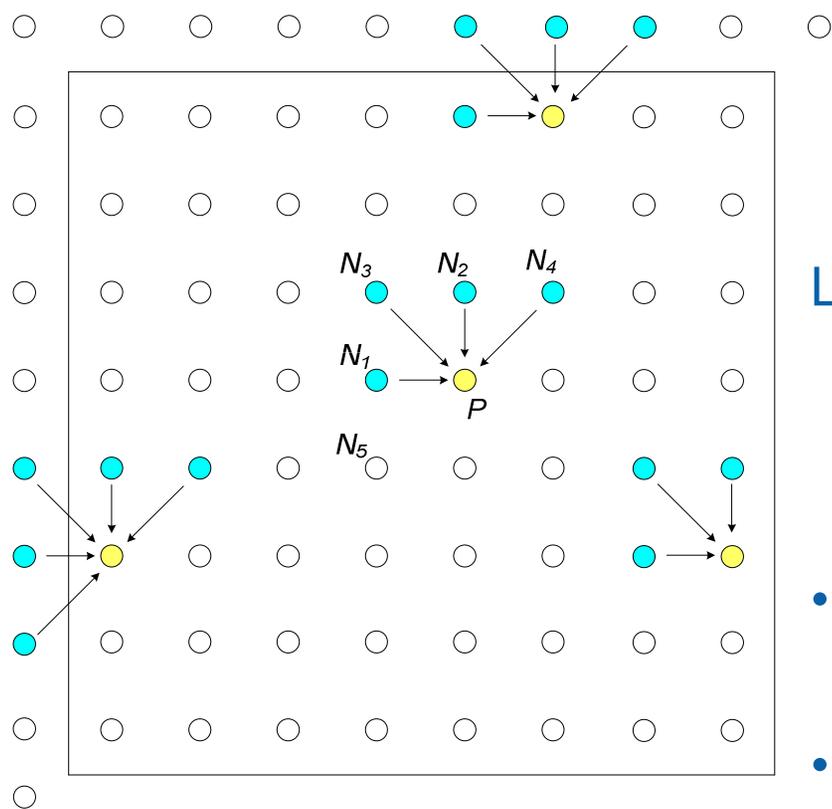
Proposed 3x2 filter



$$\begin{bmatrix} 1 & 2 & 1 \\ 1 & 2 & 1 \end{bmatrix} / 8$$

LAPS mode for intra chroma prediction

- LAPS adaptively selects chroma prediction sample based on search of local neighboring down-sampled luma.



○ : Chroma & down-sampled luma position

$L(x)$ -- Down-sampled reconstructed luma pixel value of position x
 $\hat{C}(x)$ -- Predicted chroma value of position x

LAPS of position P:

$$\begin{cases} k = \arg \min_{i=1 \sim 5} |L(P) - L(N_i)| \\ \hat{C}(P) = \hat{C}(N_k) \end{cases}$$

- If $L(N_i)$ is not available, position N_i will not be considered.
- If N_k is from neighbor PU, $\hat{C}(N_k)$ can be the reconstructed chroma value of position N_k

Simulations

- Implemented onto HM3.0
- Evaluated under the common test conditions
 - AI_HE & AI_LC
- Encoding tests
 - Compiled and tested on 64bit Linux OS
- Decoding tests
 - Compiled with VS2008 and tested on a server with the configuration:
Windows Server 2003 Enterprise x64 Edition, Intel Xeon CPU E5335 @
2.00GHz, 8GB RAM
- Cross verified by MediaTek (JCTVC-F706)

Performance of 3x2 luma down-sample filter

	All Intra HE			All Intra LC		
	Y	U	V	Y	U	V
Class A	0.0	-0.2	0.6	0.0	-0.1	0.7
Class B	-0.1	-0.2	-0.2	-0.1	-0.6	-0.4
Class C	-0.3	-1.1	-1.0	-0.3	-1.7	-1.5
Class D	-0.2	-0.8	-0.8	-0.2	-1.2	-1.2
Class E	0.0	-0.2	-0.4	0.0	-0.3	-0.5
Overall	-0.1	-0.5	-0.3	-0.1	-0.8	-0.6
Enc Time[%]	100%			99%		
Dec Time[%]	99%			99%		

Coding gain loss was observed for two 10-bit clips:

	All Intra HE			All Intra LC		
	Y	U	V	Y	U	V
Nebuta	0.0	-0.4	1.6	0.0	0.1	1.8
SteamLoco	0.0	0.5	1.2	0.0	0.4	1.3

Performance of LAPS mode

	All Intra HE			All Intra LC		
	Y	U	V	Y	U	V
Class A	0.0	0.0	0.0	0.0	-0.1	0.0
Class B	0.0	-0.2	-0.2	0.0	-0.2	-0.2
Class C	0.0	-0.5	-0.4	-0.1	-0.6	-0.5
Class D	-0.1	-0.5	-0.6	-0.1	-0.5	-0.5
Class E	0.0	-0.1	-0.1	0.0	0.2	0.1
Overall	0.0	-0.3	-0.3	0.0	-0.2	-0.2
Enc Time[%]		103%			103%	
Dec Time[%]		99%			97%	

Combination of 3x2 filter and LAPS mode

	All Intra HE			All Intra LC		
	Y	U	V	Y	U	V
Class A	0.0	-0.2	0.5	0.0	-0.1	0.7
Class B	-0.1	-0.4	-0.4	-0.1	-0.8	-0.6
Class C	-0.4	-1.5	-1.4	-0.3	-2.2	-2.0
Class D	-0.3	-1.2	-1.4	-0.3	-1.6	-1.6
Class E	0.0	-0.3	-0.5	0.0	0.0	-0.4
Overall	-0.2	-0.7	-0.6	-0.1	-1.0	-0.8
Enc Time[%]	103%			103%		
Dec Time[%]	99%			100%		

Conclusion

- 3x2 Luma down-sampling filter for LM mode
 - BD-bitrates for U & V are **0.5%** & **0.3%** for AI_HE case (up to **2.0%** & **1.7%** for clip PartyScene), no impact on run time
 - Local adaptive prediction selection (LAPS) mode based on local analysis of reconstructed luma pixels
 - BD-bitrates for U & V are **0.3%** & **0.3%** for AI_HE case (up to **0.9%** & **0.9%** for clip BasketballPass)
- Combination of 2D filter for LM mode and LAPS
 - BD-bitrates for U & V are **0.7%** & **0.6%** for AI_HE case (up to **4.0%** & **2.9%** for clip BasketballDrill)
- A similar proposal from Mitsubishi Electronics (JCTVC-F173)
- Suggest to adopt 3x2 filter into HM4.0 and to further study LAPS in CE

