JCTVC-I0110

Improved implicit weighted prediction

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Summary

- AHG18: Weighted Prediction in HEVC
  - AVC based WP (AVCWP) was adopted in HM4/WD4
  - Current implicit WP (IWP) cannot compensate pixel value additively, because offsets are always set to 0.
  - Current IWP cannot be applicable to uni-pred
- Proposal:
  - As a decoding process, simple WP parameter estimation based on alpha-blending model (JCTVC-F365) is introduced
- Results:
  - Report experimental results on black-fade and white-fade sequences
  - Cross-checking results are reported in JCTVC-I0128 by Technicolor

Weighted prediction (WP)

- **For uni-prediction**

  $pred = ((predL_0 \times W_0 + (1 << (LWD-1))) >> LWD) + O_0,$

- **For bi-prediction**

  $pred = ((predL_0 \times W_0 + predL_1 \times W_1 + ((O_0+O_1+1) << (LWD)) >> (LWD + 1),$

  where W_X is a weighting factor and O_X is an offset for list X (X is 0 or 1).

- Several WP modes:
  - Default: default HEVC uni or bi-prediction (w/o WP).
  - Explicit: weighting factors and offsets are transmitted explicitly in the slice header.
  - **Implicit**: weighting factors for bi-prediction are derived from the temporal distance among the current POC of the target picture and the POCs of the reference pictures used for bi-prediction (B-slices only). Offsets are always set to 0.

→ Implicit WP cannot compensate the pixel value additively and cannot be applicable to uni-prediction in P/B-slices.

Simple WP parameter estimation as a decoding process

- **α -Blending model** (See detailed algorithm in JCTVC-F326)

  $Y'(t) = \alpha(t) * Y(t) + (1-\alpha(t)) * C$

  where $Y(t)$ is the original picture at time t and $Y'(t)$ is the fading picture. C is a target pixel value (such as 16 for black fade and 235 for white fade) and $\alpha(t)$ means alpha-blending parameter.

- Weighting factors and offsets:

  $Y'(t) = \underline{\alpha(t)/\alpha(t-1)} * Y(t-1) + \underline{(1-\alpha(t)/\alpha(t-1)) * C}$,

- Introduce AC and DC components of $Y(t)$:

$$W_0 = \frac{\sum_N |AC(Y'(t))|}{\sum_N |AC(Y'(t-1))|} = \frac{\alpha(t)}{\alpha(t-1)},$$

$$O_0 = DC(Y'(t)) - W_0 \times DC(Y'(t-1)) = dc(t) - W_0 \times dc(t-1)$$

If AC and DC components of the target picture can be derived, the optimal weighting factor and offset between the reference picture and the target picture can be derived from the above equations.

Derivation of weighting factor and offset

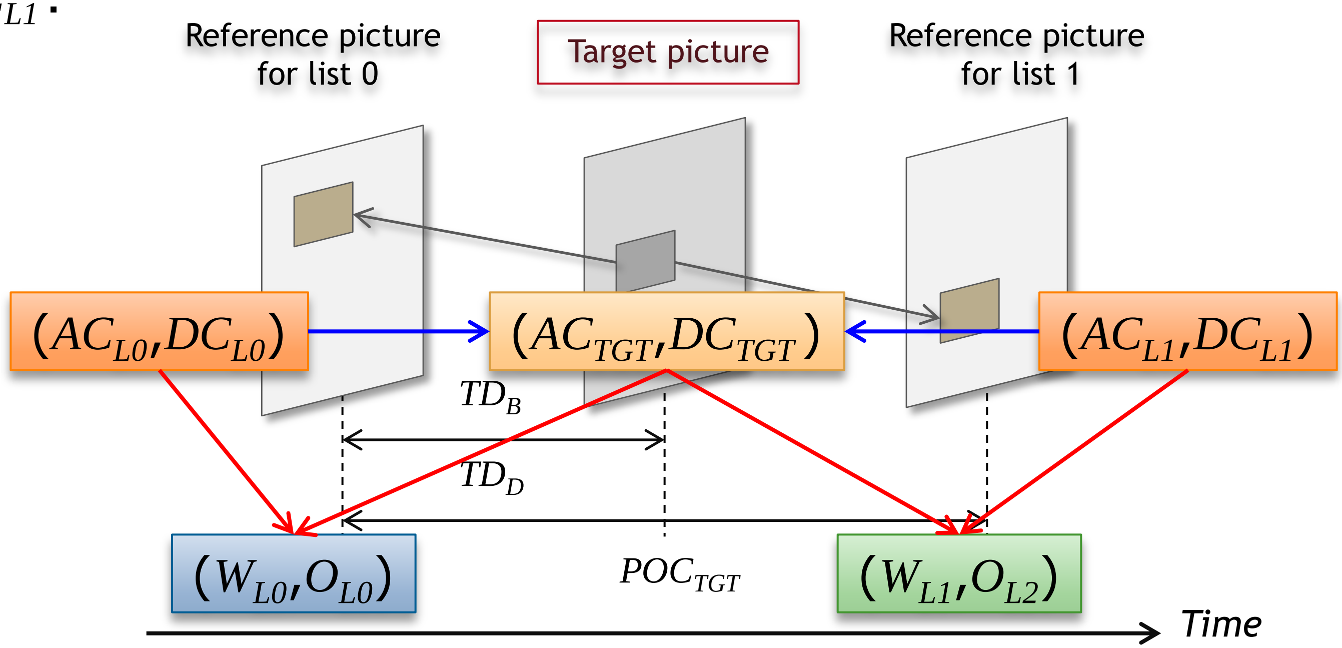
- **Derivation of AC/DC value for the target picture**

$$TD_B = Clip3(-128, 127, POC_{TGT} - POC_{L0}),$$
$$TD_D = Clip3(-128, 127, POC_{L1} - POC_{L0}),$$
$$TD_X = (16384 + abs(TD_D >> 1)) / TD_D,$$
$$DistScaleFactor = Clip3(-1024, 1023, (TD_B * TD_X + 32) >> 6).$$

These equations are already used for MV scaling process in WD

$$AC_{TGT} = (DistScaleFactor * AC_{L1} + (256 - DistScaleFactor) * AC_{L0} + \text{OFST}) >> \text{SHFT},$$
$$DC_{TGT} = (DistScaleFactor * DC_{L1} + (256 - DistScaleFactor) * DC_{L0} + \text{OFST}) >> \text{SHFT},$$

where DC_{L0} and AC_{L0} means DC/AC components for reference picture with POC_{L0} and DC_{L1} and AC_{L1} means DC/AC components for reference picture with POC_{L1}.



Experimental results of EWP, IWP and Proposal

Black-fade case	Random Access Main					Random Access HE10				
	Y	U	V	Enc[%]	Dec[%]	Y	U	V	Enc[%]	Dec[%]
ExplicitWP	-16.9%	-19.6%	-19.1%	143%	100%	-17.2%	-19.6%	-19.4%	140%	98%
ImplicitWP	-0.2%	-0.4%	-0.6%	172%	100%	-0.2%	-0.1%	-0.1%	167%	101%
Proposed	-16.3%	-17.9%	-17.9%	142%	100%	-16.1%	-18.5%	-17.9%	140%	101%
Black-fade case	**Low delay B Main**					**Low delay B HE10**				
	Y	U	V	Enc[%]	Dec[%]	Y	U	V	Enc[%]	Dec[%]
ExplicitWP	-32.3%	-40.5%	-39.2%	140%	83%	-32.0%	-43.2%	-41.1%	134%	81%
ImplicitWP	1.4%	3.2%	2.2%	181%	105%	1.9%	2.6%	2.4%	175%	104%
Proposed	-31.9%	-36.0%	-34.5%	141%	86%	-31.4%	-37.4%	-35.6%	135%	86%
Black-fade case	**Low delay P Main**					**Low delay P HE10**				
	Y	U	V	Enc[%]	Dec[%]	Y	U	V	Enc[%]	Dec[%]
ExplicitWP	-32.0%	-39.5%	-38.2%	123%	79%	-31.3%	-42.7%	-41.3%	116%	76%
ImplicitWP	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Proposed	-31.6%	-35.2%	-32.1%	122%	83%	-30.8%	-36.3%	-35.0%	117%	83%

White-fade case	Random Access Main					Random Access HE10				
	Y	U	V	Enc[%]	Dec[%]	Y	U	V	Enc[%]	Dec[%]
ExplicitWP	-20.3%	-23.4%	-23.0%	137%	97%	-20.5%	-22.9%	-23.1%	136%	96%
ImplicitWP	-0.3%	-0.6%	-0.5%	180%	101%	-0.2%	-0.2%	-0.2%	174%	101%
Proposed	-19.3%	-21.8%	-21.6%	137%	100%	-19.0%	-21.4%	-21.4%	137%	100%
White-fade case	**Low delay B Main**					**Low delay B HE10**				
	Y	U	V	Enc[%]	Dec[%]	Y	U	V	Enc[%]	Dec[%]
ExplicitWP	-34.2%	-42.3%	-41.5%	136%	80%	-33.7%	-44.7%	-43.2%	129%	79%
ImplicitWP	1.5%	2.5%	2.8%	185%	104%	2.0%	3.1%	2.7%	178%	104%
Proposed	-33.4%	-38.5%	-36.3%	136%	84%	-32.7%	-38.1%	-36.7%	131%	85%
White-fade case	**Low delay P Main**					**Low delay P HE10**				
	Y	U	V	Enc[%]	Dec[%]	Y	U	V	Enc[%]	Dec[%]
ExplicitWP	-33.8%	-40.8%	-39.7%	114%	76%	-33.1%	-44.2%	-42.4%	109%	75%
ImplicitWP	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Proposed	-33.4%	-37.1%	-34.7%	115%	81%	-32.3%	-38.0%	-36.1%	111%	82%

Conclusion

- Proposal:
  - As a decoding process, simple WP parameter estimation based on alpha-blending model is introduced

- Experimental Results:
  - For Black-fade and White-fade sequences
    - RA-Main: 16%/16% RA-HE: 19%/19%
    - LB-Main: 32%/31% LB-HE: 33%/33%
    - LP-Main: 32%/31% LB-HE: 33%/32%
    - This scheme can reduce the decoding runtime

- Suggestion;
  - Proposed implicit WP method is integrated to WD/HM.

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