A Reference Sample Padding Method for Intra Prediction in JVET

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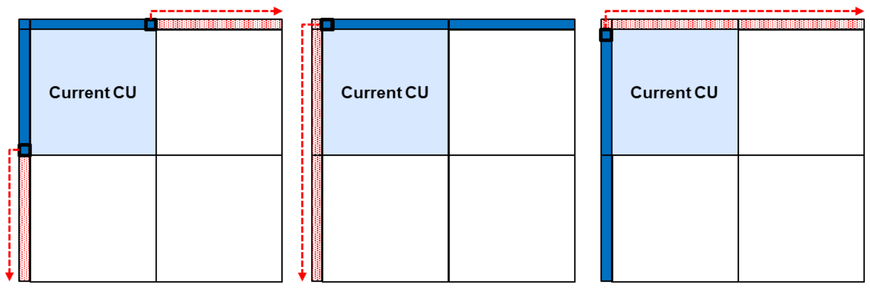
Ⅰ. Introduction

- Joint Video Exploration Team (JVET)
  - ITU-T VCEG (Q6/16) and ISO/IEC MPEG (JTC 1/SC 29/WG 11)
  - A compression capability that significantly exceeds that of the current HEVC standard
  - The scope of technology
    - Camera-view content, screen content, VR/360 video and high-dynamic-range video
  - Requirements
    - Compression performance: 30% - 50% bit-rate reductions
    - Video Formats: VGA (640x480) ~ 8K UHD
  - Timeline
    - Publication of a future video coding specification by approximately 2020
- JVET releases the Joint Exploration Model (JEM) Software codec for technical verification

Ⅱ. Reference Sample Preparation in JEM

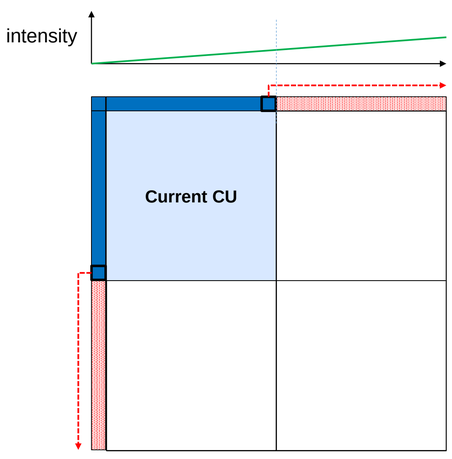
- Reference sample padding
  - The reference sample padding is performed when no reference samples exist
    - There are no reference samples around
    - The reference samples is partially available
  - The basic idea of reference sample padding
    - Fill in a sample that does not exist using the closest sample available



- We propose a reference sample padding method that considers the variation of surrounding samples

Ⅲ. Proposed Method

- Basic concept
  - The predictive performance can be improved by reflecting the correlation of the surrounding images on non-existing samples
- Assumption for reflecting the correlation
  - High correlation between non-existing samples and surrounding samples
    - If the intensity of an existing sample changes linearly, samples that do not exist are likely to be affected



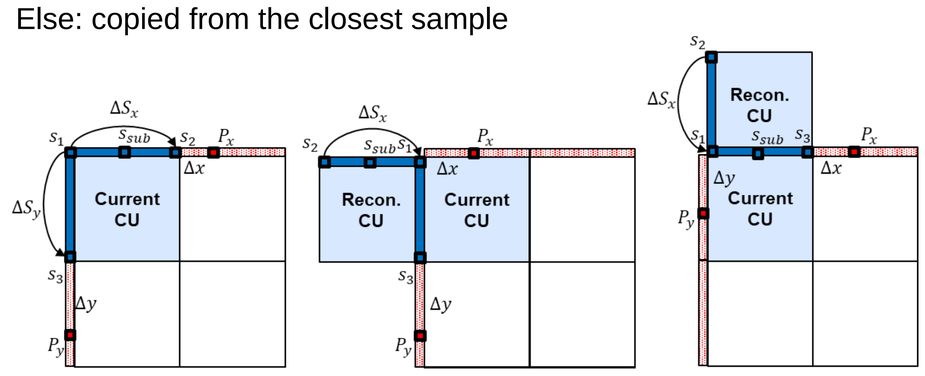
- Reference sample padding method based on variation
  - Use three samples of the available samples
    - Calculate the variation of the two samples (s_1, s_2)
    - The variation is reflected according to the position of the padding area

$$P_x = s_2 + \frac{\Delta x \Delta S_x}{width_{CU}}, P_y = s_3 + \frac{\Delta y \Delta S_y}{height_{CU}}$$

    - s_{sub} is a middle sample of available samples to determine linearity
  - If the CTU or CU is located at the boundary of a slice or image, there is no sample
    - Blocks already coded are used as reference samples
  - Determine linearity

$$Abs(s_1 + s_2 - 2s_{sub}) < (1 \ll (BitDepth_Y - x))$$

    - As Increase linearity factor of x, the condition of linearity is more strict
  - Padding samples
    - If the above condition is satisfied: linear padding is performed
    - Else: copied from the closest sample



  - The linearity factor x was set to 8 or 9 and implemented for case 1

Ⅳ. Experimental Results

- Test conditions
  - JEM CTC, Anchor: JEM 6.0, All Intra, 100 frames
  - Class A: $x = 9$, Class B: $x = 8$

			BD-rate		
Sequence			Y	U	V
Class A	3840x2160	CampfireParty	-0.03%	0.06%	0.18%
		Drums	-0.01%	-0.11%	0.08%
Class B	1920x1080	BasketballDrive	-0.04%	-0.42%	-0.12%
		Cactus	0.03%	0.54%	-0.19%
		ParkScene	-0.01%	0.00%	-0.08%
		BQTerrace	-0.01%	0.15%	0.21%

Ⅴ. Conclusions

- Utilize the characteristics of the image for reference sample padding
  - Consider the variation of the brightness of neighboring blocks
- Minor BD-rate bit saving
  - Use linearity factor of $x = 9$ for 4k, and $x = 8$ for full HD sequences
    - As the resolution increases, the image content belonging to one CU becomes smaller
  - Gain is very small, but the correlation with neighboring blocks may be increased when prediction from a padded region is performed
  - Case 2 and 3 also need to be implemented
  - Study on more effective reference padding is needed