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| *Title:* | **Crosscheck of JCTVC-F528 simplified bilateral intra smoothing filter** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Information | | |
| *Author(s) or Contact(s):* | Dzung Hoang | Tel: Email: dzung.hoang@zenverge.com |  |
| *Source:* | Zenverge, Inc. | | |

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# Abstract

The contribution presents an independent cross-check of JCTVC-F528, a proposal for a simplified bilateral intra smoothing filter.

# Introduction

JCTVC-F528 [1] proposes an alternative filter to replace the [0.25, 0.5, 0.25] FIR filter used in Mode Dependent Intra Smoothing (MDIS) in the HM 3.0 design. The proposal is claimed to be a simplification of bilateral filtering [2] [3] .

Bilateral filtering basically performs a weighted averaging of the samples within the support region. Using the terminology from [2] [1] there are two components to each weight: *geometric closeness* and *photometric similarity*. Geometric closeness is a measure of the spatial distance between the center pixel and the pixel to be weighted. Photometric similarity refers to the closeness in value between the center pixel and the pixel to be weighted. Let denote the position of the center pixel, denote the position of the pixel to be weighted, denote the input signal vector, denote the filtered signal, denote the geometric closeness between the center pixel and the weighted pixel, and denote the photometric similarity between the center pixel and the weighted pixel. Assume that the support region consists of pixels to the left and pixels to the right of the center pixel. The bilateral filter equation is given in Eq. (1).



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In the proposal [1] a 1D region of support with is used and the weighting functions are defined in Eqs. (2) and (3), where denotes the maximum possible pixel value given the internal bit depth and is a parameter that controls the amount of smoothing. In the software is fixed to 2.



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The software implements the division operation as a series of subtractions, compares, and shifts.

# Simulation Results

We ran the anchor using HM-3.1 and also ran the software provided by the proponents. The results are shown below. The results differ very slightly (0.01%) from those generated by the proponents.

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| Table : Simulation results comparing proposed scheme to HM-3.1   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | |  | All Intra HE | | | All Intra LC | | | | Y | U | V | Y | U | V | | Class A | 0.04 | 0.06 | 0.15 | 0.14 | 0.03 | 0.09 | | Class B | -0.04 | -0.07 | -0.16 | 0.02 | -0.03 | -0.08 | | Class C | -0.14 | -0.15 | -0.09 | -0.15 | -0.17 | -0.16 | | Class D | -0.12 | -0.12 | -0.07 | -0.07 | -0.05 | -0.12 | | Class E | -0.03 | -0.01 | -0.01 | 0.06 | -0.01 | -0.01 | | All | -0.06 | -0.06 | -0.04 | 0.00 | -0.05 | -0.06 | | Enc Time[%] | 110% | | | 99% | | | | Dec Time[%] | 116% | | | 105% | | | |

# Concluding Remarks

The proposed change affects a small part of the intra coding. Therefore it is not surprising that its effect is correspondingly small. The purported advantage of the proposal is to improve intra prediction by low pass filtering without softening edges. The proponents pointed out more gains from the BasketBallDrill sequence that supposedly has more edges. Close-ups of decoded images with and without the proposed modification showing the visual differences would be more convincing than small BD-rate improvements.

One concern that the proponents recognized and tried to address is the division operation that is part of the filtering. Implementing the division as a series of arithmetic operations is an implementation optimization that does not really remove the division operator.

# References

1. G. Li, et. al., “Simplified bilateral intra smoothing filter,” JCT-VC Document, JCTVC-F528, Torino, July 2011.
2. C. Tomasi and R. Manduchi, “Bilateral filtering for gray and color images,” in Proc. 6th Int. Conf. Computer Vision, New Delhi, India, pp. 839–846, 1998.
3. M. Elad, “On the origin of the bilateral filter and ways to improve it,” IEEE Transactions on Image Processing, v. 11, no. 10, pp. 1141–1151, Oct 2002.