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| *Title:* | **Intra coding improvements for slice boundary blocks** | | |
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# Abstract

This proposal presents two improvements on Intra coding for the boundary blocks of a slice or picture, including Intra prediction mode coding and reference pixel padding. Firstly, bit spending for Intra prediction mode coding is saved by reducing the number of the candidate Intra prediction modes. Secondly, the unavailable reference pixels for boundary block are padded with the closest pixel from its available neighbor block, instead of a fixed DC value. The test results show 0.5% and 0.4% bit-rate reduction for Intra and Intra LoCo configurations with almost the same encoding and decoding time.

# Introduction

Multiple slice partition will be supported by HEVC to meet the requirement of video transmission over error-prone channel. From the last meeting, the reference software HM0.9-AHG-SLICES, supporting multiple slice partition, has been released in the branch of SVN server. The test results show large gain drop comparing to the HM0.9 anchor. For example, about 5% bit-rate increase is observed for both Intra and Intra LoCo configurations in case of 1500bytes per slice. The gain drop is caused by the restriction on the reference relationship between different slices.

This proposal presents two improvements on Intra coding for the boundary blocks to improve coding performance, especially in the case of multiple slice partition. One is related to Intra prediction mode coding, another is about reference pixel padding.

# Intra coding improvements for slice boundary blocks

More boundary blocks will be generated when a picture is partitioned into multiple slices. Boundary blocks of a slice or picture have at least an unavailable neighbor reference blocks among its left, upper and upper-left reference positions. This section discusses how to effectively coding these boundary blocks.

## Intra prediction mode coding

For boundary blocks of a slice or picture, the number of candidate Intra prediction modes can be further reduced according to the availability of the neighbor reference blocks.

For example, the vertical modes as shown in Figure 1 may not be coded for the blocks at the top boundary of slice, due to the unavailability of its upper neighbor block. Only the horizontal modes and DC mode need to be coded, which means less bit spending for Intra prediction mode coding. When the number of the candidate Intra prediction modes is reduced to half, one bit can be saved. It’s also true for those blocks at the left boundary of a slice.

Fig. 1 Vertical modes and horizontal modes

A special case is the upper-left corner block of a slice for which no reference block is available. In this case, only DC mode is always used. Thus bit for coding prediction mode is not required.

## Reference pixel padding

Boundary blocks lead to the gain drop due to its unavailable reference pixels. In current implementation of HM0.9, those unavailable reference pixels for boundary blocks are padded with DC value, e.g., 128 for LoCo case. However the fixed value doesn’t adapt to the different content of the boundary blocks. Padding with the pixel value from the closest available block is more appropriate to improve the prediction accuracy.

Figure 2a shows the proposed padding process for the blocks at the top boundary of a slice, where the left neighbor block is available but the upper and upper-left neighbor blocks are not available. The closest pixel from the available neighbor block, *i.e.* the left neighbor block, is copied to generate the upper reference pixels for Intra prediction. It is noticed that the upper-left corner reference pixel is also padded.



1. Top boundary block b) Left boundary block

Fig. 2 Padding process for the top and left boundary blocks of a slice

As shown in Fig. 2b, similar padding process can be applied for the blocks at the left boundary of a slice, where the left and upper-left neighbor blocks are not available while its upper neighbor block is available.

# Test conditions and Results

The proposed two improvements have been integrated into reference software HM0.9-AHG-SLICES. The maximum size of a slice is set to 1500bytes.

The following platform and compiler have been used.

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| **Platform** | **Compiler** |
| Windows Server 2003 64 bits  Intel Xeon X7560 @2.27GHz | VS2005 |

We have run Intra and Intra LoCo cases using the same computer in order to obtain coherent encoding and decoding time [1]. The following table summarizes the simulation results. The complete results can be found from the attached excel file.



The test results show that 0.5% and 0.4% bit-rate reduction for Intra and Intra LoCo configurations can be achieved with almost the same encoding and decoding time.

# Conclusion

This proposal presents two improvements on Intra coding for slice boundary blocks, including Intra prediction mode coding and reference pixel padding. Both of them have been tested based on reference software HM0.9-AHG-SLICES. The results show 0.5% and 0.4% bit-rate reduction for Intra and Intra LoCo configurations with almost the same encoding and decoding time.

# References

1. F. Bossen., “Common conditions and software reference configurations”, Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, JCTVC-C500, 3rd Meeting: Guangzhou, CN, Oct., 2010.

# Patent rights declaration(s)

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