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| *Title:* | **SAO processing with virtual LCU( vLCU )** | | |
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| *Purpose:* | Proposal | | |
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# Abstract

This contribution introduces a coding concept called SAO processing with virtual LCU(vLCU) that changes LCU-based SAO processing to vLCU-based SAO processing. It is argued that it allows for better SAO estimation results and on-chip memory saving for ASIC, while struggling with limited on-chip memory. Experimental results using the compulsory configurations with one tile and one slice per picture show that the BD-rate gain is % on average.

# Introduction

In the HM 6.0 when LCU-based SAO is used, the encoder does not use any pixel from the bottom four luma pixel rows and the bottom two chroma pixel rows in each LCU during the parameter estimation of SAO. However, the rightmost four luma pixel columns and the rightmost two chroma pixel columns in each LCU are used by the parameter estimation of SAO. This means deriving parameters for one LCU is dependent on the future LCU, which is not desirable for practical LCU-based pipelining systems, as shown in Figure 1. In the other hand, the SAO reconstruction parameters must be saved into a line buffer in the SAO processing, because the pixels in the bottom that using these parameters are not processed by the Deblocking Filter (DF) module yet in LCU-based pipelining systems. The SAO parameter line buffer can be updated until all pixels are processed by the DF and SAO module as shown in Figure 2.



**Figure 1. An example of LCU pipelining processed by DF**



**Figure 2. SAO filter processing current LCU**

# Algorithm description

As mentioned above, the SAO parameters for current LCU must be stored in the line buffer when the SAO module is processing the current LCU pixels, until all pixels of current LCU have been processed by the DF module. Furthermore, not all the LCU pixels are used by the SAO estimation algorithm in the HM 6.0.

In order to remove the SAO parameter line buffer and increase the SAO estimation algorithm, we change LCU-based SAO filter processing to virtual-LCU based SAO filter processing. The positions of LCU and corresponding virtual LCU are shown in Figure 3, Figure 4. The virtual LCU is a LCU that moves 4 pixels up and 4 pixels left refer to the positions of the current LCU. The current implementation of proposed software decoder is shown in Figure 5.In addition, the techniques for SAO processing at virtual LCU boundary refer to the JCTVC-F232, the techniques eliminate grid line type of visual artifact and presented do not use additional line buffer.



**Figure 3. The positions of LCU and corresponding virtual LCU in picture**



**Figure 4. The positions of LCU and corresponding virtual LCU**



**Figure 5. Block diagram of proposal software decoder**

# Description of experiments

Experiments exploring the effects on coding efficiency are described in this section.

## Common conditions

The reference software HM 6.0[1] was used to produce results for the reference in the experiment. In addition, the encoder and decoder source code from the reference codebase was modified to introduce this functionality. The common conditions and encoding configurations described in [2] were used.

# Results

The results are shown below in Table 4.

Table 4. BD-rate results for encoding when using this proposal

# Conclusion and recommendation

In this document, SAO processing with virtual LCU has been proposed as an alternative to decrease the on-chip memory for ASIC codec and increase the results of SAO estimation. Benefit of using this has been identified and experimental results show significant BD-rate gains, and **save more than one SAO parameters line buffer and one DF filtered pixels line buffer** on-chip memory for in the ASIC codec.

In addition, this adds no meaningful computational complexity. It is proposed to be adopted to the HM.

# References

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# Patent rights declaration(s)

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