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| *Title:* | **AHG19: A lossless coding solution for HEVC** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Proposal | | |
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# Abstract

Lossless coding can be used in many practical applications, such as automatic vision, web conferencing including remote desktop sharing, and online gaming, etc. In this contribution, we combine the sample-based angular intra prediction (SAP) as proposed in JCTVC-H0083 and the lossless coding signaling method as proposed in JCTVC-H0528 to form a simple and efficient lossless coding solution for HEVC. The proposed sample-based prediction is exactly the same as the HM5.0 block-based angular prediction in terms of prediction angles and sample interpolation, and it requires no syntax or semantics changes, but differs in decoding process in terms of reference sample selection. The proposed lossless enabling method utilizes QP to indicate lossless coding mode in a coding unit (CU), If QPof a CU is equal to the smallest value (e.g. QP=0 for the 8-bit bit-depth case), inverse quantization, inverse transform, de-blocking filter, SAO and ALF are bypassed and the sample-based prediction (SAP) is used to replace the existing intra prediction method. The advantage of this signaling method is that no additional syntax element is needed and the coding performance of HEVC for the lossy mode would not be impacted or compromised. In addition, using QP also brings us the flexibility in the sense that this lossless mode can be used not only for the entire picture or a slice but also for the individual CUs as well. The HM5.0 software has been modified to incorporate this lossless coding solution, which is attached in this contribution together with the test results. The modified HEVC draft is also provided in the contribution, showing that the lossless coding solution can be incorporated into the HEVC WD with only minor changes to the decoding process.

# Introduction

In recent years, we observe more and more usage of lossless coding in real-world applications. For example, in the automotive vision application, video captured from cameras of a vehicle may need to be transmitted to the center processors losslessly for video analytics purpose. Another example is video conferencing or long-distance education in which hybrid nature and syntactic video coding might be required, where part of video scene might contain syntactic contents such as presentation slides that need to be coded losslessly. In those application scenarios, lossless coding mode which provides certain level of compression is required, and is desirable to enable it in profiles of 4:2:0 chroma format as well.

In a basic lossless coding solution, the transform and quantization and their inverse operations are bypassed in the encoder and decoder. Without transform operation, sample based intra predictions, as proposed in JCTVC-H0083 [1] can be incorporated to significantly improve coding efficiency [1]. To avoid the potential coding performance loss for the lossy case and to minimize the necessary changes to the HEVC specification, we also propose not to add any additional flag and instead to use QP’Y=0 to indicate the lossless coding mode, where QP’Y = QPY + QpBdOffsetY as defined in the WD (JCTVC-G1103\_d9). Using this method, the lossless coding mode can be conveniently applied to the entire picture or at CU level [2]. The overall system diagram for proposed lossless coding solution is shown in Figure 1.

bypass if QP’Y=0

-

+

DCT

Q

Entropy coding

IQ

IDCT

De-blocking

SAO

ALF

MC

IP if QP’Y≠0

Frame

buffer

IPE

ME

**LCU**

bypass if QP’Y=0

SAP if QP’Y=0

Figure 1. Diagram of HEVC encoder with the proposed lossless coding solution

Note that all the in-loop operations including deblocking filter, SAO and ALF are bypassed when QP’Y=0 for a CU, i.e., the lossless coding mode is employed. This is done due to the fact that there is no distortion existing in the reconstructed picture and in-loop filtering will not help either the picture quality or the coding efficiency for lossless coding.

To demonstrate the efficiency of the sample based intra prediction method and the effectiveness of the signaling method, we have modified the HM5.0 software to incorporate both the SAP method and the QP signaling, which enables the lossless coding mode at picture level and CU level by bypassing the transform, quantization, deblocking filter, SAO and ALF operations and replacing the existing intra prediction with the sample based intra prediction (SAP).

# Sample-based Angular Intra Prediction (SAP)

For detailed description of SAP and its performance, please refer to [1]

# Signaling Method for lossless coding

For detailed description of the lossless coding signaling method using QP’Y=0 and the test results, please refer to [2].

# Software and test results

The proposed lossless coding solution has been implemented in HM5, which is done by integrating the QP signaling method in H0528 into the HM5-based SAP software in H0083. This new software was actually used in the tests in H0528. To confirm the new software will behave the same as in H0083 for the frame based lossless coding, additional frame-based lossless coding tests were performed and the test results are identical to those reported in H0083, as shown in the attached spreadsheet. Many thanks to I2R (Yih Han Tan, Chou Han Yeo, and Zhengguo Li), they have cross-checked these tests as well as the software. The cross-check report is in JCTVC-H0673.

# Conclusion and recommendation

It is recommended to adopt this lossless coding solution into HM test model and HEVC working draft to enable not only lossless coding mode at both picture and CUs levels but also better coding efficiency with perfect fidelity.

# References

[1] M. Zhou, “AHG19: Sample-based angular prediction (SAP) for HEVC lossless coding”,JCT-VC Document , JCTVC-H0083, San Jose, USA, Feb. 2012.

[2] [W.](mailto:benjamin.bross@hhi.fraunhofer.de) Gao, [M.](mailto:wjhan.han@samsung.com) Jiang, and H. Yu “AHG19:A QP-based enabling method for lossless coding in HEVC” JCT-VC Document, JCT-VC Document , JCTVC-H0528, San Jose, USA, Feb. 2012.

# Patent rights declaration(s)

**Huawei Technologies (USA) may have IPR relating to the technology described in this contribution and, conditioned on reciprocity, is prepared to grant licenses under reasonable and non-discriminatory terms as necessary for implementation of the resulting ITU-T Recommendation |ISO/IEC International Standard (per box 2 of the ITU-T/ITU-R/ISO/IEC patent statement and licensing declaration form).**

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# WD text changes

Please see the details of the changes to the HEVC WD (JCTVC-G1103\_d9) and “Missing description about pcm\_sample\_loop\_filter\_disable\_flag for SAO” (WD Ticket #301) are given in details in the attachment of JCTVC-H0530-WD-r2.doc and JCTVC-H0530-WD-supplement-SAO.doc.

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