

# Improvement of HEVC Lossless Coding using Transform Coefficient Coding

Min-Su Cheon, Yumi Sohn, Sunil Lee, Il-Koo Kim, and Jeonghoon Park



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## Motivation

- Lossless coding has many applications, e.g. medical image compression.
- However, the performance of the current HEVC lossless coding (HM7.1) is not satisfactory and need to be improved.
- The goal of this contribution is to propose an improved HEVC lossless coding method based on HEVC lossy coding framework.

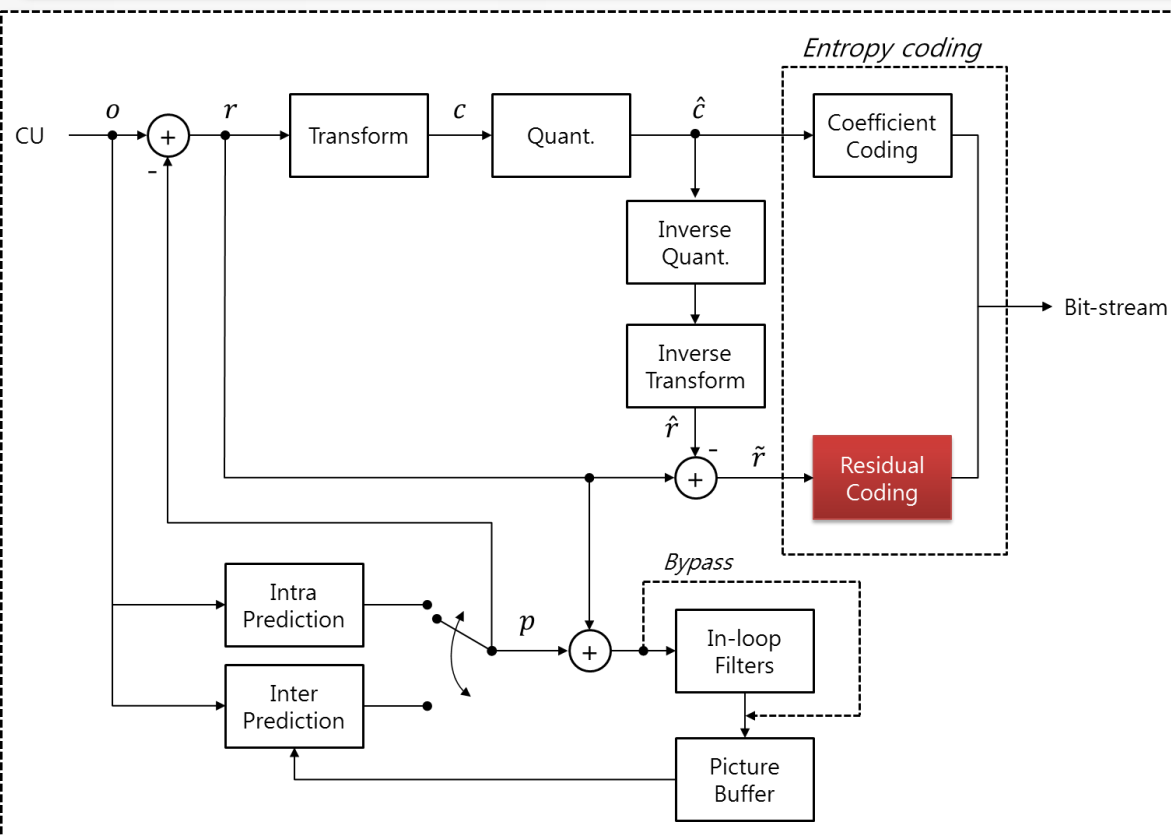
## Current Design

- In the current design of HEVC, lossless coding is implemented by bypassing transform, quantization, and all the in-loop filtering (de-blocking, SAO, and ALF).
- The spatial residual, which is the difference between original and predicted CU, is directly signaled to the decoder.

# Algorithm Description



- On top of HEVC lossy coding, the remaining residual is additionally signaled to the decoder to achieve lossless coding.
- Only in-loop filtering is bypassed.



$o$  : Original CU

$p$  : Intra/Inter-Predicted CU

$r$  : Spatial residual  
( $r = o - p$ )

$c$  : Transform coefficients

$\hat{c}$  : Quantized transform coefficients

$\hat{r}$  : Reconstructed residual

$\tilde{r}$  : Remaining residual  
( $\tilde{r} = r - \hat{r}$ )



## Simulation Set-up

- The proposed method is implemented on top of HM7.1.
- The simulation is performed using only All Intra Main and HE10 configurations.
- The performance of the proposed method combined with the sample-based angular prediction (SAP) proposed by JCTVC-I0117 is also provided.

## Summary of the Results

- The **proposed method outperforms HM7.1 lossless coding by 8.8% and 8.3%** in All Intra Main and HE10 configurations (w/o Class F), respectively.
- The **SAP provides 1.9 ~ 2.8% additional gain on average** when combined with the proposed method.
- The complexity at the encoder side can be reduced by limiting the number of intra prediction modes to 3 (DC, Vertical, and Horizontal), and the performance degradation due to this limit is 1.3 ~ 2.4% on average.

# Simulation Results (2/2)



|                        | Proposed     |              | Proposed + SAP |               | Proposed + SAP<br>+ 3 Intra pred. modes |               |
|------------------------|--------------|--------------|----------------|---------------|---|---------------|
|                        | AI Main      | AI HE10      | AI Main        | AI HE10       | AI Main                                 | AI HE10       |
| Class A                | -12.4%       | -11.6%       | -14.5%         | -13.8%        | -13.3%                                  | -12.1%        |
| Class B                | -7.4%        | -6.8%        | -8.1%          | -8.3%         | -6.7%                                   | -7.7%         |
| Class C                | -8.0%        | -7.7%        | -9.5%          | -10.0%        | -5.7%                                   | -7.8%         |
| Class D                | -9.1%        | -9.8%        | -11.5%         | -13.0%        | -8.8%                                   | -11.3%        |
| Class E                | -6.7%        | -5.3%        | -10.8%         | -12.0%        | -9.5%                                   | -11.7%        |
| <b>Overall (w/o F)</b> | <b>-8.8%</b> | <b>-8.3%</b> | <b>-10.8%</b>  | <b>-11.2%</b> | <b>-8.7%</b>                            | <b>-9.9%</b>  |
| <b>Overall (w/ F)</b>  | <b>-8.3%</b> | <b>-7.9%</b> | <b>-10.9%</b>  | <b>-11.7%</b> | <b>-8.5%</b>                            | <b>-10.1%</b> |
| Class F                | -5.8%        | -5.5%        | -11.4%         | -13.2%        | -7.5%                                   | -11.0%        |
| Enc Time               | 193%         | 158%         | 195%           | 156%          | 117%                                    | 90%           |
| Dec Time               | 107%         | 101%         | 104%           | 94%           | 105%                                    | 92%           |



- In this contribution, **an improved HEVC lossless coding based on HEVC lossy coding framework** is proposed.
- The proposed method provides 8.8% and 8.3% coding gain in All Intra Main and HE10 configurations, respectively.
- We recommend adopting the proposed method in the HM.

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# THANK YOU

