

# AHG7: Coefficient Coding for Lossless Coding

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# Contents

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I

Introduction

II

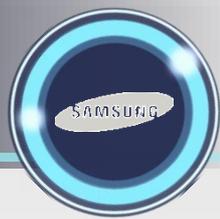
Algorithm Description

III

Experimental Results

IV

Conclusion

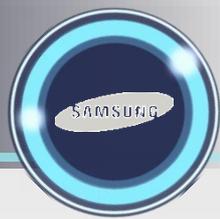


## Lossless coding in HEVC

- HEVC lossless coding is enabled by bypassing transform, quantization and in-loop filters.
- Coefficients to be coded are actually **spatial residues** in lossless coding.

## Motivation

- Statistical distributions of **transform coefficients and spatial residues are different.**
  - Transform coefficients are sparsely distributed in frequency domain and have smaller level (mostly zero when quantized) in high frequency.
  - Prediction error at positions far from up and left (→ corresponding to high frequency) reference pixels is relatively large in intra prediction.
- **The coefficient coding method is inefficient for the spatial residue coding.**
  - E.g., no incremental tendency of levels from high frequency to low frequency area in spatial residual signals → trailing one is meaningless in lossless coding.



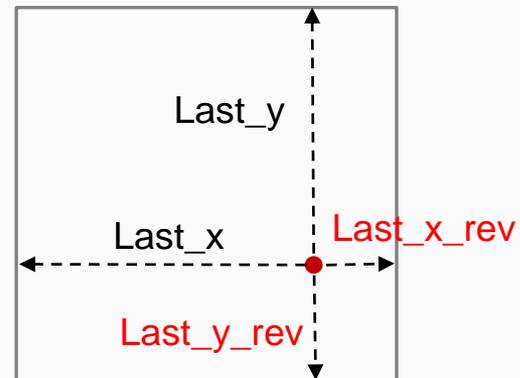
## Current method

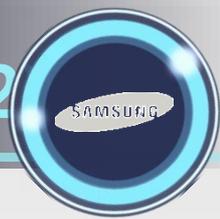
- More bins for greater magnitude
- Last position to be coded
  - last\_significant\_coeff\_x
  - last\_significant\_coeff\_y

Magnitude of last position component	Truncated unary (context model)	Fixed binary(bypass)	
0	0	-	0
1	10	-	0
2	110	-	0
3	111(0)	-	0
4-5	11110	X	0-1
6-7	11111(0)	X	0-1
8-11	1111110	XX	0-3
12-15	1111111(0)	XX	0-3
16-23	111111110	XXX	0-7
24-31	111111111	XXX	0-7

## Proposed method

- Less bins for greater magnitude
- Last position to be coded
  - $tsize - 1 - last\_significant\_coeff\_x$
  - $tsize - 1 - last\_significant\_coeff\_y$





## Current context derivation in level coding

- coded\_sub\_block\_flag
    - Derive context according to the availability of non-zero coefficient in right and bottom subblocks.
  - significant\_coeff\_flag
    - Derivation of predict pattern depending on the availability of non-zero coefficient in right and bottom subblocks, then derive context with the predicted pattern and local position in current subblock.
  - coeff\_abs\_level\_greater1\_flag
    - Select context set according to the number of greater than 1 coefficient in previous sub-block, then derive context with the context set and number of trailing ones in current subblock.
  - coeff\_abs\_level\_greater2\_flag
    - select context set according to number of greater than 1 coefficient in previous sub-block, then context is equal to the context set.
- All the context derivation process is not effective for spatial residues to be coded in lossless coding

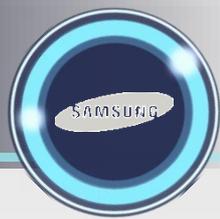


## Proposed context derivation in level coding

- All the context derivation process is simply bypassed.
- Only one single context model is used for each symbol.
  - Number of removed context: 89%

symbols	Current		Proposed	
	Luma	Chroma	Luma	Chroma
coded_sub_block_flag	2	2	1	1
significant_coeff_flag	27	15	1	1
coeff_abs_level_greater1_flag	16	8	1	1
coeff_abs_level_greater2_flag	4	2	1	1
<b>Total</b>	<b>76</b>		<b>8</b>	

# Experimental results



## P1: Reversed last position

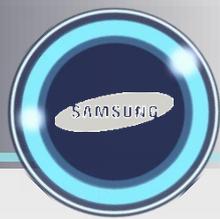
	AI	RA	LD
RGB 4:4:4	-0.2%	-0.1%	-0.1%
YCbCr 4:4:4	-0.3%	-0.2%	-0.2%
YCbCr 4:2:2	-0.3%	-0.2%	-0.2%
<b>Overall</b>	<b>-0.3%</b>	<b>-0.2%</b>	<b>-0.2%</b>
Enc Time[%]	99%	99%	100%
Dec Time[%]	100%	100%	100%

## P2: Context derivation bypass

	AI	RA	LD
RGB 4:4:4	-0.1%	-0.1%	-0.1%
YCbCr 4:4:4	-0.1%	-0.1%	-0.1%
YCbCr 4:2:2	-0.1%	-0.1%	0.0%
<b>Overall</b>	<b>-0.1%</b>	<b>-0.1%</b>	<b>-0.1%</b>
Enc Time[%]	89%	91%	92%
Dec Time[%]	93%	94%	94%

## P1 + P2

	AI	RA	LD
RGB 4:4:4	-0.3%	-0.2%	-0.2%
YCbCr 4:4:4	-0.4%	-0.3%	-0.2%
YCbCr 4:2:2	-0.4%	-0.2%	-0.2%
<b>Overall</b>	<b>-0.4%</b>	<b>-0.2%</b>	<b>-0.2%</b>
Enc Time[%]	89%	90%	91%
Dec Time[%]	93%	94%	94%



- A more efficient last position coding method is proposed. (P1)
  - Reversed last position coding
  - (-0.3% / -0.2% / -0.2%) in AI / RA / LD
- A simplified context derivation for level coding is proposed. (P2)
  - Context derivation for level coding is bypassed.
  - Use single context for each symbol
  - (-0.1% / -0.1% / -0.1%) in AI / RA / LD
  - 90% / 94% enc/dec time
- Combination of P1 and P2 (P1+P2)
  - (-0.4% / -0.2% / -0.2%) in AI / RA / LD
  - Save 10% / 6% enc/dec time
  - Number of removed context: 89%
- **It is suggested to adopt P1+P2 to the HEVC range extension for lossless coding.**



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# THANK YOU



# Appendix: Additional test results



## 1 context for CG

	<b>AI</b>	<b>RA</b>	<b>LD</b>
RGB 4:4:4	0.0%	0.0%	0.0%
YCbCr 4:4:4	0.0%	0.0%	0.0%
YCbCr 4:2:2	0.0%	0.0%	0.0%
<b>Overall</b>	0.0%	0.0%	0.0%
Enc Time[%]	99%	101%	101%
Dec Time[%]	99%	100%	100%

## 1 context for sigmap

	<b>AI</b>	<b>RA</b>	<b>LD</b>
RGB 4:4:4	-0.1%	-0.1%	-0.1%
YCbCr 4:4:4	-0.1%	-0.1%	0.0%
YCbCr 4:2:2	0.0%	-0.1%	-0.1%
<b>Overall</b>	-0.1%	-0.1%	-0.1%
Enc Time[%]	89%	91%	92%
Dec Time[%]	94%	95%	95%

## 1 ctx for G1, 1 ctx for G2

	<b>AI</b>	<b>RA</b>	<b>LD</b>
RGB 4:4:4	0.0%	0.0%	0.0%
YCbCr 4:4:4	0.0%	0.0%	0.0%
YCbCr 4:2:2	0.0%	0.0%	0.0%
<b>Overall</b>	0.0%	0.0%	0.0%
Enc Time[%]	99%	100%	101%
Dec Time[%]	100%	101%	101%