

CE7-related: Unification of CCB check method and bypass coding between two residual coding modes (JVET-P0298)

Y. Kato, K. Abe, T. Toma
Panasonic Corporation

Introduction

1. In the current TS residual coding, the number of CCB check per coefficient is large compared to that of transform residual
2. CE7-1.3b-alt tries to unify TS residual coding with transform residual coding

Two items are proposed:

Item 1 aims to solve 1st problem

Item 2 aims more unified syntaxes between two residual syntaxes

1. Current problem of transform skip residual syntax

Transform residual syntax:

```
for (n=numSbCoeff-1, n ≥ 0 && CCB ≥ 4, n--)  
  sig_coeff_flag (CABAC)  
  abs_level_gtx_flag[0] (CABAC)  
  par_level_flag (CABAC)  
  abs_level_gtx_flag[1] (CABAC)
```

per each coeff

Transform skip residual syntax:

```
for (n=0, n ≤ numSbCoeff-1, n++)  
  if (CCB)  
    sig_coeff_flag (CABAC)  
  else  
    sig_coeff_flag (bypass)  
  if (CCB)  
    coeff_sign_flag (CABAC)  
  else  
    coeff_sign_flag (bypass)  
  if (CCB)  
    abs_level_gtx_flag[0] (CABAC)  
  else  
    abs_level_gtx_flag[0] (bypass)  
  if (CCB)  
    par_level_flag (CABAC)  
  else  
    par_level_flag (bypass)  
  ...
```

per each flag

Worst CCB check number	
2 per coeff	8 per coeff

Item1: Proposed syntax of TS residual coding

```
for (n=0, n ≤ numSbCoeff-1, n++) //1st pass
```

```
if (CCB ≥ 4)
```

```
    sig_coeff_flag (CABAC)
```

```
    coeff_sign_flag (CABAC)
```

```
    abs_level_gtx_flag[0] (CABAC)
```

```
    par_level_flag (CABAC)
```

```
else
```

```
    sig_coeff_flag (bypass)
```

```
    coeff_sign_flag (bypass)
```

```
    abs_level_gtx_flag[0] (bypass)
```

```
    par_level_flag (bypass)
```

```
for (n=0, n ≤ numSbCoeff-1, n++) //2st pass
```

```
if (CCB ≥ 4)
```

```
    abs_level_gtx_flag[1] (CABAC)
```

```
    abs_level_gtx_flag[2] (CABAC)
```

```
    abs_level_gtx_flag[3] (CABAC)
```

```
    abs_level_gtx_flag[4] (CABAC)
```

```
else
```

```
    abs_level_gtx_flag[1] (bypass)
```

```
    abs_level_gtx_flag[2] (bypass)
```

```
    abs_level_gtx_flag[3] (bypass)
```

```
    abs_level_gtx_flag[4] (bypass)
```

- worst CCB check number is reduced to 2 per coeff.
- CCB check method is unified to that of transform residual coding

per each coeff

2. Comparison of Item2 and TS residual syntax of CE7-1.3b-alt

Transform residual syntax after CCB count:

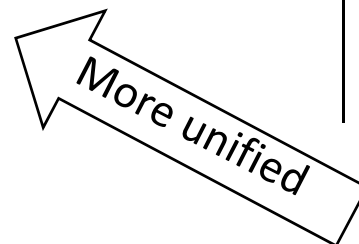
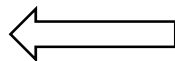
firstPosMode: position of coefficient which CCB count exceeds the limit

for (n=firstPosMode, $n \geq 0$, n--)

`dec_abs_level[n]`

for (n=numSbCoeff-1, $n \geq 0$, n--)

`coeff_sign_flag[n]`



- More unified design with transform residual than CE7-1.3b-alt.
- Complexity reduction by disabling level mapping .

CE7-1.3b-alt syntax after CCB count:

iFirstpassBypassPos: position of coefficient which CCB count exceeds the limit

for (n=0, $n < \text{FirstPassBypassPos}$, n++)

`abs_remainder[n]`

`coeff_sign_flag[n]`

inverse level mapping

Item2 syntax after CCB count:

iFirstpassBypassPos: position of coeff which CCB count exceeds the limit

for (n=0, $n < \text{FirstPassBypassPos}$, n++)

`dec_abs_level[n]`

`coeff_sign_flag[n]`

Level mapping process of VTM6.0 and CE7-1.3b-alt

VTM6.0 (encoder side)

1st pass
sig_coeff_flag[n]
coeff_sign_flag[n]
Level mapping
abs_level_gtx_flag[0]

2st pass
abs_level_gtx_flag[1]
abs_level_gtx_flag[2]
abs_level_gtx_flag[3]
abs_level_gtx_flag[4]

3st pass
remainder[n]

- In VTM6.0, if prediction of level mapping is correct, abs_level_gtx_flag[0] is set to be 0.
- After CCB count, even if prediction of level mapping is correct, the coding length isn't always reduced.

CE7-1.3b-alt (encoder side)

1st pass
sig_coeff_flag[n]
coeff_sign_flag[n]
Level mapping
abs_level_gtx_flag[0]

2st pass
abs_level_gtx_flag[1]
abs_level_gtx_flag[2]
abs_level_gtx_flag[3]
abs_level_gtx_flag[4]

3st pass
remainder[n]

Until CCB
exceeds
limit

4st pass
Level mapping
remainder[n]

After CCB
exceeds
limit

Modified Item2: Proposed syntax of TS residual coding

Transform residual syntax after CCB count:

firstPosMode: position of coefficient which CCB count exceeds the limit

```
for (n=firstPosMode, n  $\geq$  0, n--)  
    dec_abs_level[n]
```

```
for (n=numSbCoeff-1, n  $\geq$  0, n--)  
    coeff_sign_flag[n]
```

▪ In modified item2, in addition to item2, coeff_sign_flag (bypass) is excluded from the bypass coded pass.

Item2 syntax after CCB count:

iFirstpassBypassPos: position of coeff which CCB count exceeds the limit

```
for (n=0, n < FirstPassBypassPos, n++)  
    dec_abs_level[n]  
    coeff_sign_flag[n]
```

Modified Item2 syntax after CCB count:

iFirstpassBypassPos: position of coefficient which CCB count exceeds the limit

```
for (n=0, n < iFirstPassBypassPos, n++)  
    dec_abs_level[n]
```

```
for (n=0, n < iFirstPassBypassPos, n++)  
    coeff_sign_flag[n]
```

Simulation results

■ Item1 (standard QP)

All Intra Main10					
Over VTM-6.0					
	Y	U	V	EncT	DecT
Class A1	0.00%	0.00%	0.01%	100%	100%
Class A2	0.00%	0.01%	0.03%	100%	100%
Class B	0.00%	0.01%	-0.05%	100%	99%
Class C	0.00%	-0.06%	-0.01%	99%	99%
Class E	0.00%	0.08%	0.02%	100%	99%
Overall	0.00%	0.01%	-0.01%	100%	99%
Class D	0.00%	0.00%	-0.01%	100%	100%
Class F	0.02%	0.00%	0.06%	101%	100%
TGM	0.04%	0.05%	0.06%	101%	99%

There are no coding losses.

Random Access Main 10						Low delay B Main10					
Over VTM-6.0						Over VTM-6.0					
	Y	U	V	EncT	DecT		Y	U	V	EncT	DecT
Class A1	0.00%	0.00%	0.01%	100%	100%	Class A1					
Class A2	0.02%	0.13%	0.07%	100%	100%	Class A2					
Class B	-0.01%	0.12%	-0.03%	100%	100%	Class B	0.02%	0.07%	0.26%	101%	101%
Class C	0.02%	0.05%	0.10%	101%	100%	Class C	-0.04%	-0.27%	0.05%	100%	100%
Class E						Class E	-0.01%	0.24%	0.54%	100%	98%
Overall	0.01%	0.08%	0.03%	100%	100%	Overall	-0.01%	0.00%	0.26%	100%	100%
Class D	-0.08%	-0.22%	-0.10%	100%	101%	Class D	-0.04%	0.35%	-0.04%	100%	99%
Class F	0.02%	-0.03%	-0.07%	101%	99%	Class F	-0.01%	-0.26%	0.08%	100%	97%
TGM	0.00%	-0.02%	0.00%	101%	100%	TGM	-0.01%	0.01%	0.06%	101%	99%

Simulation results

■ Item2 (standard QP)

All Intra Main10					
Over VTM-6.0					
	Y	U	V	EncT	DecT
Class A1	0.00%	0.01%	-0.01%	100%	101%
Class A2	0.01%	0.01%	0.02%	100%	99%
Class B	0.00%	-0.01%	-0.05%	101%	99%
Class C	0.01%	-0.14%	0.09%	100%	99%
Class E	0.00%	0.04%	0.03%	100%	99%
Overall	0.00%	-0.02%	0.01%	100%	99%
Class D	-0.01%	0.02%	-0.02%	100%	101%
Class F	0.01%	0.03%	-0.11%	102%	100%
TGM	0.05%	0.10%	0.08%	101%	100%

There are no coding losses.
Note that modified Item2 has no BD-rate change with Item2.

	Random Access Main 10						Low delay B Main10				
	Over VTM-6.0						Over VTM-6.0				
	Y	U	V	EncT	DecT		Y	U	V	EncT	DecT
Class A1	0.00%	0.00%	0.08%	100%	100%	Class A1	0.00%	0.18%	-0.05%	101%	101%
Class A2	0.01%	0.09%	0.04%	101%	99%	Class A2					
Class B	-0.01%	0.14%	-0.03%	101%	100%	Class B					
Class C	-0.02%	0.07%	0.08%	101%	100%	Class C					
Class E						Class E					
Overall	-0.01%	0.08%	0.04%	101%	100%	Overall	0.00%	-0.10%	-0.15%	101%	100%
Class D	-0.06%	-0.19%	-0.07%	101%	101%	Class D	0.00%	-0.09%	0.86%	101%	99%
Class F	0.02%	0.06%	0.07%	101%	100%	Class F	0.00%	-0.07%	0.29%	101%	97%
TGM	0.04%	0.06%	0.08%	101%	100%	TGM	-0.06%	0.04%	0.09%	101%	99%

Simulation results

■ Item1 (low QP)

All Intra Main10					
Over VTM-6.0					
	Y	U	V	EncT	DecT
Class A1	0.00%	0.01%	0.01%	#NUM!	#NUM!
Class A2	0.00%	0.00%	0.00%	#NUM!	#NUM!
Class B	0.00%	0.01%	0.00%	100%	100%
Class C	0.00%	0.00%	0.02%	100%	100%
Class E	0.01%	-0.01%	-0.01%	100%	101%
Overall	0.00%	0.00%	0.01%	#NUM!	#NUM!
Class D	0.01%	-0.01%	0.03%	100%	102%
Class F	0.08%	0.03%	0.00%	100%	101%
TGM	0.10%	0.07%	0.08%	100%	101%

There are no coding losses.

	Random Access Main 10						Low delay B Main10				
	Over VTM-6.0						Over VTM-6.0				
	Y	U	V	EncT	DecT		Y	U	V	EncT	DecT
Class A1	#VALUE!	#VALUE!	#VALUE!	#NUM!	#NUM!	Class A1					
Class A2	#VALUE!	#VALUE!	#VALUE!	#DIV/0!	#DIV/0!	Class A2					
Class B	0.00%	0.01%	0.03%	100%	100%	Class B	0.00%	-0.01%	0.00%	100%	100%
Class C	-0.01%	0.00%	-0.03%	100%	101%	Class C	-0.01%	0.01%	0.00%	100%	100%
Class E						Class E	0.00%	-0.06%	0.07%	100%	100%
Overall	#VALUE!	#VALUE!	#VALUE!	#DIV/0!	#DIV/0!	Overall	0.00%	-0.01%	0.02%	100%	100%
Class D	-0.02%	-0.05%	0.05%	100%	101%	Class D	0.00%	0.03%	-0.04%	99%	100%
Class F	-0.01%	-0.16%	-0.07%	100%	101%	Class F	0.03%	0.08%	-0.03%	100%	101%
TGM	0.06%	0.10%	0.07%	100%	101%	TGM	0.00%	0.05%	0.07%	99%	98%

Simulation results

■ Item2 (low QP)

	All Intra Main10				
	Over VTM-6.0				
	Y	U	V	EncT	DecT
Class A1	-0.02%	-0.01%	0.01%	#NUM!	#NUM!
Class A2	0.00%	0.00%	0.00%	#NUM!	#NUM!
Class B	-0.03%	-0.01%	0.00%	100%	101%
Class C	-0.07%	-0.04%	-0.04%	100%	101%
Class E	-0.05%	-0.08%	-0.06%	100%	100%
Overall	-0.04%	-0.03%	-0.02%	#NUM!	#NUM!
Class D	-0.07%	-0.05%	-0.06%	99%	101%
Class F	-1.21%	-0.45%	-0.45%	99%	101%
TGM	-1.36%	-0.95%	-0.96%	99%	101%

There are high coding gains in SCC and some coding gains can be seen in natural video contents.

	Random Access Main 10						Low delay B Main10				
	Over VTM-6.0						Over VTM-6.0				
	Y	U	V	EncT	DecT		Y	U	V	EncT	DecT
Class A1	#VALUE!	#VALUE!	#VALUE!	#NUM!	#NUM!	Class A1					
Class A2	#VALUE!	#VALUE!	#VALUE!	#DIV/0!	#DIV/0!	Class A2					
Class B	-0.01%	0.01%	-0.01%	100%	101%	Class B	-0.02%	0.00%	0.00%	100%	101%
Class C	-0.05%	-0.02%	-0.03%	100%	101%	Class C	-0.02%	-0.01%	0.01%	100%	101%
Class E						Class E	-0.08%	-0.01%	0.00%	100%	101%
Overall	#VALUE!	#VALUE!	#VALUE!	#DIV/0!	#DIV/0!	Overall	-0.03%	-0.01%	0.00%	100%	101%
Class D	-0.08%	-0.12%	-0.13%	100%	100%	Class D	-0.04%	-0.02%	-0.03%	100%	101%
Class F	-1.55%	-0.59%	-0.51%	100%	102%	Class F	-0.44%	-0.31%	-0.30%	100%	101%
TGM	-2.01%	-0.72%	-0.69%	100%	102%	TGM	-0.91%	-0.43%	-0.38%	99%	100%

Simulation results (Additional information)

■ Item2 over CE7-1.3b-alt

	All Intra Main10				
	Over CE7-1.3b-alt				
	Y	U	V	EncT	DecT
Class A1	0.00%	0.01%	0.01%	#DIV/0!	#DIV/0!
Class A2	0.00%	0.00%	0.01%	#DIV/0!	#DIV/0!
Class B	0.00%	-0.02%	0.00%	#DIV/0!	#DIV/0!
Class C	0.00%	-0.08%	0.10%	#DIV/0!	#DIV/0!
Class E	0.00%	-0.02%	0.03%	#DIV/0!	#DIV/0!
Overall	0.00%	-0.02%	0.03%	#DIV/0!	#DIV/0!
Class D	-0.01%	0.06%	0.07%	#DIV/0!	#DIV/0!
Class F	0.01%	0.08%	-0.09%	#DIV/0!	#DIV/0!
TGM	0.01%	0.02%	0.03%	#DIV/0!	#DIV/0!

No loss compared to CE7-1.3b-alt

	Random Access Main 10						Low delay B Main10				
	Over CE7-1.3b-alt						Over CE7-1.3b-alt				
	Y	U	V	EncT	DecT		Y	U	V	EncT	DecT
Class A1	0.00%	0.01%	0.07%	#DIV/0!	#DIV/0!	Class A1					
Class A2	0.00%	0.00%	-0.04%	#DIV/0!	#DIV/0!	Class A2					
Class B	-0.01%	-0.05%	-0.09%	#DIV/0!	#DIV/0!	Class B	-0.01%	0.07%	0.10%	#DIV/0!	#DIV/0!
Class C	-0.03%	-0.02%	-0.01%	#DIV/0!	#DIV/0!	Class C	-0.01%	-0.13%	-0.01%	#DIV/0!	#DIV/0!
Class E						Class E	0.02%	-0.62%	-0.22%	#DIV/0!	#DIV/0!
Overall	-0.01%	-0.02%	-0.03%	#DIV/0!	#DIV/0!	Overall	0.00%	-0.17%	-0.02%	#DIV/0!	#DIV/0!
Class D	-0.01%	0.14%	-0.09%	#DIV/0!	#DIV/0!	Class D	-0.01%	0.21%	0.88%	#DIV/0!	#DIV/0!
Class F	0.01%	0.10%	-0.07%	#DIV/0!	#DIV/0!	Class F	-0.09%	-0.34%	-0.25%	#DIV/0!	#DIV/0!
TGM	0.07%	0.07%	0.05%	#DIV/0!	#DIV/0!	TGM	0.03%	0.11%	0.13%	#DIV/0!	#DIV/0!

Simulation results (Additional information)

■ Item2 over CE7-1.3b-alt (low QP)

	All Intra Main10				
	Over CE7-1.3b-alt				
	Y	U	V	EncT	DecT
Class A1	-0.01%	-0.01%	0.00%	#DIV/0!	#DIV/0!
Class A2	0.00%	0.00%	0.00%	#DIV/0!	#DIV/0!
Class B	-0.01%	0.00%	0.00%	#DIV/0!	#DIV/0!
Class C	-0.02%	-0.01%	-0.03%	#DIV/0!	#DIV/0!
Class E	-0.02%	-0.01%	-0.03%	#DIV/0!	#DIV/0!
Overall	-0.01%	-0.01%	-0.01%	#DIV/0!	#DIV/0!
Class D	-0.01%	0.02%	-0.02%	#DIV/0!	#DIV/0!
Class F	0.00%	0.05%	0.06%	#DIV/0!	#DIV/0!
TGM	0.05%	0.08%	0.06%	#DIV/0!	#DIV/0!

No loss compared to CE7-1.3b-alt

	Random Access Main 10						Low delay B Main10				
	Over CE7-1.3b-alt						Over CE7-1.3b-alt				
	Y	U	V	EncT	DecT		Y	U	V	EncT	DecT
Class A1	#VALUE!	#VALUE!	#VALUE!	#DIV/0!	#DIV/0!	Class A1					
Class A2	#VALUE!	#VALUE!	#VALUE!	#DIV/0!	#DIV/0!	Class A2					
Class B	-0.01%	0.00%	-0.02%	#DIV/0!	#DIV/0!	Class B	-0.02%	-0.01%	0.02%	#DIV/0!	#DIV/0!
Class C	-0.01%	0.01%	0.00%	#DIV/0!	#DIV/0!	Class C	0.00%	-0.01%	0.05%	#DIV/0!	#DIV/0!
Class E						Class E	-0.03%	-0.02%	0.03%	#DIV/0!	#DIV/0!
Overall	#VALUE!	#VALUE!	#VALUE!	#DIV/0!	#DIV/0!	Overall	-0.01%	-0.01%	0.03%	#DIV/0!	#DIV/0!
Class D	-0.04%	-0.03%	0.00%	#DIV/0!	#DIV/0!	Class D	-0.03%	0.00%	0.08%	#DIV/0!	#DIV/0!
Class F	-0.04%	-0.03%	0.17%	#DIV/0!	#DIV/0!	Class F	0.05%	-0.03%	-0.03%	#DIV/0!	#DIV/0!
TGM	0.03%	0.16%	0.19%	#DIV/0!	#DIV/0!	TGM	0.09%	0.14%	0.09%	#DIV/0!	#DIV/0!

Conclusion

- Item1 reduces the number of CCB checks to one-fourth from VTM6.0,
▪ CCB check method between two residual modes are also unified.
- Item2 archives further unification between two residual modes on top of CE7-1.3b-alt and reduces complexity after CCB count.

→ Propose to adopt Item1 or Item2 into the test model

Thank InterDigital for cross checking!