

The Mediatek logo is an orange parallelogram with the word "MEDIATEK" in white, bold, sans-serif capital letters.

# AHG10: A Triplet Palette Mode Combining JCTVC-P0108 and JCTVC-P0198

Yu-Chen Sun, Tzu-Der Chuang, PoLin Lai,  
Shih-Ta Hsiang, Yi-Wen Chen, Xianguo Zhang,  
Shan Liu, Yu-Wen Huang, Shawmin Lei

Presented by Tzu-Der (Peter) Chuang  
17<sup>th</sup> JCT-VC Meeting in Valencia  
27 March – 4 April 2014

# Overview Summary

- We proposed a triplet palette mode which combines JCTVC-P0108 and JCTVC-P0198
  - The proposed palette is triplet, similar to JCTVC-P0198.
  - The proposed color index map coding is either sample by sample or a line mode, similar to JCTVC-P0108.
- Results (SC YUV 444 sequences)

Lossy coding BD-rate	AI-MT	RA-MT	LB-MT
Proposed Method	-14.2%	-13.1%	-10.2%

# Triplet Palette Representation

- Encoder determines the major sample values of each component ( $N_{1-\max} = N_{2-\max} = N_{3-\max} = 15$ )

1 <sup>st</sup> Component's Sample Value Index	1 <sup>st</sup> Component's Sample Value	2 <sup>nd</sup> Component's Sample Value Index	2 <sup>nd</sup> Component's Sample Value	3 <sup>rd</sup> Component's Sample Value Index	3 <sup>rd</sup> Component's Sample Value
0	$V_1[0]$	0	$V_2[0]$	0	$V_3[0]$
1	$V_1[1]$	1	$V_2[1]$	1	$V_3[1]$
...	$V_1[\dots]$	...	$V_2[\dots]$	...	$V_3[\dots]$
$N_1-1$	$V_1[N_1-1]$	$N_2-1$	$V_2[N_2-1]$	$N_3-1$	$V_3[N_3-1]$
$N_1$	Escape	$N_2$	Escape	$N_3$	Escape

- Encoder determines representative N combinations from the three color components, records as triplet palette and is a color index table of triplets of sample value indices of different color components ( $N_{\max} = 63$ )

Color Index	1 <sup>st</sup> Component's Sample Value Index	2 <sup>nd</sup> Component's Sample Value Index	3 <sup>rd</sup> Component's Sample Value Index
0	$I_1[0]$	$I_2[0]$	$I_3[0]$
...	$I_1[\dots]$	$I_2[\dots]$	$I_3[\dots]$
$N-1$	$I_1[N-1]$	$I_2[N-1]$	$I_3[N-1]$
$N$	Escape	Escape	Escape

# Coding of the Palettes (1/3)

- Predictive coding of the palettes
  - Palette Copy Mode
  - Palette Modification Mode
- Palette Copy Mode:
  - Set palette size of current CU  $N_1$  equal to the palette size of last palette-coded CU  $N_{1last}$
  - Copy  $N_1$  major sample values from the last palette-coded CU

Component-1 Palette Predictor	
Last Palette Size, $N_{1last}$	10
Sample Value Index	Sample Value Predictor
0	P[0]
1	P[1]
2	P[2]
...	P[...]
$N_{1max}-2=13$	P[ $N_{1max}-2$ ]
$N_{1max}-1=14$	P[ $N_{1max}-1$ ]

Derive  
Palette



Component-1 Palette for Current CU	
Palette Size, $N_1$	10
Sample Value Index	Sample Value
0	P[0]
1	P[1]
...	
9	P[9]
10	Escape

# Coding of the Palettes (2/3)

- Palette Modification Mode:
  - Signals palette size, palette prediction flags, and new major sample values (if current major sample value is not equal to the predictor)

Component-1 Palette Modification Information	
New Palette Size, $N_1$	3
Same as Predictor?	New Major Sample Value
No	P'[0]
Yes	
No	P'[2]

Signaling

Component-1 Palette Predictor	
Last Palette Size, $N_{last}$	10
Sample Value Index	Sample Value Predictor
0	P[0]
1	P[1]
2	P[2]
...	P[...]
$N_{lmax}-2=13$	P[ $N_{lmax}-2$ ]
$N_{lmax}-1=14$	P[ $N_{lmax}-1$ ]

Derive  
Palette

Component-1 Palette for Current CU	
Palette Size, $N_1$	3
Sample Value Index	Sample Value
0	P'[0]
1	P[1]
2	P'[2]
3	Escape

# Coding of the Palettes (3/3)

- Palette predictor updating:
  - Update palette size of last palette-coded CU  $N_{1\text{last}} = N_1$
  - Update  $N_1$  major sample values from the current palette

Component-1 Palette for Current CU	
Palette Size, $N_1$	3
Sample Value Index	Sample Value
0	$P'[0]$
1	$P[1]$
2	$P'[2]$
3	Escape

Component-1 Palette Predictor for Current CU	
Last Palette Size, $N_{1\text{last}}$	10
Sample Value Index	Sample Value Predictor
0	$P[0]$
1	$P[1]$
2	$P[2]$
...	$P[\dots]$
$N_{1\text{max}}-2=13$	$P[N_{1\text{max}}-2]$
$N_{1\text{max}}-1=14$	$P[N_{1\text{max}}-1]$

Update



Component-1 Palette Predictor for <b>Next</b> CU	
Last Palette Size, $N_{1\text{last}}$	<b>3</b>
Sample Value Index	Sample Value Predictor
0	<b><math>P'[0]</math></b>
1	$P[1]$
2	<b><math>P'[2]</math></b>
...	$P[\dots]$
$N_{1\text{max}}-2=13$	$P[N_{1\text{max}}-2]$
$N_{1\text{max}}-1=14$	$P[N_{1\text{max}}-1]$

# Coding of the Color Index Map (1/5)

- CU represented by color index map
- Color indices are coded line-by-line
- Three index line modes:
  - **Vertical mode:** Indices of the current line are copied from the above line
  - **Horizontal mode:** One color index is signaled, all indices in the current line are set to the signaled color index
  - **Normal mode:** Indices of the line are signaled sample-by-sample
  - Escape sample values only occur under normal line mode

# Coding of the Color Index Map (2/5)

- If normal line mode is selected, the color indices are coded sample-by-sample
- Index of the current sample can be:
  - Predicted from index candidate list, or
  - Signaled by a new index value
- Color index candidates
  - Four-neighbors prediction: left, above, above-left, above-right
  - Transition-copy prediction: most recently occurred color index values after the appearance of its left sample



# Coding of the Color Index Map (3/5)

- Transition-Copy prediction
  - Use left sample index as pilot color index to identify index candidates
  - TC Table: For each pilot color index, it maintains 2 most recently occurred color index values (TC1 and TC2 ) after the appearance of the pilot color index
  - TC table inherits the TC values of the previous CU

Illustration of a transition copy table.

Pilot Color Index	1 <sup>st</sup> TC Color Index	2 <sup>nd</sup> TC Color Index
0		
1	2	3
...		
N <sub>TC</sub>		

0	0	0	1	3	3	3	3
0	0	0	1	3	3	3	3
0	0	0	1	2	2	2	2
0	0	0	1	2	2	2	2
0	0	0	1	C			

→ Pilot Color Index = 1

1<sup>st</sup> TC Color Index  
= TC[Pilot Color Index][0]=2

2<sup>nd</sup> TC Color Index  
= TC[Pilot Color Index][1]=3

# Coding of the Color Index Map (4/5)

- Color index candidate list
  - Initial candidate list, for color index:  
{above, left, TC1, TC2, above-left, above-right, 0, 1, 2, 3}
  - Select first 4 non-equal indices, and New color index, forms the final list
  - A candidate index is signaled to indicate which predictor is selected

Selected Candidate Index	Codeword
0: Color index candidate 0	1
1: Color index candidate 1	01
2: Color index candidate 2	001
3: Color index candidate 3	0000
4: New color index candidate	0001

# Coding of the Color Index Map (5/5)

- Index map rotation
  - For palette-coded CU, an `index_rotation_flag` is signaled to indicate whether the color indices are rotated
  - If 1, axes of the color index map is swapped:
  - `color_index[ x0 ][ y0 ]`  $\rightarrow$  `color_index[ y0 ][ x0 ]`

# Summary

- Triplet palette representation
  - 3 component-wise palette
- Coding of the palettes
  - Palette Copy Mode: Copy the last palette
  - Palette Modification Mode: Signal the palette size and values
- Coding of the color index map
  - Three index line mode: Vertical, horizontal, and normal mode
  - In normal mode: Sample-by-sample color index prediction
    - Four spatial neighbors and transition-copy candidates
  - Index map rotation

# Lossy Coding Result

- Anchor: RExt6.0
- 14.2%/13.1% /10.2% BD-rate saving for SC YUV444 sequences under AI-MT/RA-MT/ LD-MT
- Thank Microsoft for cross-verification

BD-rate Y	AI-MT	AI-HT	AI-SHT	RA-MT	RA-HT	LB-MT	LB-HT
Class F	-4.5%	-4.1%	-3.8%	-3.3%	-2.9%	-2.3%	-2.2%
Class B	0.0%	0.0%	0.0%	0.1%	0.0%	0.1%	0.1%
SC RGB 444	-17.4%	-17.2%	-17.3%	-16.5%	-16.2%	-14.5%	-14.6%
Animation RGB 444	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
SC YUV 444	-14.2%	-16.2%	-17.0%	-13.1%	-14.9%	-10.2%	-12.4%
Animation YUV 444	0.1%	0.0%	0.0%	0.1%	0.1%	0.1%	0.1%
RangeExt	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%
SC(444) GBR Optional	-39.1%	-41.0%	-44.2%	-33.4%	-36.1%	-29.5%	-33.4%
SC(444) YUV Optional	-28.8%	-34.9%	-39.9%	-25.1%	-30.1%	-24.6%	-28.0%

# Lossless Coding Result

- Anchor: RExt6.0
- 11.9%/10.0% /9.0% bit saving for SC YCbCr444 sequences under AI/RA/ LD

	Average bit-rate increase		
	AI	RA	LB
Class F	-0.8%	-0.2%	-0.1%
Class B	0.0%	0.0%	0.0%
RGB 4:4:4 SC	-13.7%	-11.3%	-10.5%
RGB 4:4:4 Animation	-0.3%	-0.3%	-0.3%
YCbCr 4:4:4 SC	-11.9%	-10.0%	-9.0%
YCbCr 4:4:4 Animation	-1.3%	-1.3%	-1.3%
RangeExt	0.0%	0.0%	0.0%
RGB 4:4:4 SC (Optional)	-36.4%	-34.1%	-28.3%
YCbCr 4:4:4 SC (Optional)	-33.2%	-30.6%	-28.3%

# Conclusion

- We proposed a triplet palette mode which combines JCTVC-P0108 and JCTVC-P0198
  - The proposed palette is triplet, similar to JCTVC-P0198 in spirit.
  - The proposed color index coding is either sample by sample or a line mode, similar to JCTVC-P0108 in spirit.
- Results (SC YUV 444 sequences)

Lossy coding BD-rate	AI-MT	RA-MT	LB-MT
Proposed Method	-14.2%	-13.1%	-10.2%