

Diagonal scan for quantization matrix coefficients

Hui Yong Kim

Summary

❑ Proposal

- ❖ Use diagonal scan instead of zigzag scan for QM coefficients

❑ Benefits

- ❖ Simplified design
 - Unified scanning for both QM coefficient and transform coefficient
- ❖ Reduced complexity
 - Implementation of zigzag scanning is not needed anymore.
- ❖ Simplified text
 - “6.5.4 Zig-zag scanning array initialization process” is completely removed.

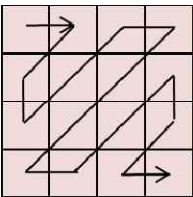
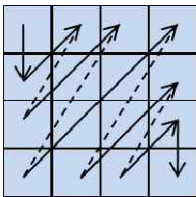
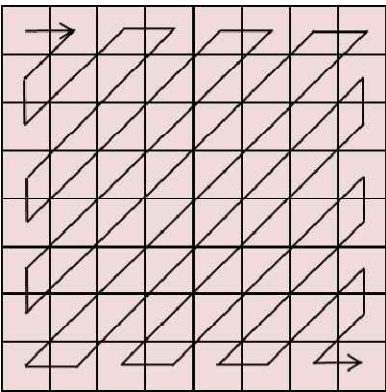
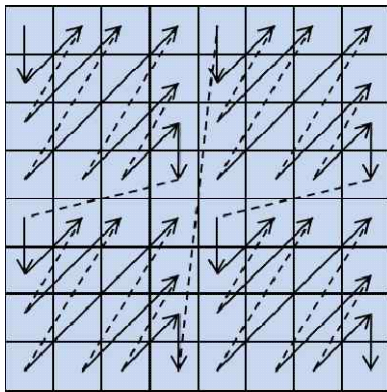
❑ Results

- ❖ Negligible BDR impact

Background

❑ HM 6.0

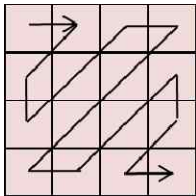
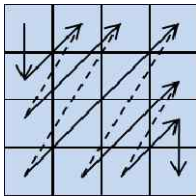
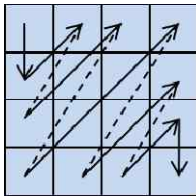
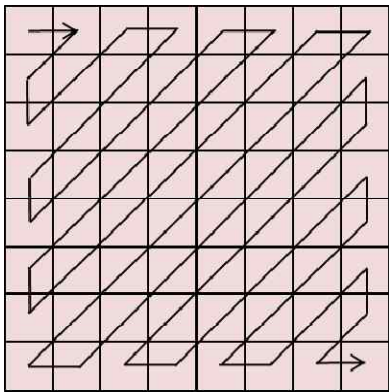
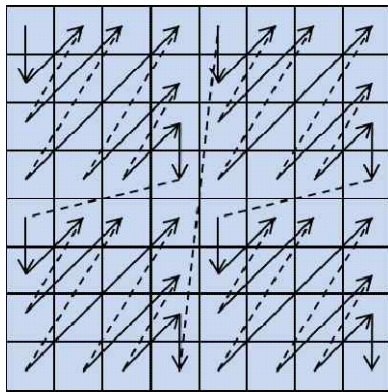
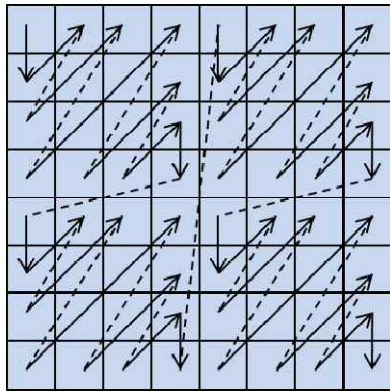
- ❖ Zigzag scan is only used for QM coefficients.
- ❖ Diagonal, Horizontal, and Vertical scans are used for transform coefficient.

Size	HM6	
	For QM	For TCoeff
4x4		
8x8		

Proposal

❑ Use diagonal scan for QM coefficients.

- ❖ For 4x4 QM: use the 4x4 diagonal scan
- ❖ For 8x8 QM: use the 4x4 sub-block based diagonal scan
- *Unified scanning for both QM coefficient and transform coefficient*

Size	HM6		Proposed
	For QM	For TCoeff	For both QM and TCoeff
4x4			
8x8			

Benefits

❑ Text simplification

- ❖ “6.5.4 Zig-zag scanning array initialization process” is completely removed.
- ❖ ZigZag scan is replaced by DiagScan

❑ Reduced complexity

- ❖ Implementation of zigzag scanning is not needed anymore.

❑ Source code modification

- ❖ Only two lines are modified

3 Definitions

For the purposes of this Recommendation | International Standard, the following definitions apply:

zig-zag scan: ~~A specific sequential ordering of transform coefficient levels from (approximately) the lowest spatial frequency to the highest.~~

6.5 Scanning array initialization process

6.5.4 Zig-zag scanning array initialization process

~~Input to this process is a block size blkSize.~~

~~Output of this process is the array ZigZag[sPos][sComp]. The array index sPos specify the scan position ranging from 0 to (blkSize * blkSize) - 1. The array index sComp equal to 0 specifies the horizontal component and the array index sComp equal to 1 specifies the vertical component. The array ZigZag is derived as follows.~~

```
ZigZag[ 0 ][ 0 ] = 0
ZigZag[ 0 ][ 1 ] = 0
i = 1
x = 1
y = 0
stopLoop = ( blkSize == 1 ) ? TRUE : FALSE
while( !stopLoop ) {
  while( x >= 0 ) {
    if( x >= 0 && x < blkSize && y >= 0 && y < blkSize ) {
      ZigZag[ i ][ 0 ] = x
      ZigZag[ i ][ 1 ] = y
      i++
    }
    x--
    y++
  }
  x = 0
  while( y >= 0 ) {
    if( x >= 0 && x < blkSize && y >= 0 && y < blkSize ) {
      ZigZag[ i ][ 0 ] = x
      ZigZag[ i ][ 1 ] = y
      i++
    }
    x++
    y--
  }
  y = 0
  if( i >= blkSize * blkSize )
    stopLoop = TRUE
}
```

Experimental results

❑ QM setting for test

- ❖ “scaling_list_symmetry1.txt” in CE4
 - Downsampled
 - DC matrix coefficient = The first matrix coefficient

❑ Results

- ❖ Negligible impact on coding loss
- ❖ Max. 0.0047% BDR increase
- ❖ Confirmed by TI (JCTVC-I0505)

	All Intra Main			All Intra HE10		
	Y	U	V	Y	U	V
Class A	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
Class B	0.0001%	0.0000%	0.0000%	0.0000%	0.0000%	0.0001%
Class C	0.0001%	0.0001%	0.0001%	0.0001%	0.0001%	0.0001%
Class D	0.0003%	0.0003%	0.0003%	0.0003%	0.0003%	0.0003%
Class E	0.0001%	0.0001%	0.0001%	0.0001%	0.0001%	0.0001%
Overall	0.0001%	0.0001%	0.0001%	0.0001%	0.0001%	0.0001%
Class F	0.0001%	0.0001%	0.0001%	0.0001%	0.0001%	0.0001%
Enc Time[%]	99%			100%		
Dec Time[%]	100%			100%		

	Random Access Main			Random Access HE10		
	Y	U	V	Y	U	V
Class A	0.0004%	0.0003%	0.0003%	0.0004%	0.0003%	0.0003%
Class B	0.0004%	0.0004%	0.0004%	0.0004%	0.0004%	0.0004%
Class C	0.0008%	0.0008%	0.0008%	0.0008%	0.0007%	0.0007%
Class D	0.0025%	0.0023%	0.0023%	0.0026%	0.0023%	0.0024%
Class E						
Overall	0.0010%	0.0009%	0.0009%	0.0010%	0.0009%	0.0009%
	0.0010%	0.0009%	0.0012%	0.0010%	0.0009%	0.0012%
Class F	0.0008%	0.0008%	0.0008%	0.0008%	0.0008%	0.0008%
Enc Time[%]	100%			101%		
Dec Time[%]	100%			100%		

	Low delay B Main			Low delay B HE10		
	Y	U	V	Y	U	V
Class A						
Class B	0.0005%	0.0004%	0.0004%	0.0005%	0.0004%	0.0004%
Class C	0.0008%	0.0007%	0.0007%	0.0008%	0.0007%	0.0007%
Class D	0.0024%	0.0022%	0.0022%	0.0025%	0.0022%	0.0022%
Class E	0.0029%	0.0026%	0.0026%	0.0030%	0.0026%	0.0026%
Overall	0.0015%	0.0013%	0.0014%	0.0015%	0.0013%	0.0013%
	0.0015%	0.0014%	0.0014%	0.0015%	0.0014%	0.0014%
Class F	0.0018%	0.0016%	0.0016%	0.0018%	0.0016%	0.0017%
Enc Time[%]	101%			100%		
Dec Time[%]	99%			100%		

Conclusions

☐ **Proposal**

- ❖ Use diagonal scan instead of zigzag scan for QM coefficients

☐ **Benefits**

- ❖ Unified scanning for both QM coefficient and transform coefficient
- ❖ Reduced complexity
- ❖ Simplified text

☐ **Results**

- ❖ Negligible coding loss

☐ **Identical to the “Option 2” of JCTVC-I0370 (Canon)**

☐ **We suggest the proposal to be included in the next HM.**



Thank You Very Much !

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