

Directional Feature based Subsampling Algorithm and Hardware Architecture for Adaptive Loop Filter in H.265/HEVC

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Research background

- ❑ In the new standard, adaptive loop filter (ALF) is one of most promising tools.
- ❑ ALF is extremely efficient for high resolution encoding
- ❑ Calculating correlation matrix is the most time consuming part in ALF

Research Target

- ❑ Calculating correlation matrix for 4K × 2K @30fps sequences in real time
 - Low complexity algorithm : reduce ALF processing time while keep similar coding efficiency
 - Hardware architecture: process 4K × 2K sequences in real time

Proposed method

❑ Low complexity algorithm

Directional feature based subsampling algorithm

➢ SML reusing based directional feature analysis

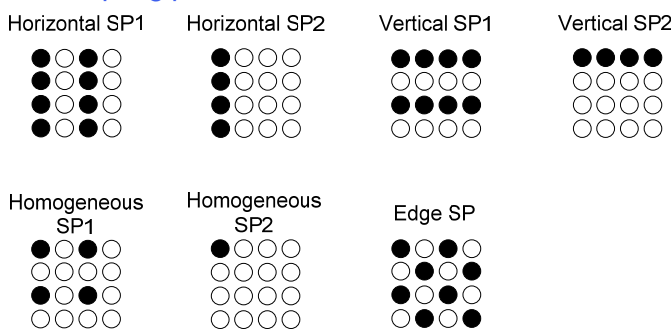
Sum Modified Laplacian(SML) is applied in previous step

$$var(i, j) = \sum_{k=-K}^K \sum_{l=-L}^L (|2R(i+k, j+l) - R(i+k-1, j+l) - R(i+k+1, j+l)| + |2R(i+k, j+l) - R(i+k, j+l-1) - R(i+k, j+l+1)|)$$

$$DF_v = \sum_{k=-K}^K \sum_{l=-L}^L |2R(i+k, j+l) - R(i+k-1, j+l) - R(i+k+1, j+l)|$$

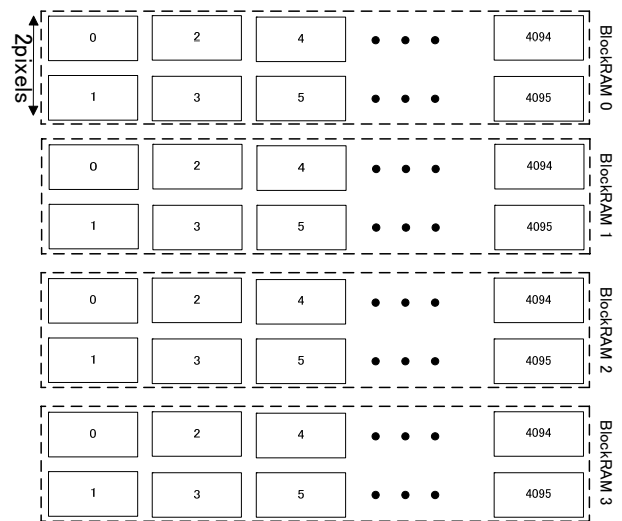
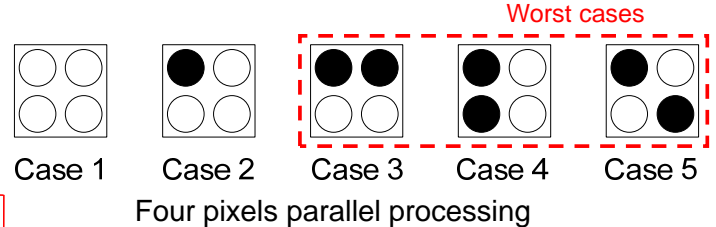
$$DF_h = \sum_{k=-K}^K \sum_{l=-L}^L |2R(i+k, j+l) - R(i+k, j+l-1) - R(i+k, j+l+1)|$$

➢ Subsampling patterns decision



SP: Subsampling Pattern

❑ Parallel hardware architecture



Parity pixel organization method

Experiment results

❑ Conclusion

- Time Reduction: **38.08%**
- BDRATE increases **0.10%**
- BDPSNR decreases **0.0025dB**
- Process 4K × 2K @30fps sequences with **336.825MHz**

Sequences	Coding Efficiency		Time Reduction				
	BDRATE(%)	BDPSNR(dB)	QP=22	QP=27	QP=32	QP=37	
720P	vidyo1	0.1513	-7.50E-04	36.21%	38.24%	46.95%	51.01%
	vidyo3	0.0588	-9.19E-04	36.30%	39.00%	40.35%	43.58%
	vidyo4	0.029	-0.0036	33.17%	37.33%	38.47%	48.58%
1080P	BQTerrace	0.1328	-0.0024	33.74%	35.31%	39.59%	43.62%
	Kimono1	0.3245	-0.0111	40.64%	41.01%	44.05%	49.15%
	BasketballDrive	0.285	-0.0081	42.68%	46.16%	47.54%	51.79%

