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(JVET-K0158)

AHG9: Separable Convolutional Neural Network Filter with Squeeze-and-Excitation block

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Outline

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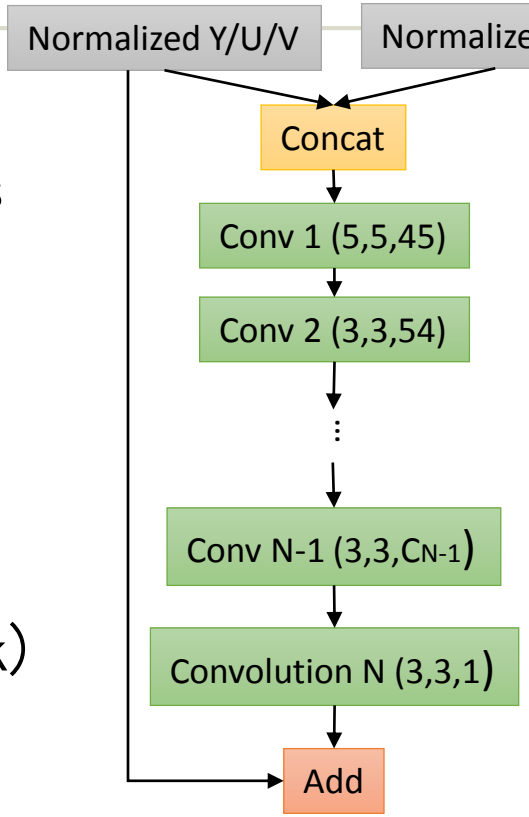
- Introduction
- Proposed network structures
- Simulation results
- Conclusion

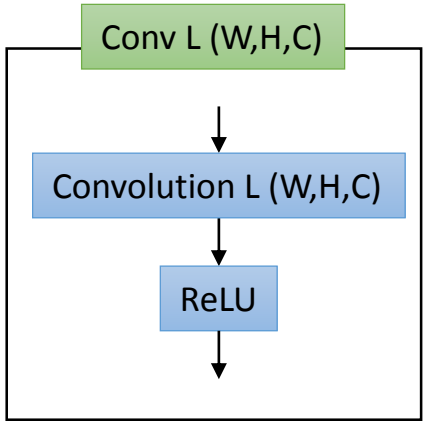
Introduction

- Convolutional Neural Network Filter (CNNF) exceeded conventional filters in JVET-I0022.

- To reduce the number of parameters of CNNF, we apply two methods
  - Squeeze and Excitation block (SE-block)
  - Spatial Separable Convolution

- In BMS simulation, conventional filters (SAO, DF and ALF) are replaced by proposed CNNF.





Network structure of SECNNF

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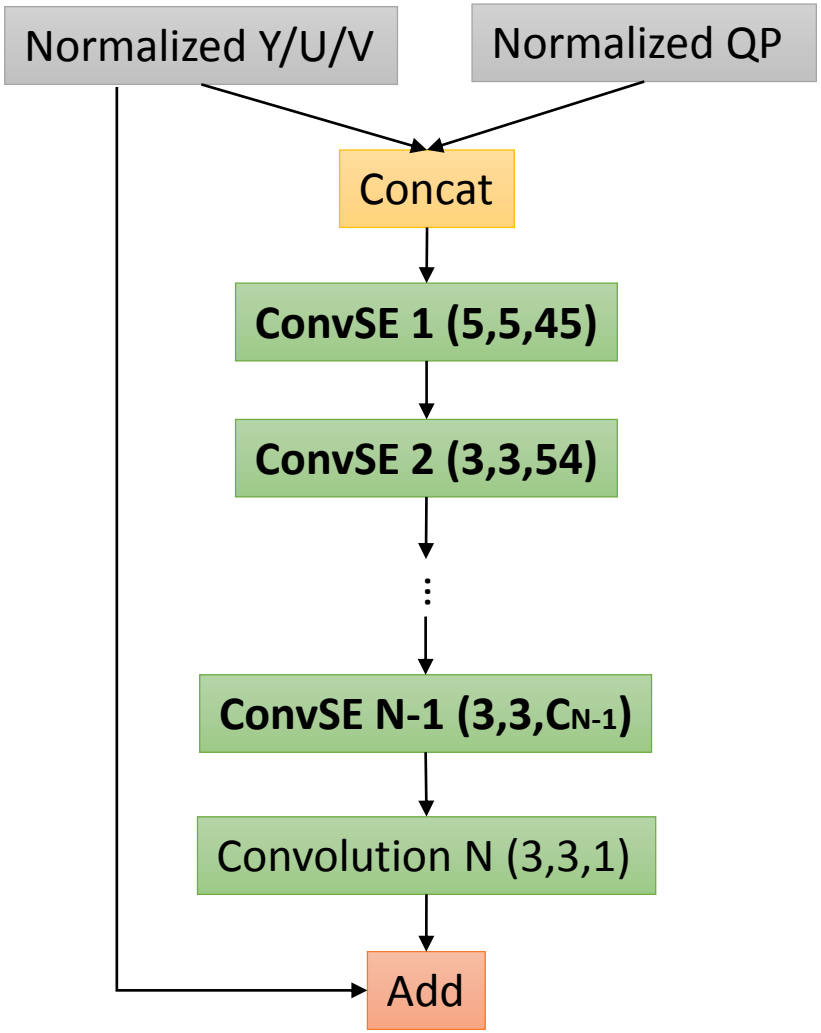
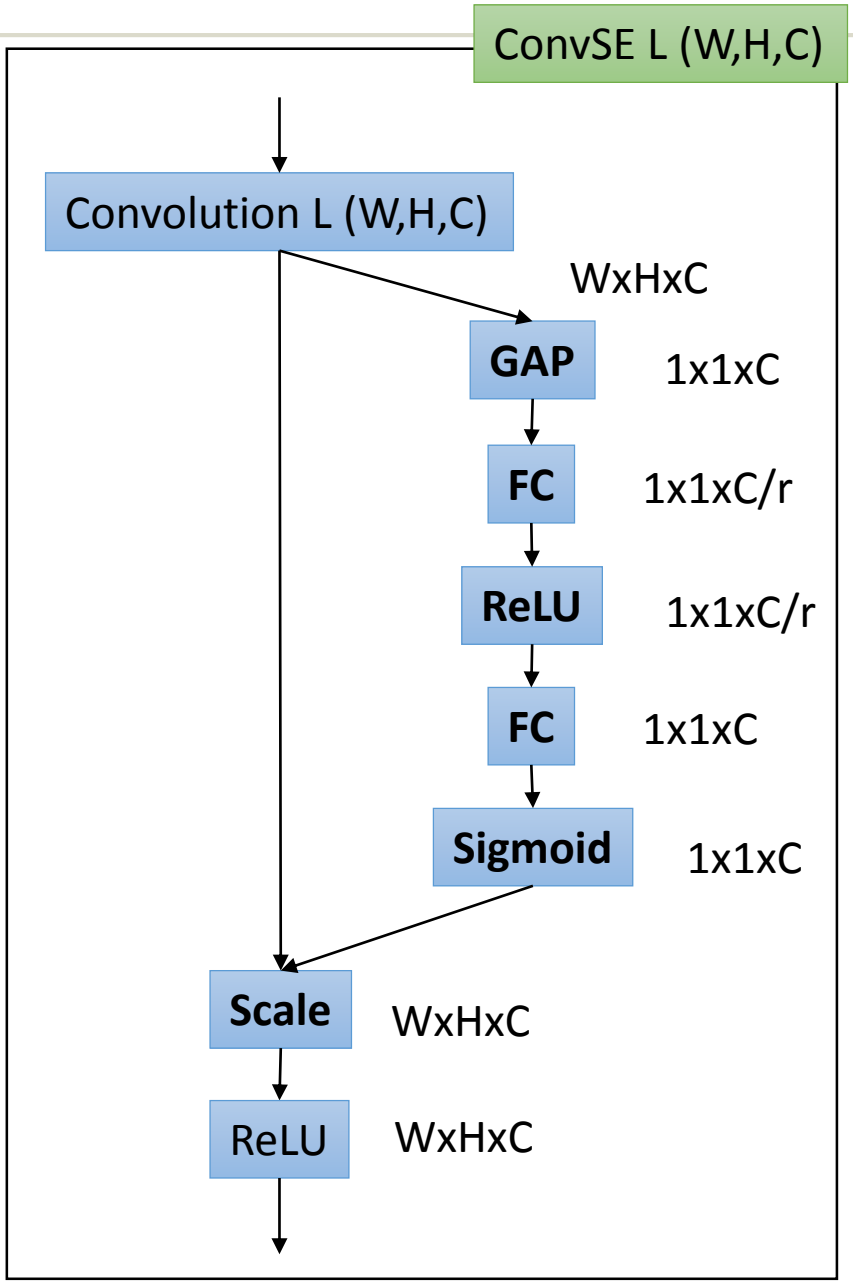
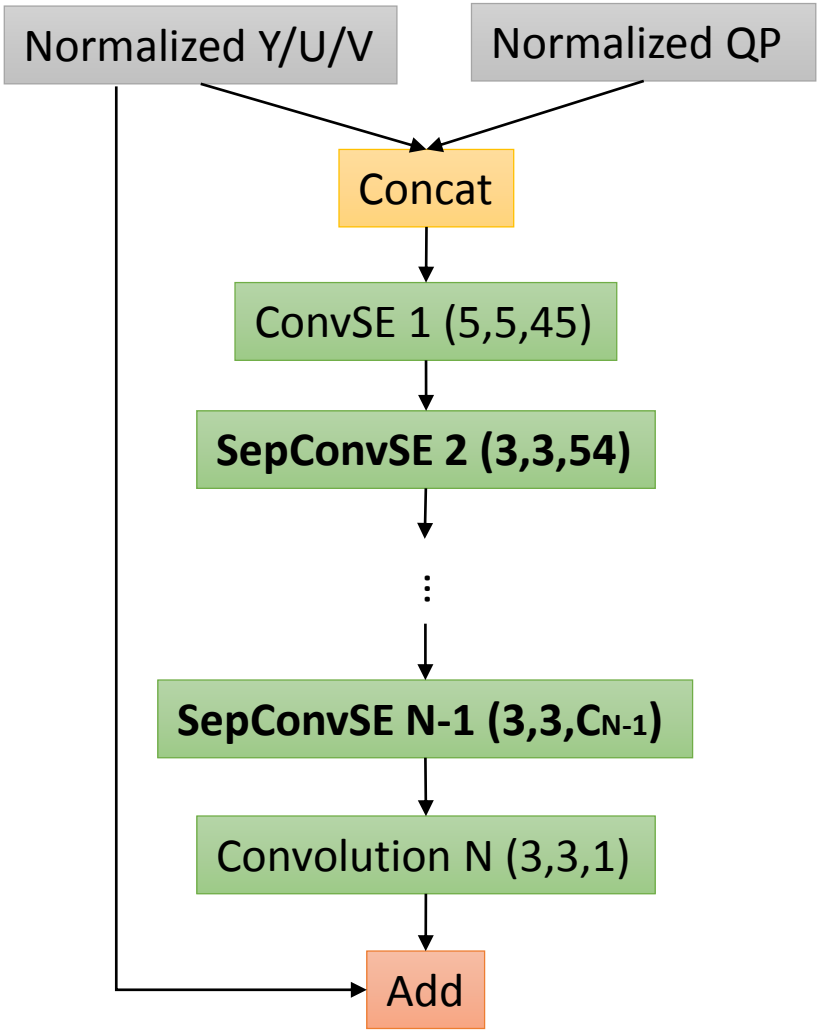
- Apply SE-block to CNNF

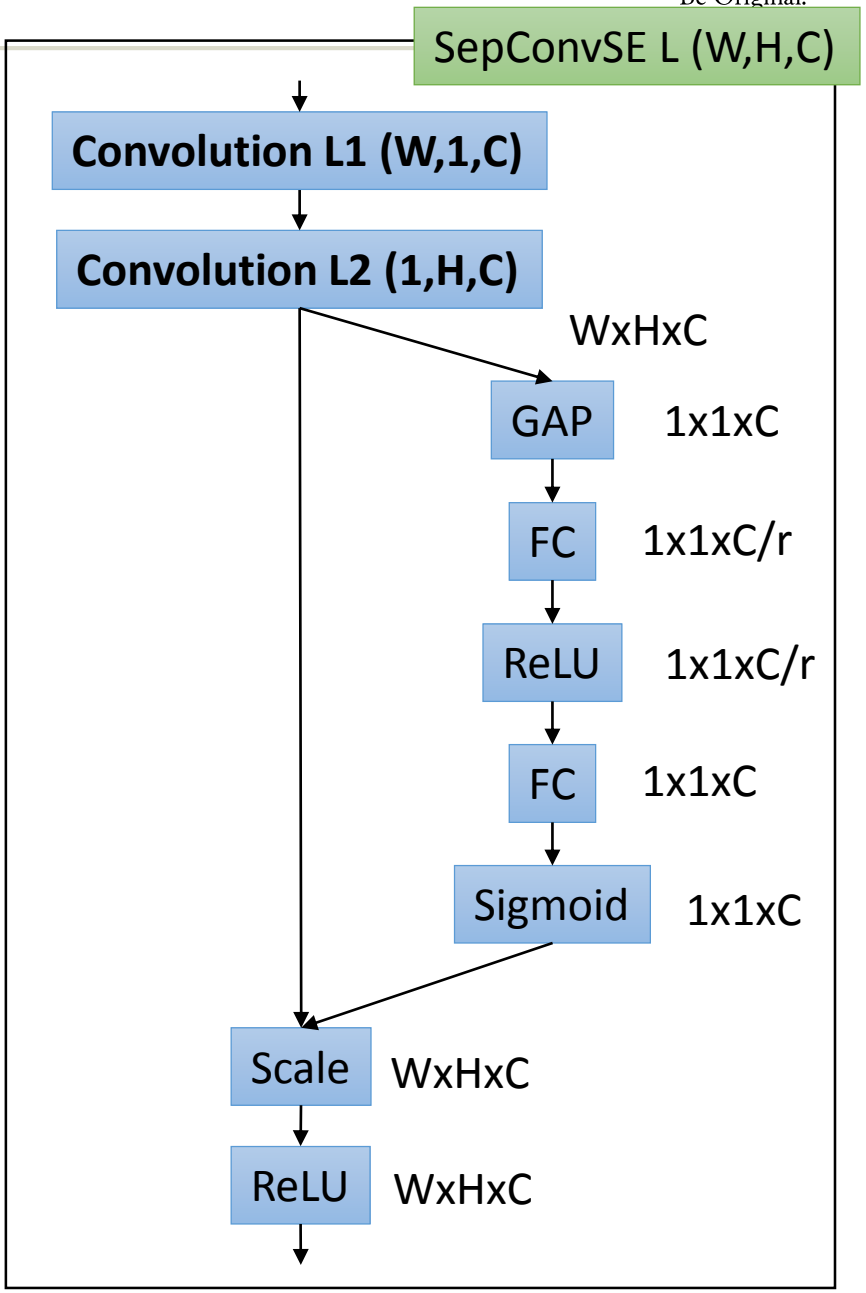




Network structure of SESCNNF

- Apply spatial separable convolution to SECNNF





Parameter reduction ratio of Separable Convolution

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- Number of Parameters of Convolution and Separable Convolution are:
  - Convolution = $I \times O \times k \times k$
  - SepConv = $(I \times O \times k) \times 2$
    → **reduction ratio = $2 / k$**

I : # of input channels
O : # of output channels
k : kernel size

- In the case of 3x3 kernel size, number of parameter can be reduced to about 67%

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- 8L CNNF results in IO configuration (Anchor: BMS-1.1)

	All Intra Main10				
	Over BMS-1.1				
	Y	U	V	EncT	DecT
Class A1	-1.86%	-4.45%	-6.55%	123%	61531%
Class A2	-2.65%	-4.29%	-5.66%	118%	55509%
Class B	-3.01%	-5.42%	-5.92%	118%	59626%
Class C	-4.13%	-6.91%	-8.69%	113%	49777%
Class E	-4.43%	-3.12%	-1.11%	122%	64578%
Overall	-3.24%	-5.02%	-5.80%	118%	57661%
Class D	-4.32%	-6.33%	-8.18%	109%	40129%

# of parameters: 129523

- 6L SESCNNF results in IO configuration (Anchor: BMS-1.1)

	All Intra Main10				
	Over BMS-1.1				
	Y	U	V	EncT	DecT
Class A1	-1.71%	-3.02%	-6.56%	112%	28089%
Class A2	-2.54%	-4.30%	-5.73%	110%	25881%
Class B	-2.97%	-5.15%	-5.83%	109%	27415%
Class C	-3.83%	-6.80%	-8.60%	107%	22757%
Class E	-4.17%	-2.76%	-0.88%	112%	31003%
Overall	-3.08%	-4.62%	-5.73%	110%	26700%
Class D	-4.09%	-6.42%	-8.21%	106%	19390%

# of parameters: 70298 (about 54%)

Simulation results

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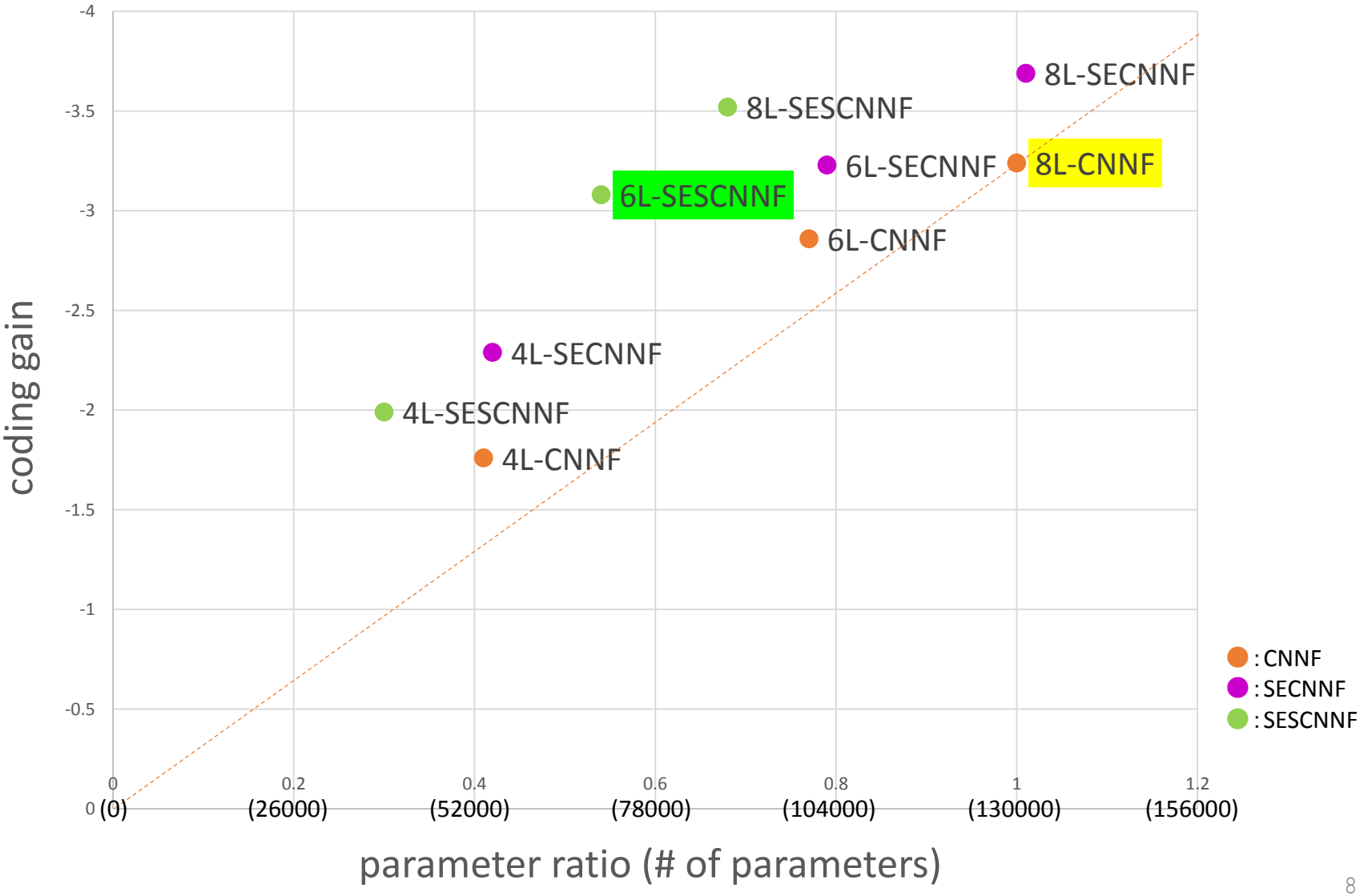
- Test for 4/6/8 layers CNNF/SECNNF/SESCNNF.



Conclusion

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- Propose applying SE-block and Spatial Separable Convolution to CNNF.
- 6 layers SESCNNF shows 3.08%, 4.62%, and 5.73% gain on Y, Cb, and Cr average in BMS IO configuration.
  - The number of parameters of this network is about half of that of 8 layers CNNF, and shows approximately same coding gain.
- Continuous studies about deep learning in codec are recommended.

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