

An Architecture for the new Adaptive Loop Filter of the High Efficiency Video Coding

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Outline

- ❑ Introduction
- ❑ HEVC – High Efficiency Video Coding
- ❑ ALF – Adaptive Loop Filter
- ❑ Proposed Architectures
- ❑ Results
- ❑ Conclusions

Introduction

- Digital video popularization;
- Several devices that held digital video;
- Inviabile task without video compression.

HEVC

- The H.264/AVC standard is still the state-of-art;
- Higher resolutions demand;
- High Efficiency Video Coding – HEVC;
- HEVC goals:
 - Double H.264 compression rates;
 - Same or reduced computational complexity;
- New techniques are required;

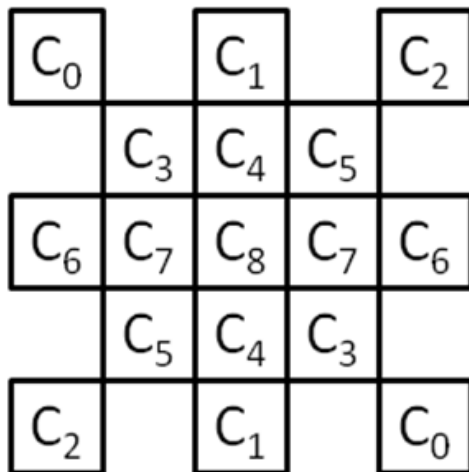
ALF

- Subjective quality of video is deteriorated with coding steps;
- ALF was removed after Working Draft 7 due to high complexity;
- Possible future reinsertion on HEVC's new profile (High efficiency)

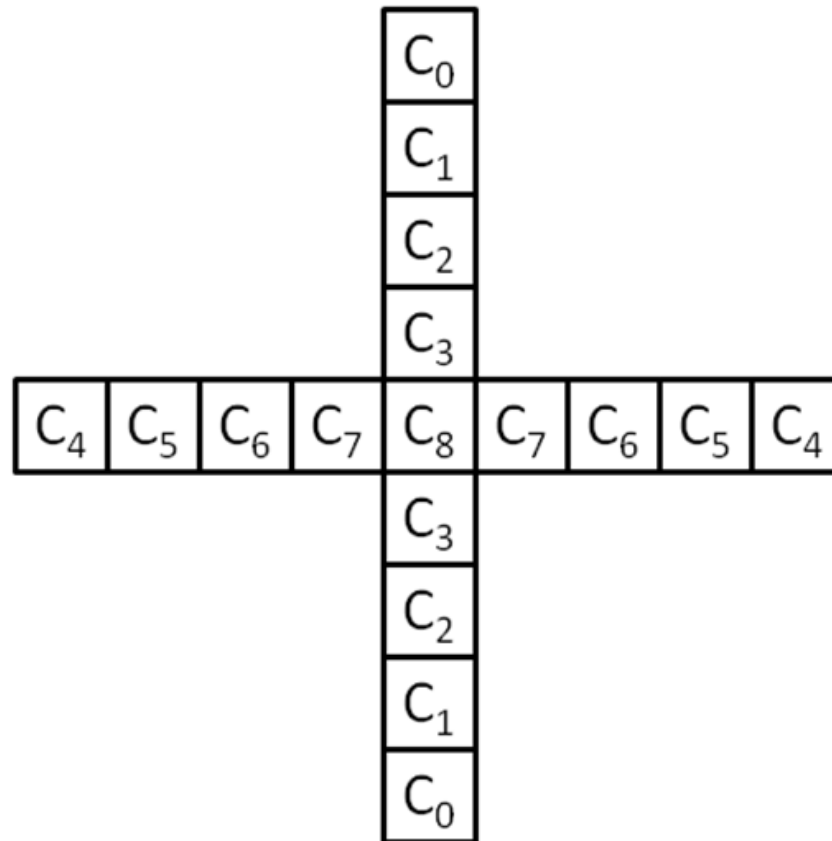
ALF

- Aims to reduce the image distortion;
- Two core sizes: 5x5 and 9x9;
- Filter coefficients generated by Wiener filters.

ALF



5x5



9x9

ALF 5x5

Video Samples

l		n		p
	f	h	k	
d	b	a	c	e
	j	i	g	
q		o		m

Filter Coefficients

C_6		C_7		C_8
	C_3	C_4	C_5	
C_2	C_1	C_0	C_1	C_2
	C_5	C_4	C_3	
C_8		C_7		C_6

ALF 5x5

Video Samples

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	C_5	C_4	C_3	
C_8		C_7		C_6

$$(n * C_7)$$

ALF 5x5

Video Samples

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	f	h	k	
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q		o		m

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	C_3	C_4	C_5	
C_2	C_1	C_0	C_1	C_2
	C_5	C_4	C_3	
C_8		C_7		C_6

$$(q * C_8)$$

ALF 5x5

Video Samples

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	C_5	C_4	C_3	
C_8		C_7		C_6

$$(l * C_6) + (f * C_3) + (h * C_4) + \dots + (m * C_6)$$

ALF 5x5

Video Samples

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	f	h	k	
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ALF 5x5

Video Samples

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	C_3	C_4	C_5	
C_2	C_1	C_0	C_1	C_2
	C_5	C_4	C_3	
C_8		C_7		C_6

$$((l + m) * C_6) + \dots$$

ALF 5x5

Video Samples

l		n		p
	f	h	k	
d	b	a	c	e
	j	i	g	
q				

Filter Coefficients

C_6		C_7		C_8
	C_3	C_4	C_5	
C_2	C_1	C_0	C_1	C_2
	C_5	C_4	C_3	

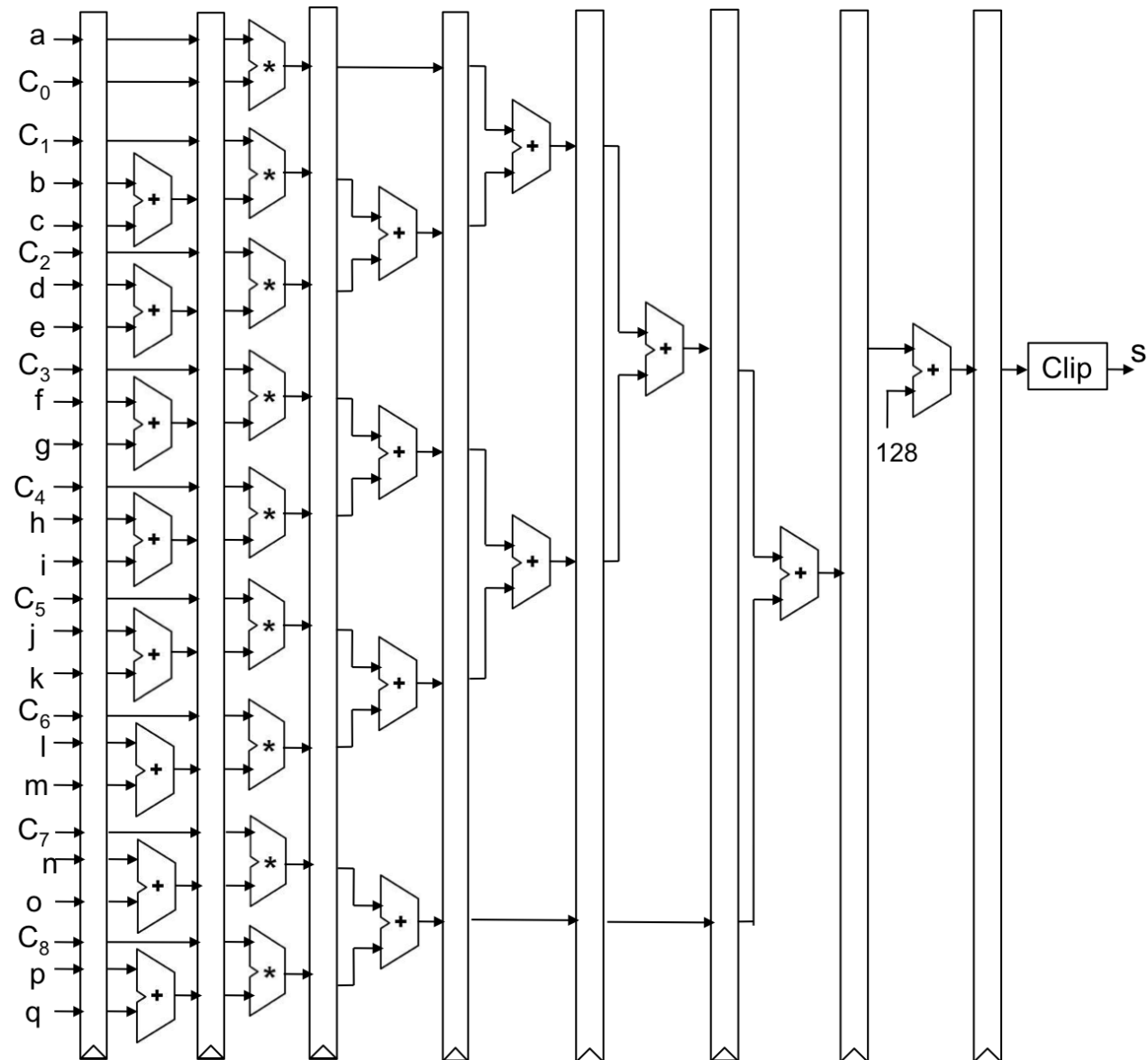
Reduce multipliers from 17 to 8

$$((l + m) * C_6) + \dots$$

Proposed Architecture

- ALF Core based on HEVC Draft Version 7.0
- Described in VHDL;
- Synthesized for Altera Stratix II EP2S15F484C3 FPGA ;

Proposed Architecture for ALF 5x5



Synthesis Results

Filter Size	ALF Core
ALUTs	371 (2%)
Total Registers	613 (<1%)
Embedded Multiplier 9-bit	14 (5%)
Frequency (MHz)	326

Altera Stratix II EP2S15F484C3

Comparison

Filter Size	ALF Core
Adders	17
Multipliers	9
Clipping	1
Pipeline stages	8

Estimated Processing Rates

Video resolution	ALF Core
720p (1280x720)	353
1080p (1920x1080)	157
WQXGA (2560x1600)	79
QFHD(3840x2160)	39

Frames per second

Conclusions and Future Work

- This work shown the hardware design for the ALF Core;
- High Throughput;
- At least 157 1080p and 39 QFHD frames per second;
- Future works:
 - Other ALF steps;
 - Architecture for the entire ALF.

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Thank You!

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