AHG8: Adaptive Resolution Change (ARC) with downsampling

J. Samuelsson, S. Deshpande, A. Segall

SHARP
LABORATORIES
OF AMERICA

Proposal summary

1. Proposes to introduce two additional sets of 8-tap interpolation filters for luma, used when a reference picture is downsampled.
2. Which filter to used is selected based on the scaling factor.

> If scale_fp > 49152, luma interpolation filter coefficients $f_L[p]$ for each 1/16 fractional sample position p equal to $xFrac_L$ or $yFrac_L$ are specified in Table 18-3.
>
> Otherwise, if scale_fp > 24576, luma interpolation filter coefficients $f_L[p]$ for each 1/16 fractional sample position p equal to $xFrac_L$ or $yFrac_L$ are specified in Table 18-4.
>
> Otherwise, luma interpolation filter coefficients $f_L[p]$ for each 1/16 fractional sample position p equal to $xFrac_L$ or $yFrac_L$ are specified in Table 18-5.

3. Corresponding 4-tap filters for chroma

Introduction

Several of the ARC use cases involves predicting from higher resolution:

- The coded resolution is reduced due to a (significant) drop in available bandwidth.
- The rendered resolution is reduced due to change of active speaker in a multiparty conversation, or switch between “main video” and screen sharing.
- The rendered resolution is reduced due to switching from full-screen to window/thumbnail, or rotating a handheld device from landscape to portrait.
- The received resolution is reduced in an open-GOP Adaptive Bit Rate (ABR) streaming service when switching to a lower representation.

Problem

The interpolation filters in VVC can be reused to provide ARC functionality as described in JVET-N0279, but VVC interpolation filters are not adjusted for downsampling and results in aliasing artifacts.

Problem

The interpolation filters in VVC can be reused to provide ARC functionality as described in JVET-N0279, but VVC interpolation filters are not adjusted for downsampling and results in aliasing artifacts.

4x downsampling using
VVC interpolation filters
and
4x upsampling using
VVC interpolation filters

Proposal

It is proposed to use 8-tap filters adjusted for downsampling.

(Integer Lanczos filters for scaling factors 2:1 and 4:1, with cut-off frequencies of 0.9π and 0.8π, respectively.)

4x downsampling using proposed interpolation filters and
4x upsampling using VVC interpolation filters

Proposal

For 2:1 scaling factor, (suggested to be used if scaling factor is larger than 1.5:1):

Fractional sample position p	interpolation filter coefficients							
	$f_L[p][0]$	$f_L[p][1]$	$f_L[p][2]$	$f_L[p][3]$	$f_L[p][4]$	$f_L[p][5]$	$f_L[p][6]$	$f_L[p][7]$
0	−5	4	37	56	37	4	−5	0
1	−5	3	34	57	39	6	−5	−1
2	−5	2	32	57	41	7	−5	−1
3	−4	1	30	56	42	9	−5	−1
4	−4	0	28	55	45	11	−5	−2
5	−4	−1	25	55	47	13	−5	−2
6	−3	−2	23	53	48	15	−4	−2
7	−3	−3	21	53	50	17	−4	−3
8	−3	−4	19	52	52	19	−4	−3
9	−3	−4	17	50	53	21	−3	−3
10	−2	−4	15	48	53	23	−2	−3
11	−2	−5	13	47	55	25	−1	−4
12	−2	−5	11	45	55	28	0	−4
13	−1	−5	9	42	56	30	1	−4
14	−1	−5	7	41	57	32	2	−5
15	−1	−5	6	39	57	34	3	−5

Proposal

For 4:1 scaling factor, (suggested to be used if scaling factor is larger than 3:1):

Fractional sample position p	interpolation filter coefficients							
	$f_L[p][0]$	$f_L[p][1]$	$f_L[p][2]$	$f_L[p][3]$	$f_L[p][4]$	$f_L[p][5]$	$f_L[p][6]$	$f_L[p][7]$
0	7	17	26	28	26	17	7	0
1	7	16	25	28	25	17	8	2
2	6	15	24	29	26	18	8	2
3	6	15	24	28	26	18	9	2
4	5	14	23	28	27	19	9	3
5	5	13	23	28	27	19	10	3
6	5	13	22	28	27	20	10	3
7	4	12	22	28	27	20	11	4
8	4	12	21	27	27	21	12	4
9	4	11	20	27	28	22	12	4
10	3	10	20	27	28	22	13	5
11	3	10	19	27	28	23	13	5
12	3	9	19	27	28	23	14	5
13	2	9	18	26	28	24	15	6
14	2	8	18	26	29	24	15	6
15	2	8	17	25	28	25	16	7

Proposal summary

1. Proposes to introduce two additional sets of 8-tap interpolation filters for luma, used when a reference picture is downsampled.
2. Which filter to used is selected based on the scaling factor.

> If scale_fp > 49152, luma interpolation filter coefficients $f_L[p]$ for each 1/16 fractional sample position p equal to $xFrac_L$ or $yFrac_L$ are specified in Table 18-3.
>
> Otherwise, if scale_fp > 24576, luma interpolation filter coefficients $f_L[p]$ for each 1/16 fractional sample position p equal to $xFrac_L$ or $yFrac_L$ are specified in Table 18-4.
>
> Otherwise, luma interpolation filter coefficients $f_L[p]$ for each 1/16 fractional sample position p equal to $xFrac_L$ or $yFrac_L$ are specified in Table 18-5.

3. Corresponding 4-tap filters for chroma


SHARP
LABORATORIES
OF AMERICA

Example 2x

The interpolation filters in VVC can be reused to provide ARC functionality as described in JVET-N0279, but VVC interpolation filters are not adjusted for downsampling and results in aliasing artifacts.

2x downsampling using VVC interpolation filters
and
2x upsampling using VVC interpolation filters

Proposal 2x

It is proposed to use 8-tap filters adjusted for downsampling.

(Integer Lanczos filters for scaling factors 2:1 and 4:1, with cut-off frequencies of 0.9π and 0.8π, respectively.)

2x downsampling using proposed interpolation filters and
2x upsampling using VVC interpolation filters

Proposal 4x

It is proposed to use 8-tap filters adjusted for downsampling.

(Integer Lanczos filters for scaling factors 2:1 and 4:1, with cut-off frequencies of 0.9π and 0.8π, respectively.)

4x downsampling using proposed interpolation filters and
4x upsampling using VVC interpolation filters

SHVC 12-tap 4x

The 12-tap filters from SHVC are shown for reference:

4x downsampling using
SHVC interpolation
filters and
4x upsampling using
VVC interpolation filters

Alternative cut-off frequency for 4x

Aliasing can be reduced further by reducing the cut-off frequency, e.g. to 0.6π instead of 0.8π.

4x downsampling using alternative cut-off frequency and
4x upsampling using VVC interpolation filters

Problem

The interpolation filters in VVC can be reused to provide ARC functionality as described in JVET-N0279, but VVC interpolation filters are not adjusted for downsampling and results in aliasing artifacts.

4x downsampling using
VVC interpolation filters
and
4x upsampling using
VVC interpolation filters