ALTERNATIVE HALF-SAMPLE INTERPOLATION FILTERS FOR VERSATILE VIDEO CODING

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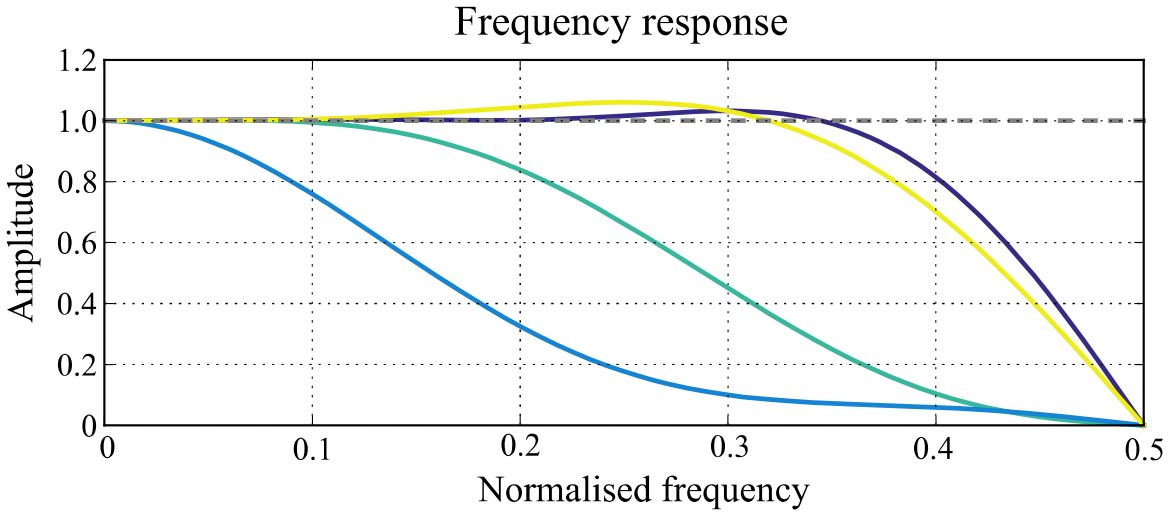


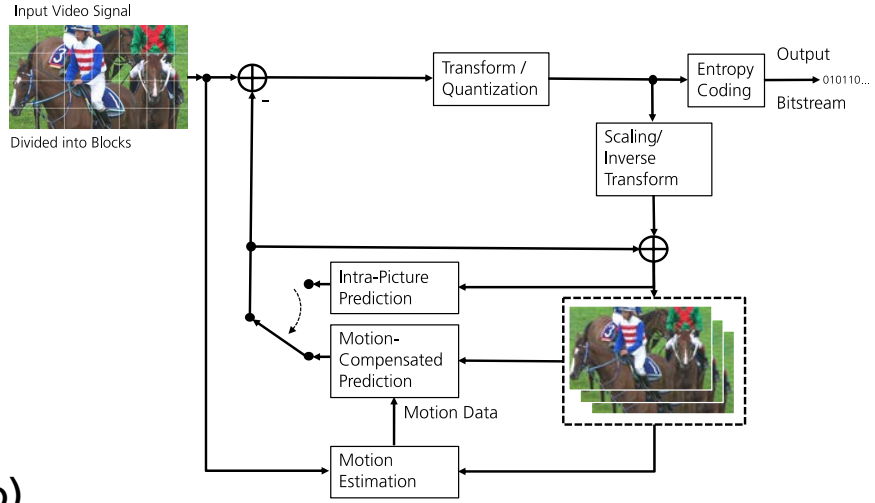
Versatile Video Coding (VVC)

Overview

- ITU-T (VCEG) and ISO/IEC (MPEG) Standard
- Successor to High Efficiency Video Coding (HEVC)
- Expected finalization July 2020
- 50% bit-rate reduction

  (over HEVC subjectively)
- Versatility

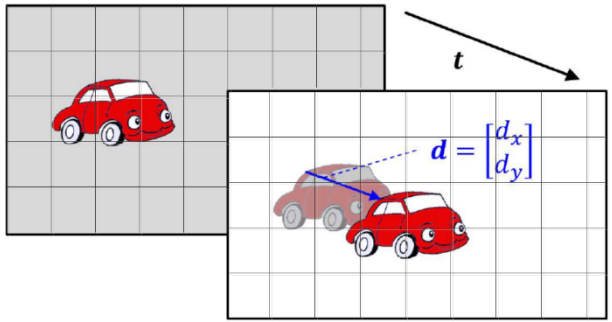
  (HDR, screen/game content, immersive video)
- Block-based hybrid video coding

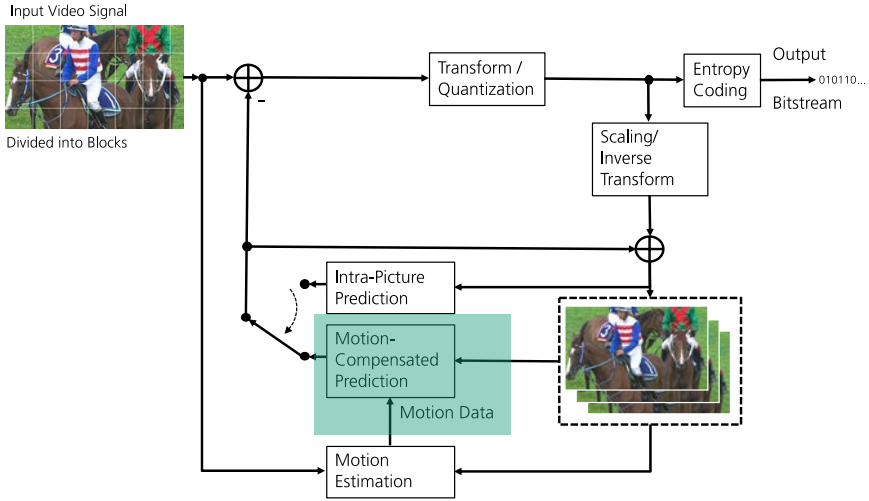


Versatile Video Coding (VVC)

Fractional Sample Motion Compensation

- Fractional sample MV accuracy
  - Full-sample (FPEL)
  - Half-sample (HPEL)
  - Quarter-sample (QPEL)
- Adaptive Motion Vector Resolution (AMVR)

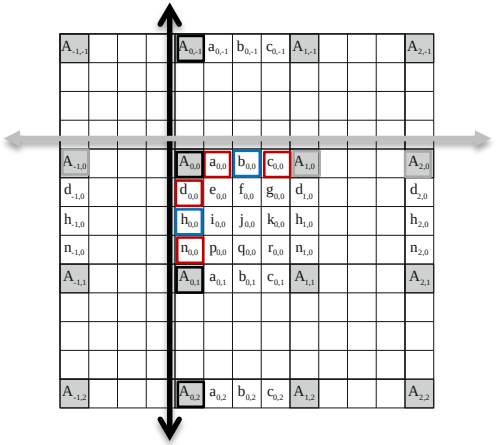




Versatile Video Coding (VVC)

Fractional Sample Motion Compensation

- Interpolation filter
  - Generate fractional samples
  - HEVC filters
    - 15 fractional luma sample positions
    - QPEL accuracy
    - 1-dimensional FIR Filter
      - in vertical direction
      - in horizontal direction
    - 8-taps for ½-pel
    - 7-taps for ¼ -pel



$$b_{0,j} = \sum_{i=-3..4} A_{i,j}\, hfilter[i]$$

$$a_{0,j} = \sum_{i=-3..3} A_{i,j}\, qfilter[i]$$

Interpolation filters are **fixed**

- H.264/Advanced Video Coding
- H.265/High Efficiency Video Coding
- H.266/Versatile Video Coding (till Draft 5)

Basic Idea

Alternative Half-Sample Interpolation Filters

- Select an interpolation filter for each fractional-sample position from a set of interpolation filters
- Allow selecting an interpolation filter at a finer granularity (i.e. CU level)
- Allow alternative filters only in case of HPEL MVs

AIF/SAIF[1]
SIFO[2]
EAIF[3]

Drawback

- Switching only at a coarse granularity
- Transmitting the FIR filter coefficients

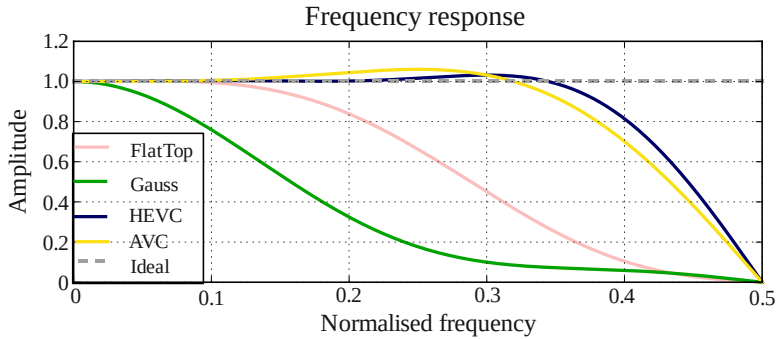
Alternative
Half-Sample
Interpolation Filters

Benefit

- Switching at a finer granularity
- Better adaptation to the local image characteristics
- Better matching the true displacement
- Less signalling for HPEL MVDs
- Improve encoding efficieny
- Use 6-Tap interpolation filters

Alternative Interpolation Filters for HPEL MVs

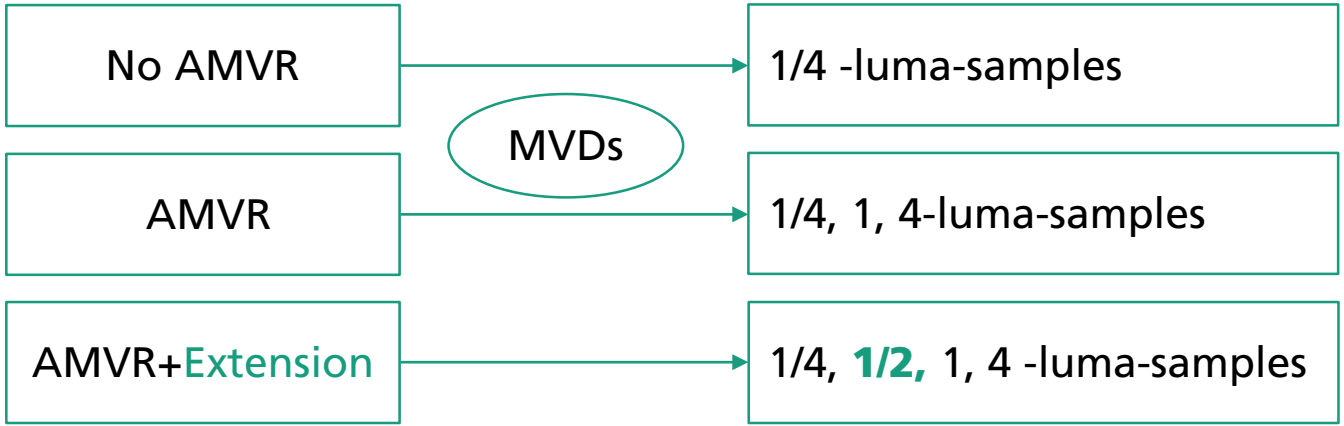
- Using alternative filters with different characteristics
- Filters with stronger low pass characteristics can be beneficial for attenuating high-frequency noise components
  - Flat Top $w[n] = a_0 - a_1 \cos\left(\frac{2\pi n}{N-1}\right) + a_2 \cos\left(\frac{4\pi n}{N-1}\right) - a_3 \cos\left(\frac{6\pi n}{N-1}\right) + a_4 \cos\left(\frac{8\pi n}{N-1}\right)$
  - Gauss $w[n] = \exp\left(-\frac{1}{2}\left(\frac{n-\frac{N-1}{2}}{\frac{\sigma(N-1)}{2}}\right)^2\right)$



HPEL	Normalised filter cefficients
Flat Top	{0, -3, 4, 31, 31, 4, -3, 0}
Gauss	{0, 3, 9, 20, 20, 9, 3, 0}
AVC(N=6)	{1, -10, 40, 40, -10, 1}
HEVC	{-1, 4, -11, 40, 40, -11, 4, -1}

AMVR with Alternative Half-Sample Interpolation Filters

- AMVR allows MVD on a CU level to be coded in different precision
- New Concept as an extension of AMVR, new HPEL AMVR mode



Signalling

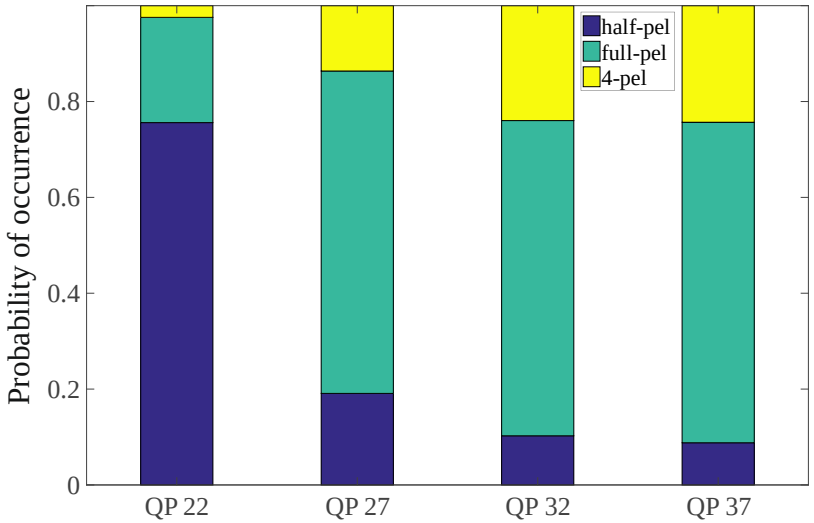
- hpel_flag and if_idx
  - 2 bins with fixed CABAC ctx
- Explicit signalling
  - if AMVR_mode=HPEL => if_idx
- Implicit signalling
  - Merge copies if_idx from neighboring CUs

AMVR Mode before	bin string	ctx	
		0	1
0 (QPEL)	0	0,1,2*	
1 (FPEL)	10	0,1,2*	3
2 (4PEL)	11	0,1,2*	3

AMVR Mode + Extension	bin string	ctx		
		0	1	2
0 (QPEL)	0	0,1,2*		
1 (HPEL)	10	0,1,2*	3	
2 (FPEL)	110	0,1,2*	3	4
3 (4PEL)	111	0,1,2*	3	4

Results

BD-rate[%]						
	HEVC		Gauss		2Filters	
Sequences	RA	LP	RA	LP	RA	LP
UHD	-0.15	/	-0.24	/	-0.40	/
HD	-0.09	-0.03	-0.38	-0.79	-0.50	-0.92
832x480	-0.12	-0.02	-0.18	-0.42	-0.21	-0.54
JVET CTC Avg.	**-0.10**	**-0.00**	**-0.29**	**-0.68**	**-0.40**	**-0.76**
EncT[%] Avg.	107	109	107	111	112	112



Summary

Alternative Interpolation Filters for HPEL MVs

- Improve BD-Rate of VTM 5.0

  -0.40% Random Access

  -0.76% Low Delay P
- Slightly increase of encoding time
- No impact on decoding complexity
- Concept with 1 filter was adopted into VVC(Draft 6)

THANK YOU FOR YOUR ATTENTION!

References

- [1] S. Wittmann and T. Wedi, “Separable adaptive interpolation filter for video coding,” in 2008 15th IEEE International Conference on Image Processing (ICIP), October 2008, pp. 2500–2503.
- [2] M. Karczewicz, Y. Ye, and P. Chen, “Switched interpolation filter with offset,” Tech. Rep., Video Coding Experts Group (VCEG), Document VCEG-AI35, July 2008.
- [3] Y. Ye, G. Motta, and M. Karczewicz, “Enhanced adaptive interpolation filters for video coding,” in 2010 Data Compression Conference (DCC), March 2010, pp. 435–444.