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1 Introduction

The interpolation filters with invariable coefficients are adopted in the new video coding standard H.264/MPEG-4 AVC for motion compensated prediction of 1/4-pel or 1/8-pel resolution displacement. The performance of these conventional filters based on the known signal properties may be degraded for the signals with the unknown and/or non-stationary statistical properties. In [1-3] an adaptive interpolation filter (AIF) for motion compensated prediction of 1/4-pel resolution displacement was proposed, where the filter coefficients are adapted once per frame to the unknown and/or non-stationary statistical properties of the video signals.

A more complicated adaptive interpolation filter for motion compensated prediction of 1/8-pel resolution displacement is presented in this proposal. This adaptive interpolation filter is compatible with the JVT filter. Only 4 filter coefficients are estimated, coded and transmitted. No more memory space is required. It can be flexibly used just as the MPEG quantization matrices. This adaptive interpolation filter is implemented on the JVT software codec JM2.0 and available as JVT-E053_Software.zip. Experimental results in the common test conditions show that the codec with this adaptive interpolation filter achieves up to 0.26dB PSNR gain or 5% bit rate savings correspondingly by comparison to the JVT codec.

2 Description

2.1 Filter Model

Introducing the AIF for 1/4-pel resolution in Figure 1 of [2] into the interpolation process for motion compensated prediction of 1/8-pel resolution displacement adopted in JFCD [4], we obtain the AIF for 1/8-pel resolution in Fig.1 of this proposal. The interpolation for 1/8-pel resolution in JFCD includes 2 sequential interpolation steps: three 8-tap filter are used as JFCD Filter 1 to implement 4:1 up-sampling, and a bilinear filter is applied as JFCD Filter 2 to complete 2:1 up-sampling. The filter coefficients coeff1~coeff3 for interpolation at the positions of 1/4-pel, 2/4-pel and 1/8-pel respectively are listed below

– coeff1 for sample values at 1/4 positions: (-3, 12, -37, 229, 71, -21, 6, -1)/256,

– coeff2 for sample values at 2/4 positions: (-3, 12, -39, 158, 158, -39, 12, -3)/256,

– coeff3 for sample values at 3/4 positions: (-1, 6, -21, 71, 229, -37, 12, -3)/256.

The proposed AIF consists of 3 sequential interpolation steps: one 8-tap adaptive filter is adopted in both JFCD-AIF Filter 1 and JFCD-AIF Filter 2 to implement 2:1 up-sampling, and JFCD-AIF Filter 3 is the same as JFCD Filter 2. The filter coefficients of the adaptive filter is expressed below

– AIF-coeff: (a_4, a_3, a_2, a_1, a_1, a_2, a_3, a_4)/256,

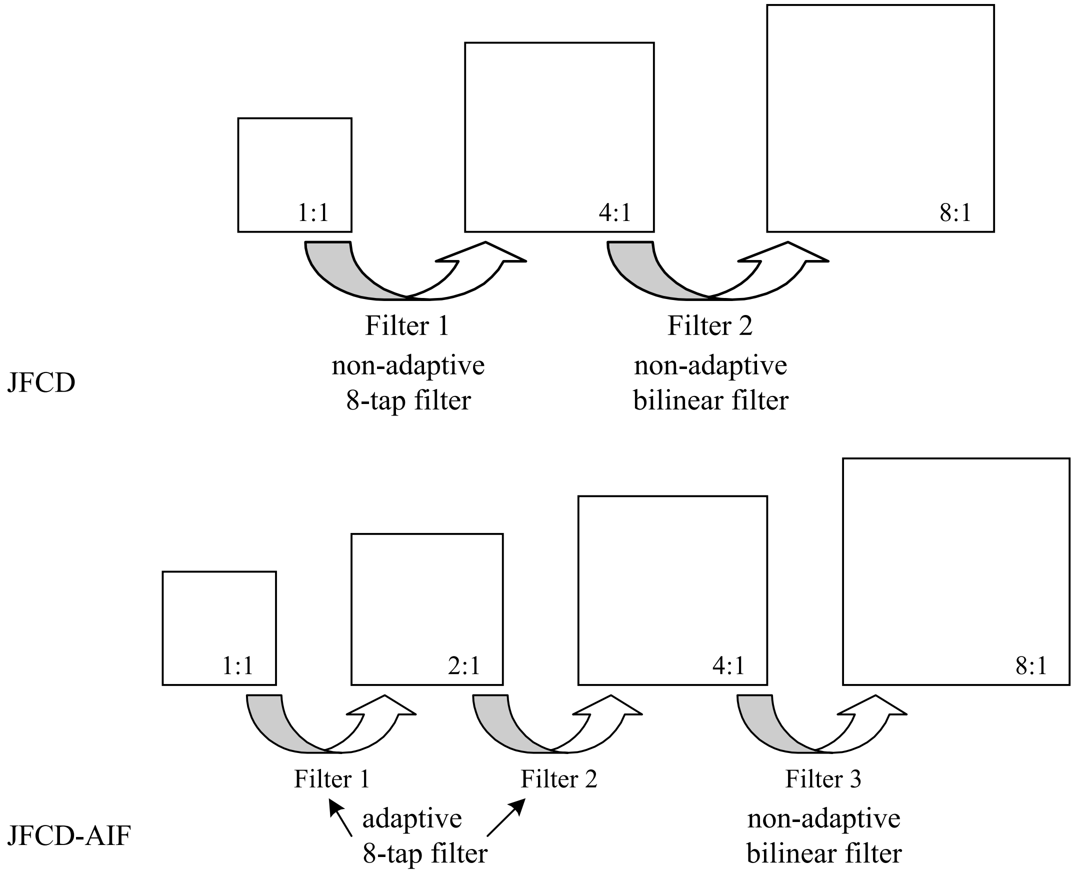

Fig.1 Interpolation process for motion compensated
prediction of 1/8-pel resolution displacement

Complexity is the No.1 reason why the same adaptive filter is adopted for both JFCD-AIF Filter 1 and JFCD-AIF Filter 2, and bit rate of the AIF coefficients is the No.2 reason. Because high spatial correlation exists in image signals, it is reasonable to assume that the image signals are the stationary Gauss signals in local areas of image planes. It is indicated in [5] that the filter with optimized linear estimation such as the Wiener filter is a symmetric filter for the stationary stochastic signals. The process of adaptive interpolation contains a similar linear estimation of optimized filter coefficients. So the 8-tap adaptive filter is a symmetric filter. Thus only 4 parameters a_1, a_2, a_3, a_4 have to be estimated, coded and transmitted. As the non-adaptive filter in JFCD shows better performance in most cases, its coefficients are set as default values of the AIF coefficients. That is, a_1=158, a_2=-39, a_3=12, a_4=-3.

2.2 Implementation of Adaptive Interpolation

For the purpose of further reduction of complexity on the basis of [3], we propose to use AIF flexibly. That is, as the conventional usage, the AIF is disable and the non-adaptive filter of JFCD is activated for many cases. Only in some special cases, the AIF is activated and the AIF coefficients are transmitted through bit streams for some video sequences and some frames in the same sequence. This is just as the use of the MPEG quantization matrices.

In the MPEG standards, the syntax of load_intra/inter_quantizer_matrix is defined at sequence header. In many cases, the default quantization matrices are used. In some special cases, one or two user defined 8x8 quantization matrix is transmitted through bit stream so as to employ the characteristics of the human vision system (HVS) more efficiently. The syntax of AIF is defined at picture header. This means that the use of AIF is more flexible that that of the MPEG quantization matrices.

In order to implement the said flexible use of AIF, the adaptive interpolation of 1/8-pel resolution in Fig.1 has to be transformed into the one including 2 interpolation steps. Thus the AIF is compatible with the non-adaptive filter in JFCD. The non-adaptive filter in JFCD can be used as the default filter of the AIF. This interpolation process is the physical process of the JVT encoder. At the JVT encoder, the frame memory size for each reference picture is 4x4 times as large as the original image size. With regard to each reference picture, the reconstructed image of the original image size is up sampled to the one of 4:1 resolution by JFCD Filter 1 and then stored into the frame memory. Using JFCD Filter 2, the interpolation is performed on the fly at the 1/8-pel positions for both motion search and motion compensated prediction. Moreover, it is known from [6] that at decoder the complexity of direct interpolation is lower than that of subsequent interpolation. That means that at the decoder the complexity of JFCD is lower than that of JFCD-AIF.

Position	1/4-pel		2/4-pel		3/4-pel
coeff	AIF-coeff1	Default	AIF-Coeff2	Default	AIF-coeff3
c_{-6}	$a_4^2/256$	0.03515625	0	0	0
c_{-5}	$(a_4a_2+a_3a_4)/256$	0.31640625	0	0	$a_3a_4/256$
c_{-4}	$(a_4a_1+a_3a_2+a_2a_4)/256$	-3.22265625	a_4	-3	$(a_1a_4+a_3^2)/256$
c_{-3}	$(a_4a_3+a_3a_1+a_2^2+a_1a_4)/256$	11.35546875	a_3	12	$(a_1a_3+a_2a_3+a_2a_4)/256$
c_{-2}	$(a_3^2+2a_1a_2+a_1a_4)/256+a_3$	-37.42968750	a_2	-39	$(a_1a_2+a_1a_3+a_2a_3+a_4^2)/256+a_4$
c_{-1}	$(a_1^2+a_1a_2+a_2a_3+a_2a_4)/256+a_1$	230.07421875	a_1	158	$(a_1^2+a_2^2+a_1a_3+a_3a_4)/256+a_2$
c_1	$(a_1^2+a_2^2+a_1a_3+a_3a_4)/256+a_2$	71.72265625	a_1	158	$(a_1^2+a_1a_2+a_2a_3+a_2a_4)/256+a_1$
c_2	$(a_1a_2+a_1a_3+a_2a_3+a_4^2)/256+a_4$	-21.45703125	a_2	-39	$(a_3^2+2a_1a_2+a_1a_4)/256+a_3$
c_3	$(a_1a_3+a_2a_3+a_2a_4)/256$	6.03515625	a_3	12	$(a_4a_3+a_3a_1+a_2^2+a_1a_4)/256$
c_4	$(a_1a_4+a_3^2)/256$	-1.28906250	a_4	-3	$(a_4a_1+a_3a_2+a_2a_4)/256$
c_5	$a_3a_4/256$	-0.14062500	0	0	$(a_4a_2+a_3a_4)/256$
c_6	0	0	0	0	$a_4^2/256$

Table 1 Filter coefficients of the equivalent interpolation filtering

Position	1/4-pel		2/4-pel		3/4-pel
coeff	AIF-coeff1	Default	AIF-Coeff2	Default	AIF-coeff3
c_{-4}	$0.5a_4+(a_4a_1+a_3a_2+a_2a_4)/256$	-3.01171875	a_4	-3	$(a_1a_4+a_3^2)/256$
c_{-3}	$(a_4a_3+a_3a_1+a_2^2+a_1a_4)/256$	11.35546875	a_3	12	$(a_1a_3+a_2a_3+a_2a_4)/256$
c_{-2}	$(a_3^2+2a_1a_2+a_1a_4)/256+a_3$	-37.42968750	a_2	-39	$(a_1a_2+a_1a_3+a_2a_3+a_4^2)/256+a_4$
c_{-1}	$(a_1^2+a_1a_2+a_2a_3+a_2a_4)/256+a_1$	230.07421875	a_1	158	$(a_1^2+a_2^2+a_1a_3+a_3a_4)/256+a_2$
c_1	$(a_1^2+a_2^2+a_1a_3+a_3a_4)/256+a_2$	71.72265625	a_1	158	$(a_1^2+a_1a_2+a_2a_3+a_2a_4)/256+a_1$
c_2	$(a_1a_2+a_1a_3+a_2a_3+a_4^2)/256+a_4$	-21.45703125	a_2	-39	$(a_3^2+2a_1a_2+a_1a_4)/256+a_3$
c_3	$(a_1a_3+a_2a_3+a_2a_4)/256$	6.03515625	a_3	12	$(a_4a_3+a_3a_1+a_2^2+a_1a_4)/256$
c_4	$(a_1a_4+a_3^2)/256$	-1.28906250	a_4	-3	$0.5a_4+(a_4a_1+a_3a_2+a_2a_4)/256$

Table 2 Filter coefficients used to implement the proposed AIF

The equivalent interpolation filtering of combination of JFCD-AIF Filter 1 and JFCD-AIF Filter 2 is obtained in the way described in Appendix. Its coefficients are in Table 1. AIF-coeff1, AIF-coeff2 and AIF-coeff3 are the filters at the positions of 1/4-pel, 2/4-pel and 3/4-pel respectively with the expression of (…, c_{-6}, c_{-5}, c_{-4}, c_{-3}, c_{-2}, c_{-1}, c_1, c_2, c_3, c_4, c_5, c_6, …)/256.

Default values of AIF-coeff1 and AIF-coeff3 approximate to a great extent to non-adaptive coeff1 and coeff3 respectively. Ignoring the very small coefficients in Table 1, we obtain the 8-tap AIF in Table 2, where the following constraint is imposed according to the conclusion in [5]

$$\text{If } \sum_{i=1}^{4} a_i = 128,\ \sum_{i=1}^{4}(c_{-i} + c_i) = 256 \text{ for AIF-coeff1/2/3} \quad (1)$$

This means that AIF-coeff1, AIF-coeff2 and AIF-coeff3 are all non-biased estimation when AIF-coeff is non-biased estimation. We set c_{-4} of AIF-coeff1 as $0.5a_4 + (a_4 a_1 + a_3 a_2 + a_2 a_4)/256$ in Table 2 so that AIF-coeff1 is within the constraint (1) and its default value also becomes more approximated to non-adaptive coeff1. Thus the filter coefficients in Table 2 are used to implement the proposed AIF.

2.3 Solution of Mismatch

Due to the transformation of AIF as Table 2, the AIF is compatible with the non-adaptive filter in JFCD. Thus implementation of the codec with the AIF becomes simpler. Most source codes of the JVT codec can continue to be used in the codec with the AIF by changing the filter coefficients from integer numbers to float numbers. In this courses, mismatch between encoder and decoder occurred. The follows in this section describe the details about this mismatch.

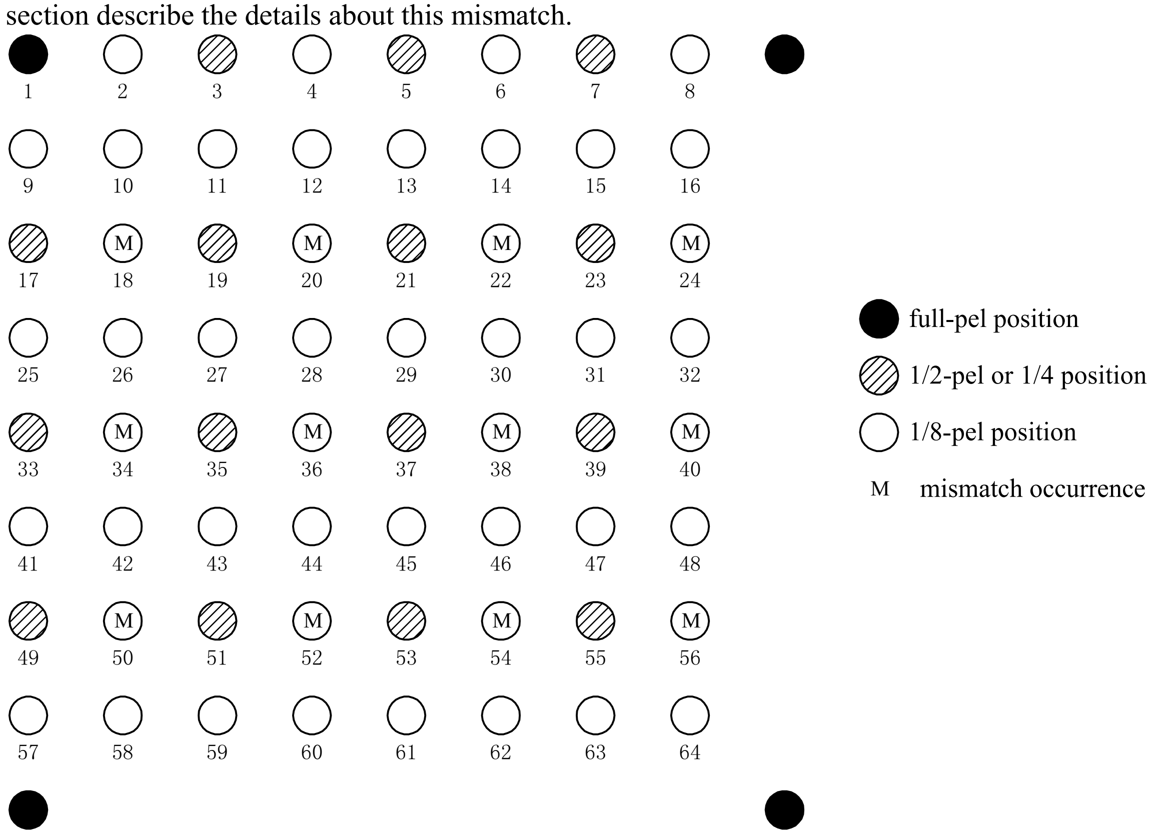

Fig.2 Image grid of 8:1 up-sampling

For the JVT codec, the 2D interpolation is accomplished sequentially by 1D interpolation in the horizontal direction followed by 1D interpolation in the vertical direction. The intermediate results are stored into an integer 2D array. Truncation is added to the interpolation process of the AIF codec. The float results of the 1st interpolation are truncated into integer numbers. Thus the result of the 1st interpolation with truncation in the horizontal direction followed by the 2nd interpolation with rounding in the vertical direction may be different from that of the 1st interpolation with truncation in the vertical direction followed by the 2nd interpolation with rounding in the horizontal direction.

Mismatch occurs only at the positions of vertical 1/4-pel interpolation followed by horizontal 1/8-pel interpolation, as shown in Fig.2. There are 12 positions for each full-pel position where mismatch maybe occur. For example, let's consider the position 20 in Fig.2. For subsequent interpolation, the sample values of the positions 19 and 21 have to be calculated before the sample value of the position 20 is calculated. In order to reduce complexity, the interpolation at the decoder at the positions 19 and 21 is performed by vertical interpolation followed by horizontal interpolation. The intermediate results of the 1st interpolation for the positions 19 and 21 are the same. However, at the encoder, the interpolation at the positions 19 and 21 is performed by horizontal interpolation followed by vertical interpolation. So the probably different values at the both positions 19 and 21 between the encoder and the decoder result in the mismatch at the position 20. In order to solve this mismatch problem, the 2D interpolation at the decoder at the positions 19 and 21 is also performed by horizontal interpolation followed by vertical interpolation, just as that at the encoder. By comparison to the interpolation in JFCD as described in [7], 8 more multiplication operations are require for the adaptive interpolation at the position 20. Thus 12*8/64=1.5 more multiplication operations are required at each full-pel position for the adaptive interpolation.

3 Experimental Results

Test Sequence	QP	JM2.0		JM2.0 with 1/8-pel AIF			Distance between two R-D curves
		Bit rate (kbps)	Y PSNR (dB)	Bit rate (kbps)	AIF bit rate (bps)	Y PSNR (dB)	
Foreman QCIF 300 frames 30 fps	28	30.15	28.31	31.85	1751.80	28.84	3.87% bit rate savings or 0.20dB gain
	24	48.30	30.83	49.31	1640.40	31.25	
	20	77.98	33.38	78.89	1478.20	33.57	
	16	129.89	35.98	128.89	1313.00	36.07	
Mobile & Calendar CIF 300 frames, 30 fps	28	185.04	24.82	182.36	1596.20	25.16	5.09% bit rate savings or 0.26dB gain
	24	322.90	27.80	315.33	1565.80	28.01	
	20	615.81	30.88	601.84	1438.80	30.98	
	16	1176.96	34.12	1159.21	1283.20	34.15	
Paris CIF 300 frames 30 fps	28	77.48	26.74	79.36	1839.20	26.77	-0.73% bit rate savings or -0.039dB gain
	24	140.93	29.54	142.17	1645.00	29.50	
	20	251.78	32.45	252.49	1506.60	32.47	
	16	434.17	35.46	434.43	1307.60	35.48	
Tempete CIF 260 frames 30 fps	28	144.88	26.54	146.52	1482.00	26.73	2.46% bit rate savings or 0.11dB gain
	24	262.26	29.22	260.77	1383.69	29.34	
	20	507.15	32.04	502.71	1279.85	32.10	
	16	986.08	35.09	979.77	1029.69	35.09	
Irene CIF 300 frames 30 fps	28	61.60	31.01	62.54	2035.00	31.00	-1.11% bit rate savings or -0.051dB gain
	24	111.53	33.55	113.28	1718.30	33.53	
	20	201.50	36.10	203.34	1530.60	36.13	
	16	343.39	38.70	345.50	1302.80	38.71	

Table 3 Experimental results

In order to compare with the AIF for 1/4-pel resolution in [3], the same JVT software codec JM2.0 instead of the most recent one JM4.2 is used as the platform to implement the proposed adaptive interpolation filter for 1/8-pel resolution. Except the contents described in 2.2 and 2.3, the other parts of the codec with the AIF for 1/8-pel resolution is similar to that of the former one with the AIF for 1/4-pel resolution. The unique different point is that the former one contains 4 variable filter coefficients while the later one contains 3 variable filter coefficients. As a temporary solution, a 2D array is defined only in the slice mode to store intra4x4 prediction mode of each 4x4 block. Otherwise decoding error occurs in the slice mode. Except this array, no a bigger array more than JM2.0 is defined for this software.

The experiment is carried out using 5 test sequences under the common test conditions. The encoding settings for all the tests are 5 reference frames, CABAC, 1/8-pel motion vector resolution, R-D optimized motion estimation and mode decision, IPP…P picture type sequence, no B-frame, no slice, H.26L VCL bit stream without encapsulation. The distance between the two R-D curves of the JM2.0 codec and the one with the proposed 1/8-pel resolution AIF for each sequence is calculated by the software avsnr4. The results are in Table 3 in the same form of Table 1 in [3] and the R-D curves are in the Excel file JVT-E053.xls.

4 Summary

An adaptive interpolation filter for motion compensated prediction of 1/8-pel resolution displacement is presented in this proposal. Firstly this adaptive interpolation is modeled as 3 sequential interpolation steps, which contain an 8-tap symmetric filter with 4 adaptive filter coefficients. Secondly it is transformed into the equivalent interpolation filtering containing 2 sequential interpolation steps with the same structure as the non-adaptive filter in JFCD. Its default approximates to a great extension to the non-adaptive filter in JFCD. So it is compatible with the non-adaptive filter in JFCD. Only 4 filter coefficients are estimated, coded and transmitted. No more memory space is required. It can be flexibly used just as the MPEG quantization matrices. This flexible use contributes to reduce complexity of adaptive interpolation filter.

By comparison to JM2.0, the codec with the proposed adaptive interpolation filter for 1/8-pel resolution achieves up to 0.26dB gain or 5.09% bit rate savings correspondingly on Mobile & Calendar sequence. This gain is higher than that of the codec with the adaptive interpolation filter for 1/4-pel resolution as 0.21dB or 4.55% bit rate savings correspondingly [3].

From the experimental results in [3] and this proposal, the performance of the adaptive interpolation filters depends on the contents of the video signals. It is found out that higher the percentage of skip macroblock mode in P-frames is, worse the coding performance of the codec with the proposed 1/8-pel adaptive interpolation filter is. In the most recent JVT software codec, the new skip mode is adopted. In this new skip mode, motion compensated prediction of 16x16 block is also performed with the predicted values of motion vectors. Maybe it is good for adaptive interpolation filters for 1/4-pel and 1/8-pel resolution displacement.

5 References

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[2] T. Wedi, "Adaptive Interpolation Filter for H.26L", ITU-T SG16/Q6, doc. VCEG-N28, Santa Barbara, CA, USA, Sep. 2001.

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Appendix

From the signal processing point of view, 1D interpolation filtering of 2:1 resolution can be interpreted as 2:1 up-sampling followed by low pass filtering, as shown in Fig.3. We want to infer the coefficients of the equivalent interpolation filtering of 4:1 up-sampling, which is the combination of Interpolation Filter 1 and Interpolation Filter 2 in series, from the relation between x and y_2.

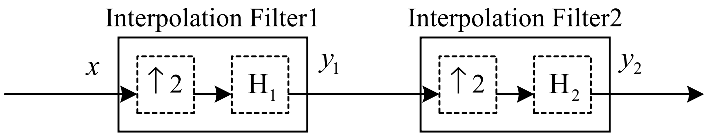

Fig.3 4:1 Up-sampling

Let both Interpolation Filter 1 and Interpolation Filter 2 be 8-tap symmetric interpolation filters as
coefficients of Interpolation Filter 1: (a_4, a_3, a_2, a_1, a_1, a_2, a_3, a_4)
coefficients of Interpolation Filter 2: (b_4, b_3, b_2, b_1, b_1, b_2, b_3, b_4)
The relation between x and y_1 is given by

$$\begin{cases} y_1(2n) = x(n) \\ y_1(2n+1) = \sum_{i=1}^{4} a_i \left[x(n-i+1) + x(n+i) \right] \end{cases}$$

The relation between y_1 and y_2 is given by

$$\begin{cases} y_2(2m) = y_1(m) \\ y_2(2m+1) = \sum_{j=1}^{4} b_j \left[y_1(m-j+1) + y_1(m+j) \right] \end{cases}$$

Now start to infer the relation between $x(n)$ and $y_2(4n)$, $y_2(4n+1)$, $y_2(4n+2)$, $y_2(4n+3)$

$$y_2(4n) = y_1(2n) = x(n) \tag{2}$$

$$y_2(4n+2) = y_1(2n+1) = \sum_{i=1}^{4} a_i \left[x(n-i+1) + x(n+i) \right] \tag{3}$$

$$y_2(4n+1) = \sum_{j=1}^{4} b_j \left[y_1(2n-j+1) + y_1(2n+j) \right] \tag{4}$$

$$y_2(4n+3) = \sum_{j=1}^{4} b_j \left[y_1(2n-j+2) + y_1(2n+j+1) \right] \tag{5}$$

$$y_1(2n-3) = \sum_{i=1}^{4} a_i \left[x(n-i-1) + x(n+i-2) \right]$$

$$y_1(2n-1) = \sum_{i=1}^{4} a_i \left[x(n-i) + x(n+i-1) \right]$$

$$y_1(2n+3) = \sum_{i=1}^{4} a_i \left[x(n-i+2) + x(n+i+1) \right]$$

$$y_1(2n+5) = \sum_{i=1}^{4} a_i \left[x(n-i+3) + x(n+i+2) \right]$$

Thus we can expand Equation (4) as

$$\begin{aligned} y_2(4n+1) = {} & a_4b_4x(n-5) + \\ & (a_4b_2 + a_3b_4)x(n-4) + \\ & (a_4b_1 + a_3b_2 + a_2b_4)x(n-3) + \\ & (a_4b_3 + a_3b_1 + a_2b_2 + a_2b_4)x(n-2) + \\ & (a_3b_3 + a_2b_1 + a_1b_2 + a_1b_4 + b_3)x(n-1) + \\ & (a_2b_3 + a_1b_1 + a_1b_2 + a_2b_4 + b_1)x(n) + \\ & (a_1b_3 + a_1b_1 + a_2b_2 + a_3b_4 + b_2)x(n+1) + \\ & (a_1b_3 + a_2b_1 + a_3b_2 + a_4b_4 + b_4)x(n+2) + \\ & (a_2b_3 + a_3b_1 + a_4b_2)x(n+3) + \\ & (a_3b_3 + a_4b_1)x(n+4) + \end{aligned}$$

$a_4 a_3 x(n+5)$

We obtain follows in the same way

$$y_2(4n+3) = a_4 b_3 x(n-4) +$$
$$(a_4 b_1 + a_3 b_3) x(n-3) +$$
$$(a_4 b_2 + a_3 b_1 + a_2 b_3) x(n-2) +$$
$$(a_4 b_4 + a_3 b_2 + a_2 b_1 + a_1 b_3 + b_4) x(n-1) +$$
$$(a_3 b_4 + a_2 b_2 + a_1 b_1 + a_1 b_3 + b_2) x(n) +$$
$$(a_2 b_4 + a_1 b_2 + a_1 b_1 + a_2 b_3 + b_1) x(n+1) +$$
$$(a_1 b_4 + a_1 b_2 + a_2 b_1 + a_3 b_3 + b_3) x(n+2) +$$
$$(a_1 b_4 + a_2 b_2 + a_3 b_1 + a_4 b_3) x(n+3) +$$
$$(a_2 b_4 + a_3 b_2 + a_4 b_1) x(n+4) +$$
$$(a_3 b_4 + a_4 b_2) x(n+5) +$$
$$a_4 b_4 x(n+6)$$

The above results are in Table 3. Obviously, if $\sum_{i=1}^{4} a_i = \frac{1}{2}$ and $\sum_{j=1}^{4} b_j = \frac{1}{2}$, $\sum_{k=1}^{6} [c_{-k} + c_k] = 1$ at all the fractional-pel positions. This is a very useful property.

Position→ ↓ Filter Coefficients	1/4-pel	2/4-pel	3/4-pel
c_{-6}	$a_4 b_4$	0	0
c_{-5}	$a_4 b_2 + a_3 b_4$	0	$a_4 b_3$
c_{-4}	$a_4 b_1 + a_3 b_2 + a_2 b_4$	a_4	$a_4 b_1 + a_3 b_3$
c_{-3}	$a_4 b_3 + a_3 b_1 + a_2 b_2 + a_1 b_4$	a_3	$a_4 b_2 + a_3 b_1 + a_2 b_3$
c_{-2}	$a_3 b_3 + a_2 b_1 + a_1 b_2 + a_1 b_4 + b_3$	a_2	$a_4 b_4 + a_3 b_2 + a_2 b_1 + a_1 b_3 + b_4$
c_{-1}	$a_2 b_3 + a_1 b_1 + a_1 b_2 + a_2 b_4 + b_1$	a_1	$a_3 b_4 + a_2 b_2 + a_1 b_1 + a_1 b_3 + b_2$
c_1	$a_1 b_3 + a_1 b_1 + a_2 b_2 + a_3 b_4 + b_2$	a_1	$a_2 b_4 + a_1 b_2 + a_1 b_1 + a_2 b_3 + b_1$
c_2	$a_1 b_3 + a_2 b_1 + a_3 b_2 + a_4 b_4 + b_4$	a_2	$a_1 b_4 + a_1 b_2 + a_2 b_1 + a_3 b_3 + b_3$
c_3	$a_2 b_3 + a_3 b_1 + a_4 b_2$	a_3	$a_1 b_4 + a_2 b_2 + a_3 b_1 + a_4 b_3$
c_4	$a_3 b_3 + a_4 b_1$	a_4	$a_2 b_4 + a_3 b_2 + a_4 b_1$
c_5	$a_4 b_3$	0	$a_3 b_4 + a_4 b_2$
c_6	0	0	$a_4 b_4$

Table 3 Coefficients of the equivalent interpolation filtering of 4:1 up-sampling

(Append for Proposal Documents)

JVT Patent Disclosure Form

International Telecommunication Union
Telecommunication Standardization Sector

International Organization for Standardization

International Electrotechnical Commission

Joint Video Coding Experts Group - *Patent Disclosure Form*

(Typically one per contribution and one per Standard | Recommendation)

Please send to:
JVT Rapporteur Gary Sullivan, Microsoft Corp., One Microsoft Way, Bldg. 9, Redmond WA 98052-6399, USA
Email (preferred): Gary.Sullivan@itu.int Fax: +1 425 706 7329 (+1 425 70MSFAX)

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Submitting Organization or Person:

Organization name	**South China University of Technology**
Mailing address	**College of Electronic & Information Engineering, South China University of Technology, Guangzhou 510641, China**
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Place and date of submission	Guangzhou, China, Oct. 4, 2002

Relevant Recommendation | Standard and, if applicable, Contribution:

Name (ex: "JVT")	**JVT**
Title	**1/8-pel Resolution Adaptive Interpolation Filter**
Contribution number	**JVT-E053**

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