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| *Title:* | **CE3: 7Q6H taps interpolation filters test by Samsung.** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Proposal | | |
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# Abstract

This is CE response from Samsung. The following combination: 7 taps quarter-pel and 6 taps half-pel interpolation filter was tested. In average across 6 test cases RA-HE/LC, LD-HE/LC and LD(P) –HE/LC this combination provides 0.07%(Y) -0.11% (U) -0.19% (V) BD-rate change (drop in Luma and gain for Chroma). Computation complexity of MC for this filter approaches to AVC interpolation filter which is 13% and 16% less in terms of number of mults and adds compare to HM4.0

# Introduction

HM4.0 uses 8 taps 2D separable interpolation filter proposed in [1-2]. In [4] the combination of 7 taps filter for 1/4 pel position and 6 taps filter for 1/2-pel position was proposed. Here we additionally modified Chroma filter are proposed in [3].

Both Luma and Croma filters are designed using uniform phase off-set: 1/4 and 1/2 for Luma and 1/8,1/4, 3/8 and 1/2 for Chroma:

* Luma:

1/4 : {2, 5, -11, 58, 18, -6, 2, 0 }  
1/2 : { 0, 2, -9, 39, 39, -9, 2, 0 }

* Chroma:

1/8: {-2, 58, 10,-2}   
1/4: {-4,  54,  16,  -2}  
3/8: {-6, 46, 28, -4}   
1/2: {-4,  36,  36,  -4}

Chroma interpolation filter in HM4.0 [2] was also designed assuming symmetric phase shift: 1/8 and 3/8, but efficient phase shift is slightly different form assumption due to rounding error. This was corrected in variant [3] and used in this test.

# Test results

We implemented both variants of proposed interpolation filters in HM4.0 and tested according to CE3 test description [9] under common test conditions [10]. Attached excel spreadsheets provides detail information for this tests. The summary of test results is presented in Table 1.

**Table 1**. 7Q(1/4)6H interpolation filter performance test in HM4.0

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Random Access HE** | | | **Random Access LC** | | |
|  | Y | U | V | Y | U | V |
| Class A | 0.0% | 0.0% | -0.1% | -0.1% | 0.4% | 0.5% |
| Class B | 0.0% | 0.0% | 0.0% | 0.0% | -0.1% | -0.1% |
| Class C | 0.1% | 0.1% | 0.2% | 0.2% | 0.2% | 0.1% |
| Class D | 0.1% | 0.0% | 0.0% | 0.4% | -0.1% | 0.0% |
| Class E |  |  |  |  |  |  |
| **Overall** | 0.0% | 0.0% | 0.0% | 0.1% | 0.1% | 0.1% |
|  | 0.0% | 0.0% | 0.0% | 0.1% | 0.1% | 0.1% |
| Enc Time[%] | 100% | | | 100% | | |
| Dec Time[%] | 101% | | | 101% | | |
| Mult[%] | -12% | | | -12% | | |
| Adds[%] | -14% | | | -15% | | |
| Access[%] | -2% | | | -2% | | |
| MemBand(2D) Ave.[%] |  | | |  | | |
| MemBand(2D) Max.[%] |  | | |  | | |
| MemBand(1D) Ave.[%] |  | | |  | | |
| MemBand(1D) Max.[%] |  | | |  | | |
|  |  |  |  |  |  |  |
|  | **Low delay B HE** | | | **Low delay B LC** | | |
|  | Y | U | V | Y | U | V |
| Class A |  |  |  |  |  |  |
| Class B | -0.1% | -0.5% | -0.5% | -0.2% | -0.6% | -0.8% |
| Class C | 0.1% | 0.0% | 0.0% | 0.0% | 0.3% | -0.1% |
| Class D | 0.6% | 0.0% | -0.4% | 0.6% | -0.5% | -0.7% |
| Class E | -0.2% | 0.3% | 0.6% | -0.4% | -0.3% | -0.5% |
| **Overall** | 0.1% | -0.1% | -0.1% | 0.0% | -0.3% | -0.6% |
|  | 0.1% | -0.2% | -0.2% | 0.0% | -0.4% | -0.6% |
| Enc Time[%] | 100% | | | 101% | | |
| Dec Time[%] | 102% | | | 103% | | |
| Mult[%] | -14% | | | -14% | | |
| Adds[%] | -16% | | | -16% | | |
| Access[%] | -3% | | | -3% | | |
| MemBand(2D) Ave.[%] |  | | |  | | |
| MemBand(2D) Max.[%] |  | | |  | | |
| MemBand(1D) Ave.[%] |  | | |  | | |
| MemBand(1D) Max.[%] |  | | |  | | |
|  |  |  |  |  |  |  |
|  | **Low delay P HE** | | | **Low delay P LC** | | |
|  | Y | U | V | Y | U | V |
| Class A |  |  |  |  |  |  |
| Class B | 0.1% | -0.3% | -0.3% | -0.6% | -0.6% | -0.9% |
| Class C | 0.3% | 0.4% | 0.2% | 0.0% | 0.1% | 0.2% |
| Class D | 1.2% | 0.6% | 0.1% | 0.9% | -0.1% | -0.5% |
| Class E | -0.1% | -0.1% | 0.4% | -1.4% | -1.8% | -1.5% |
| **Overall** | 0.4% | 0.1% | 0.1% | -0.2% | -0.5% | -0.7% |
|  | 0.4% | 0.1% | 0.1% | -0.2% | -0.5% | -0.7% |
| Enc Time[%] | 100% | | | 101% | | |
| Dec Time[%] | 101% | | | 103% | | |
| Mult[%] | -14% | | | -14% | | |
| Adds[%] | -16% | | | -17% | | |
| Access[%] | -3% | | | -3% | | |
| MemBand(2D) Ave.[%] |  | | |  | | |
| MemBand(2D) Max.[%] |  | | |  | | |
| MemBand(1D) Ave.[%] |  | | |  | | |
| MemBand(1D) Max.[%] |  | | |  | | |

|  |  |  |  |
| --- | --- | --- | --- |
| Gain Ave.[%] | 0.07% | -0.11% | -0.19% |
| Gain Min. [%] | -2.70% | -3.17% | -2.39% |
| Gain Max.[%] | 3.28% | 3.10% | 1.52% |
| Enc Time[%] | 100.34% | | |
| Dec Time[%] | 101.99% | | |
| Mult Ave.[%] | -13% | | |
| Mult Worst[%] | -9% | | |
| Adds Ave.[%] | -16% | | |
| Adds Worst[%] | -11% | | |
| Access[%] | -3% | | |
| MemBand(2D) Ave.[%] | -100% | | |
| MemBand(2D) Max.[%] | -100% | | |
| MemBand(2D) Worst[%] | 0% | | |
| MemBand(1D) Ave.[%] | -100% | | |
| MemBand(1D) Max.[%] | -100% | | |
| MemBand(1D) Worst[%] | -5% | | |

# Visual quality check

One part of CE3 is visual quality test. Under common test condition there is no problem with visual quality for HM4.0. Under common test conditions both tested variation for interpolation filters shows no visual quality difference with anchor; there is no need to include pictures in this case.

It was noticed that if SAO is disabled in LD(P)-LC test case then in some cases one may see ring artifacts. Fig. 1-2 illustrate this.

Fig 1. 100th frame of PartyScene encoded with QP=37, LD(P)-LC.



Fig 2. 100th frame of PartyScene encoded with QP=37, LD(P)-LC id SAO is disabled.



Fig 3. 100th frame of PartyScene encoded with QP=37, LD(P)-LC id SAO is disabled and proposed 7q91/4)6H filter is used.



Corresponding pictures for the same test: LD(P)-LC, SAO off, QP=37 with proposed interpolation filters is shown on Fig 3. We may notice that proposed filter improves visual quality for this test case.

# Conclusions

Based on test results

* performance 0.07% (Y)/ -0.11%(U) /-0.19% (V);
* 13-16% computation reduction compare to HM,
* 3-5% memory band-width reduction in avg.;

and visual quality test for PartySciene, LD(P)-LC, QP=37, SAO off we recommend to take into account possibility to change interpolation filter in HM s/w to proposed 7Q(1/4)6H.

# References

1. JCT-VC, “CE3: Experimental results of DCTIF by Samsung”, JCTVC-D344, 4th JCT-VC Meeting, Daegue, Korea, January, 2011
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4. JCT-VC, “CE3: DCT derived interpolation filter test by Samsung”, JCTVC-F247, 6th JCT-VC Meeting, Torino, Italy, 14-22 July, 2011
5. JCT-VC, “CE3: Motion Compensation”, JCTVC-F903, 6th JCT-VC Meeting, Torino, Italy, 14-22 July, 2011
6. JCT-VC, “Common test conditions and software reference configurations”, JCTVC-F900, 6th JCT-VC Meeting, Torino, Italy, 14-22 July, 2011

# Patent rights declaration(s)

**Samsung Electronics Co., Ltd. may have current or pending patent rights relating to the technology described in this contribution and, conditioned on reciprocity, is prepared to grant licenses under reasonable and non-discriminatory terms as necessary for implementation of the resulting ITU-T Recommendation | ISO/IEC International Standard (per box 2 of the ITU-T/ITU-R/ISO/IEC patent statement and licensing declaration form).**