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| *Title:* | **Unified design for motion compensation filter** | | |
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# Abstract

This contribution presents a unification scheme for motion compensation filters. In this proposal, the filter for uni-prediction doesn’t round the prediction to input bit-depth but do the rounding when predictions results are added with residual coefficients, while keeping all the intermediate calculations in 16-bit. According to JCTVC- D321 and JCTVC-E242, bi-prediction filters are already using this scheme. By this proposal, the filter for bi- and uni-directional prediction can be unified without any coding loss and increasing complexity.

# Proposal

Currently, the filters for bi-prediction and uni-prediction are separated in HM3.0. In case of bi-prediction, the rounding offset isn’t signaled but keeps each of the interpolated signals at high precision. The rounding is performed at the last step after both prediction signals are added. The calculations are performed in 16-bit intermediate buffer. In case uni-prediction, each interpolated signals are rounded at the filter stage. So the calculations are performed in input-bit depth. This is illustrated in Figure 1 where the N and M represent filter input bit depth and filter output bit depth, respectively. The blue number in parenthesis is the example when input bit depth is equal to eight.



**Figure 1 Current MC prediction in HM3.0**

In order to unify filters for bi- and uni- prediction, we propose the scheme that the uni-prediction keeps the interpolated signals at high precision. The calculations are performed in 16-bit. The rounding is performed when prediction results are added with residual coefficients. According to this proposal, the uni-prediction filter has high accuracy with 16 bit depth as same with bi-prediction. So finally bi- and uni- prediction can be used with the same filter in high precision. Figure 2 illustrates the proposal.



**Figure 2 Proposed unified MC prediction method**

# Experimental Results

We compare our test results with the HM3.0 anchor which are represented in Table 1 and Table 2. The results show that the unified design leads similar or slightly better results compared with previous non-unified design. The complexity is changeless in both cases.



**Table 1. Results on the random access test case**



**Table 2. Results on the low delay test case**

# Harmonize proposal with JCTVC-F537

In JCTVC-F537, two modifications toward the motion compensation process are proposed to simplify the process by removing data offset adding operations and to ensure that all data after each of the vertical and horizontal filtering passes holds in 16-bit memory. We harmonized our proposal with JCTVC-F537 and cross checked with JCTVC-F537 each other.

We modified the intermediate buffer size from 32 bit to 16 bit as the purpose of the JCTVC-F537. The current process is illustrated in Figure 3. The filter input bit-depth can be 8, 10 or 12 bits. To cover for the input bit-depth to be equal to 12 bits as explained in Figure 3, the intermediate buffer size should be more than 32 bits.



**Figure 3 The vertical and horizontal filter example in the current HM3.0**

However as explained in the Figure 4, the intermediate buffer can be reduced to under 16 bits when the JCTVC-F537 proposal is harmonized.



**Figure 4 The vertical and horizontal filter example harmonized with JCTVC-F537**

# Experimental Results for the harmonized MC filter with JCTVC-F537

We improved the unified MC filter with intermediate buffer reduction of JCTVC-F537. The test is taken under the HM3.0 software which is represented in Table 3 Table 4. The results show that the harmonized design with the modification of intermediate buffer size leads similar results compared with the proposal while keeping the benefit for reduced intermediate buffer.



**Table 3. Results on the random access test case**

**Table 4. Results on the low delay test case**

# Cross-check results for the motion compensation process of the JCTVC-F537

The cross-check results of the motion compensation process to simplify the process by removing rounding operations and to ensure that all data after each of the vertical and horizontal filtering passes holds in 16-bit memory are verified. The cross-verification task has been successfully completed, and it is confirmed that the BD-rate results match those provide by the proponent.

We think that it is beneficial that the restriction of an intermediate buffer size from 32 bits to 16 bits can make software optimization more effectively especially when SIMD-like operation is used.

The test results are shown in the Table 5.







**Table 5. Results on motion compensation process of the JCTVC-F537**

# Conclusion

This contribution proposed a minor fix on the uni-prediction. Using this proposal, uni-prediction performs high accuracy calculation using 16 bit-depth same as bi-prediction. So the two directional prediction filters can be unified without any coding loss and increasing complexity. Finally the encoder or decoder needs not to use separated prediction filters any more for motion compensation. We harmonized our proposal with JCTVC-F537. The test result of modifying the size of intermediate buffer is similar to the result of our own proposal. Finally we verified the cross-check for the JCTVC-F537 where the BD-rate results match those provide by the proponent. We think that JCTVC-F537 is useful for simplified implementations and effective optimizations for the software.

# Patent rights declaration(s)

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