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| *Title:* | **CE6 Subset A: Report of Improved Intra prediction for positive directions in UDI** | | |
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# Abstract

This contribution presents the experimental results of Bidirectional UDI Intra Prediction (BUDI) for Core Experiment 6 (CE6) on intra prediction improvement. BUDI was firstly proposed to replace mode 6 (*i.e.* ver+8) in JCTVC-D300. In this document, BUDI has been extended to other positive directions, including ver+8, ver+5 and hor+6. Three BUDI schemes have been tested based on HM2.0 for both Intra HE and LC configurations. The test results show the original BUDI scheme with replacement of mode ver+8 achieves 0.4% and 0.5 bit-rate reduction with approximately the same encoding and decoding time. The extended BUDI scheme achieves an average BD-rate reduction of 0.6% and 0.7% with minimum complexity increase. It is also reported that the division-free implementation for the extended BUDI scheme achieves 0.5% and 0.6% bit-rate reduction.

# Introduction

UDI Intra prediction uses main and side arrays as prediction references. When Intra prediction direction is positive, only the reference pixels from the main array are used for prediction [1]. In fact, for those positive directions in UDI, both the reference pixels from main and side arrays can be further exploited to improve prediction accuracy. The prediction value of a pixel in current block is linearly interpolated from the two corresponding reference pixels.

In the last JCTVC meeting, bidirectional UDI Intra prediction (BUDI) has been proposed in JCTVC-D300 to improve coding performance by replacing the existing Intra mode 6 (*i.e.* ver+8) which represents the direction of 45 degrees. It has been shown the performance of Intra prediction can be improved by using BUDI approach [2].

In this document, BUDI has been extended to other positive directions to verify its potential performance. For the positive directions other than mode ver+8, the corresponding reference pixels from main and side references may be in sub-pixel position. So 1/32 Interpolation is needed to generate the corresponding reference sub-pixels for BUDI prediction.

# Test conditions and Results

The following running environment and compiler have been used for running simulations. The same computer was used in our experiments in order to obtain coherent encoding and decoding time. Both all Intra HE and LC cases have been tested under common test conditions [3][ 4].

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| **Running environment** | **Compiler** |
| Intel Xeon X7560 @2.27GHz, 256G RAM  Windows Server 2003, 64 bits | VS2005 |

The proposed BUDI approaches have been integrated into the reference software HM2.0. The following tables summarize the simulation results. See the attached documents for the details.

Table 1. BUDI with replacement of mode ver+8 (“BUDI”)



Table 2. BUDI with replacement of mode ver+8, ver+5 and hor+6 (“BUDI\_EXT”)



Table 3. Division-free BUDI with replacement of mode ver+8, ver+5 and hor+6 (“BUDI\_EXT\_FAST”)



The following three cases have been tested.

Table 1 shows the performance of the BUDI approach with the replacement of the existing mode ver+8 (which is denoted as “BUDI”). The bit-rate reduction of 0.4% and 0.5% over HM2.0 can be achieved for both all Intra HE and LC configurations. The encoding and decoding time is almost the same as anchor.

“BUDI\_EXT” denotes the BUDI approach which has been extended to other positive directions. Besides mode ver+8, other mode ver+5 and hor+6 are also replaced in this “BUDI\_EXT” approach. In our implementation, it is found that replacing all positive modes with BUDI prediction is not the optimal solution, so these three Intra modes are chosen for simulation. As shown in Table 2, the test results show that “BUDI\_EXT” achieves 0.6% and 0.8% bit-rate reduction over HM2.0 with minimum increase of encoding and decoding time for both all Intra HE and LC configurations.

“BUDI\_EXT\_FAST” denotes the division-free “BUDI\_EXT” approach, where division operation in linear interpolation process can be removed by using a kind of approximate weighting algorithm. Test results in Table 3 shows the gain is 0.5% and 0.6% bit-rate reduction for all Intra HE an LC cases with minimum increased encoding and decoding time.

According to above test results, the “BUDI” approach with replacement of mode ver+8 has better trade-off between performance and complexity. In addition, the “BUDI” approach has an advantage that both the two corresponding reference pixels are integer pixel.

# Conclusion

The document reports the test results of three BUDI approaches to evaluate the performance and complexity. According to the test results, it’s suggested that the “BUDI” approach with replacement of Intra mode ver+8 be introduced in the HEVC test model (HM).

# References

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# Patent rights declaration(s)

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