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| *Title:* | **Transform Selection for Inter-Layer Texture Prediction in Scalable Video Coding** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Proposal | | |
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# Abstract

# In this contribution, multiple transforms are allowed for coding the luma component of inter-layer texture prediction residues. The encoder selects one transform from the multiple candidates and signals its selection. All the candidate transforms can be implemented by reusing the DCT partial butterfly structure in HM software. Experimental results reportedly show luma BD-rate reductions of 1.55% and 1.27% for AI-2X and AI-1.5X respectively (BD-rate calculated using both enhancement layer and base layer rates).

# Introduction

Inter-layer texture prediction is an important tool for Scalable Video Coding (SVC) where base layer reconstructed pixels are used to predict enhancement layer pixels. The residue characteristics can be different from those of the single layer residues when inter-layer texture prediction is used. In this proposal, in addition to the two transforms in the HEVC main profile (i.e., DCT Type-2 and DST Type-7), additional DCT and DST transforms are applied to the enhancement layer to achieve better residue energy compaction. The transforms can be implemented reusing the butterfly structure from the two existing transforms in HEVC.

# Proposed Method

**2.1 Transform Selection**

Three candidate transforms can be used for encoding the luma component of inter-layer texture prediction residues. These three transforms are derived based on the DST Type-3, DCT Type-2 and DST Type-3 transforms. The transform selection method is not applied to chroma components, for which only the DCT Type-2 transform is used.

For each CU encoded with inter-layer texture prediction mode, the encoder selects a transform based on the rate-distortion criterion and signals the *transform\_selection\_index* to the decoder. The syntax element *transform\_selection\_index* is coded using a truncated unary code with CABAC. The contexts for each bin and each CU size are separated, so there are 8 (2 bins x 4 CU sizes) contexts in total for this syntax. The mapping between *transform\_selection\_index* and transform type is shown in Table 1.

Table 1 Candidate Transforms

|  |  |  |
| --- | --- | --- |
| *transform\_selection\_index* | Binarization | Transform |
| 0 | 0 | DST Type-3 |
| 1 | 10 | DCT Type-2 |
| 2 | 11 | DCT Type-3 |

**2.2 DCT Type-3 and DST Type-3**

The transform coefficients of DCT Type-3 and DST Type-3 are derived from the coefficients of DCT Type-2 as follows:

Let *A*, *B* and *C* be the N×N transform matrices of DCT Type-2, DCT Type-3 and DST Type-3, respectively. For the element at the *i*-th row and *j*-th column,

,

, for even *i,*

, for odd *i.*

It can be seen DCT Type-3 is the transpose of DCT Type-2, and thus the forward transform of DCT Type-3 can be implemented using the butterfly pipeline of the inverse transform of DCT Type-2, and vice versa. For DST Type-3, the input coefficients need extra row flipping and sign inverting for odd columns before reusing HM butterfly structure.

# Experimental results

The proposed method is implemented on Qualcomm’s SVC call for proposal response software JCTVC-K0036 [1]. Anchor is generated using the same software with only DCT Type-2 transform for inter-layer texture prediction mode. Only All-Intra coding is tested. Test conditions specified in [2] are used without rate matching. Specifically, the QP setting in configuration files are as follows:

Table 2 QP Settings

|  |  |  |
| --- | --- | --- |
| Scalability | Base Layer QP | Enhancement Layer QP |
| Spatial 2X | 22, 26, 30, 34 | Baselayer QP -2, +0, +2, +4 |
| Spatial 1.5X | 22, 26, 30, 34 | Baselayer QP -2, +0, +2, +4 |

The results of the proposed method is shown in Table 3 where the BD-rate is calculated using both enhancement layer and base layer rates.

Table 3 Performance of the Proposed Transform Selection

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | All Intra HEVC 2x | | | All Intra HEVC 1.5x | | |
|  | Y | U | V | Y | U | V |
| Class A+ | -1.69% | 1.17% | 1.16% |  |  |  |
| Class B | -1.42% | 0.99% | 0.97% | -1.27% | 1.49% | 1.50% |
| Overall | -1.55% | 1.08% | 1.07% | -1.27% | 1.49% | 1.50% |

In Table 4 additional results are provided for the case of 2 transform candidates: DCT Type-2 and DCT Type-3. As discussed before, DCT Type-3 can reuse DCT Type-2 butterfly structure by only switching the forward transform and the inverse transform stages.

Table 4 Performance of Switching between DCT Type-2 and DCT Type-3

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | All Intra HEVC 2x | | | All Intra HEVC 1.5x | | |
|  | Y | U | V | Y | U | V |
| Class A+ | -1.09% | 0.68% | 0.66% |  |  |  |
| Class B | -0.91% | 0.60% | 0.60% | -0.85% | 0.95% | 0.96% |
| Overall | -1.00% | 0.64% | 0.63% | -0.85% | 0.95% | 0.96% |

# Conclusions

This contribution describes a transform selection scheme for inter-layer texture prediction. In addition to DCT Type-2 in HM, two extra transforms (DCT Type-3 and DST Type-3) are introduced. The implementation of the extra transforms can reuse the butterfly structure in HM software, thus having negligible impact on implementation cost.

# References

1. J. Chen, *et al.* “Description of scalable video coding technology proposal by Qualcomm (configuration 1)”, JCTVC-K0035, Shanghai, China, Oct. 2012.
2. ISO/IEC JTC1/SC29/WG11 and ITU-T SG 16, “Joint Call for Proposals on Scalable Video Coding Extensions of High Efficiency Video Coding (HEVC)”, ISO/IEC JTC 1/SC 29/WG 11 (MPEG) Doc. N12957, Stockholm, Sweden, July 2012.

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