

Rate Distortion Optimized Transforms for Intra Block Coding

JCTVC-D276



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- **State-of-the-art transform techniques**
- **Proposed solution – RD optimized transforms**
- **Simulation Results**



- In most proposals, the residue data is classified according to the intra prediction mode.
Not optimal data separation.
- Residue with the same mode, different statistical or structural properties



Proposed Scheme

- This contribution proposes a rate-distortion (RD) optimized transform scheme for $N \times N$ TU in HM0.9.
- The transform pairs are trained off-line and implemented using matrix multiplication in HM0.9 software.
- This technique achieves 3.2% BDBR in Intra Low Complexity (LoCo) condition and 2.0% BDBR in Intra High Efficiency (HE) condition.

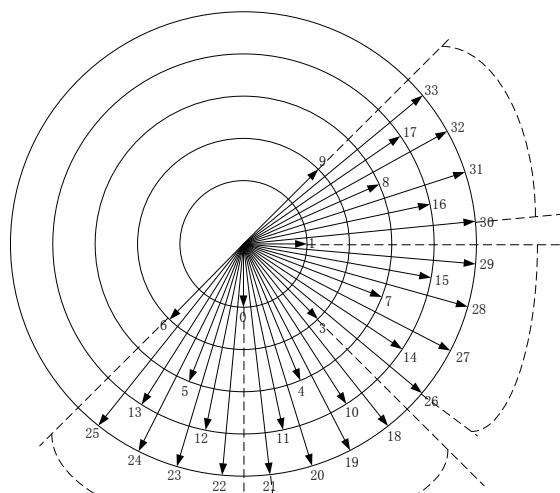


How to derive the transform matrices

Step 1: Preliminarily classify the residue data into five groups

4 directional groups + DC group

Step 2: For each group, except for DC predicted group, we use the iteration method to get the optimal transform matrices C and R which can minimize the Equation 1 for this group. For DC predicted group, we fix the transform as DCT.



$$\min \| X - C^T Y R^T \| + \lambda \| Y \|_0 \quad (1)$$

Fig. 1 Initial Intra Prediction Modes Grouping

$$Y = CXR$$

JCTVC-D276 Proposed Scheme and Implementation

Step4: After the optimal transform pairs are obtained for each group we reclassify the residue data according to Equation 1. Go to Step 2.

Step 5: After several transform optimization and residue data reclassification, the total RD cost expressed in Equation 1 is converged. The transform matrices do not change too much.

Implementation:

$$Y = CXR$$

The matrix elements are scaled by 128 in the implementation.

At the encoder, for each CU, after the best PU structure is obtained using traditional DCT, the proposed four transforms are tested.

Overhead is encoded using 1+2 mode

Test Condition and Results

- The anchor is HM0.9 with encoding conditions specified in the common test conditions in JCTVC-C500.
- Currently, we only implemented on 4x4 and 8x8 TU sizes. Zigzag scanning is used. Expect more improvement by incorporating different scanning schemes and implementing on other TU sizes.
- The results are verified at the decoder and cross checked by ZJU in JCTVC-D425

	Intra			Intra LoCo		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A	-2.6	-1.4	-1.5	-4.0	-0.2	0.2
Class B	-1.5	-0.3	-0.2	-2.6	0.1	0.2
Class C	-2.2	-0.3	-0.3	-3.3	-0.1	-0.1
Class D	-2.3	-0.4	-0.4	-3.3	-0.2	-0.2
Class E	-1.9	-0.7	-0.5	-3.3	0.9	0.6
All	-2.0	-0.5	-0.5	-3.2	0.1	0.1
Enc Time[%]	287%			351%		
Dec Time[%]	113%			125%		



- **This technique achieves 3.2% BDBR in Intra Low Complexity (LoCo) condition and 2.0% BDBR in Intra High Efficiency (HE) condition.**
- **Recommend the standard committee to include this technique into HM software.**
- **Recommend the standard committee to include this technique into future core experiment.**