

# **DCT+Hadamard large transform (JCTVC-D037)**

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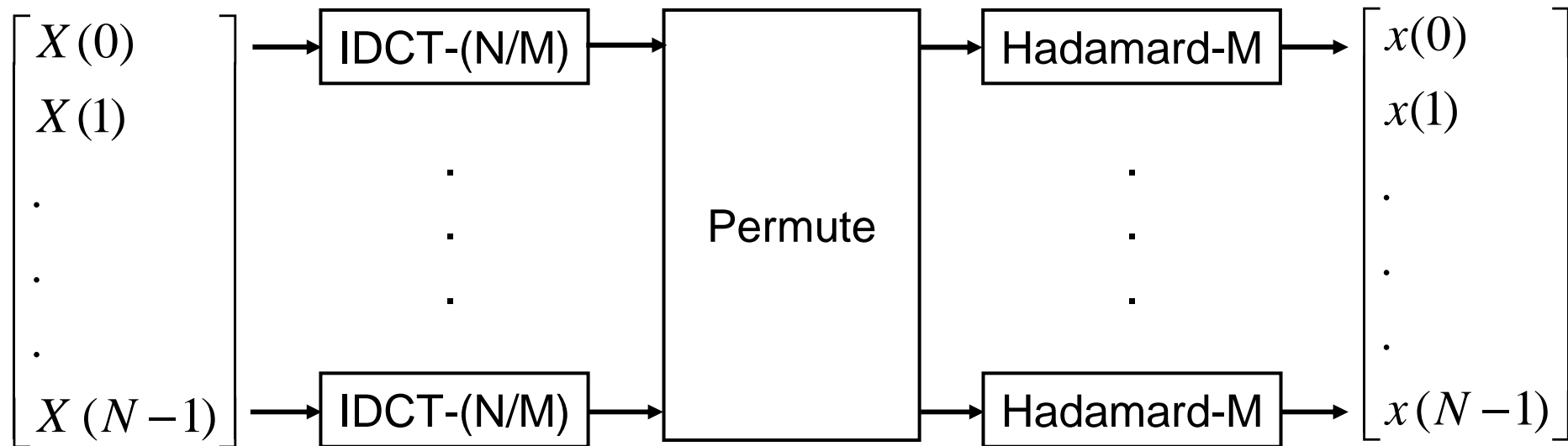
**Joint Collaborative Team on Video Coding (JCT-VC)  
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# Introduction

- Continuation of JCTVC-C255: DCT+Hadamard transform
  - Note DCT+Hadamard was also independently proposed in: JCTVC-C112
- JCTVC-255 studied following transforms for 32x32:
  - DCT32
  - Hadamard32
  - DCT16+Hadamard2
  - Hadamard2+DCT16
  - DCT8+Hadamard4
  - Hadamard4+DCT8
- DCT16+Hadamard2 (DCTH) found to provide best coding performance
- This contribution:
  - DCTH implemented using even-odd decomposition (See JCTVC-D036)
  - Software released to Sony and Qualcomm for cross-verification. Thanks to Sony and Qualcomm for cross-verifying DCTH

# Inverse DCT+Hadamard



# 8x8 Inverse DCTH (DCT16+Hadamard2)

$$H2 = \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix} \quad H = \begin{bmatrix} H2 & 0 & 0 & 0 \\ 0 & H2 & 0 & 0 \\ 0 & 0 & H2 & 0 \\ 0 & 0 & 0 & H2 \end{bmatrix} \quad P = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

$$D4 = \text{IDCT } 4 \times 4 \text{ matrix} \quad D = \begin{bmatrix} D4 & 0 \\ 0 & D4 \end{bmatrix}$$

- DCT16+Hadamard2 Inverse transform matrix

$$T = H P D$$

# Results when DCTH is applied to Inter only

	BD-Rate (%)	Dec runtime	Enc Runtime
Intra	0.0	101%	96%
Random access	0.2	101%	103%
Low delay	0.4	102%	93%
Intra LoCo	0.0	102%	95%
Random access LoCo	0.1	101%	97%
Low delay LoCo	0.2	102%	92%

Results on all frames

# Complexity considerations

- Multiplications and additions

	MatMult			Chen		
	DCT	DCTH	% Reduction	DCT	DCTH	% Reduction
MULTs	342	172	50%	116	88	24%
ADDs	404	264	35%	210	196	7%

- Hardware complexity needs to be studied further

# Conclusions

- DCT+Hadamard transforms appears to provide an interesting trade-off in terms of complexity reduction and rate-distortion performance
- Zonal coding etc. can be used on top of these transforms
- Recommend further study

# Results when DCTH is applied to Inter+Intra

	BD-Rate (%)	Dec runtime	Enc Runtime
Intra	0.8	-	-
Random access	0.6	-	-
Low delay	0.4	-	-
Intra LoCo	0.9	-	-
Random access LoCo	0.6	-	-
Low delay LoCo	0.2	-	-

Results on 65 frames