



# JCTVC-B073

## Fast Mode Dependent Directional Transform via Butterfly Structure

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# Outline

- Introduction
- Fast MDDT Transforms via butterfly structure
- Experimental Results
- Summary



# MDDT

- Mode Dependent Directional Transform
  - 18 transform matrices for 8x8 and 4x4 blocks
  - 8 transform matrices for 16x16 blocks
  - Orthogonal transform matrices
  - No fast transform algorithms without approximation



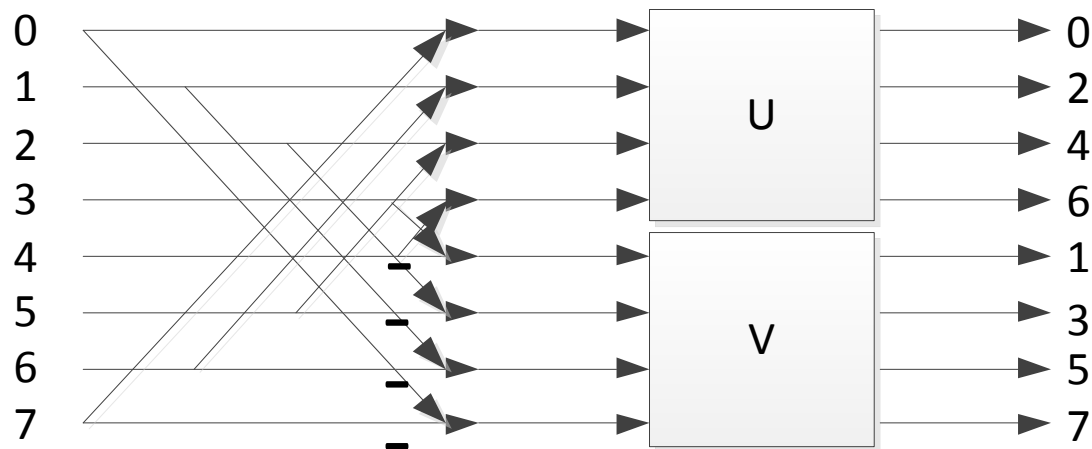
# MDDT Matrix Approximation

$$\mathbf{S}_N = \mathbf{P}_N \begin{bmatrix} \mathbf{U} & \mathbf{0} \\ \mathbf{0} & \mathbf{V} \end{bmatrix} \begin{bmatrix} \mathbf{I} & \mathbf{J} \\ \mathbf{J} & -\mathbf{I} \end{bmatrix}$$

- $\mathbf{U}$ ,  $\mathbf{V}$  can be derived by approximating MDDT matrices
- $\mathbf{P}$  is a reordering matrix



# MDDT Approximation





# Derivation of U, V

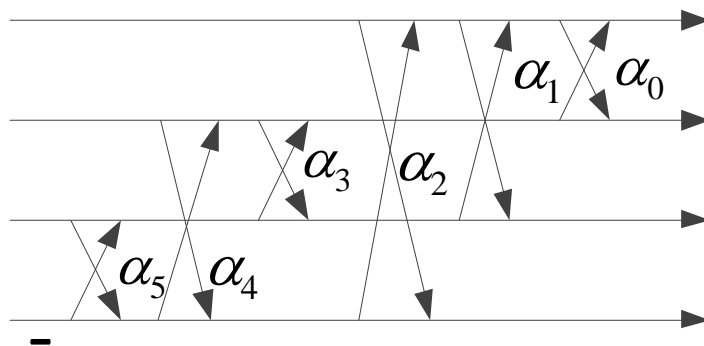
- U, V can be derived from  $\mathbf{D}_0$  and  $\mathbf{D}_3$

$$\mathbf{D} = \begin{bmatrix} \mathbf{D}_0 & \mathbf{D}_1 \\ \mathbf{D}_2 & \mathbf{D}_3 \end{bmatrix} = \begin{bmatrix} \mathbf{I} & \mathbf{J} \\ \mathbf{J} & -\mathbf{I} \end{bmatrix} \mathbf{C}_x \begin{bmatrix} \mathbf{I} & \mathbf{J} \\ \mathbf{J} & -\mathbf{I} \end{bmatrix}$$



# U, V decomposition

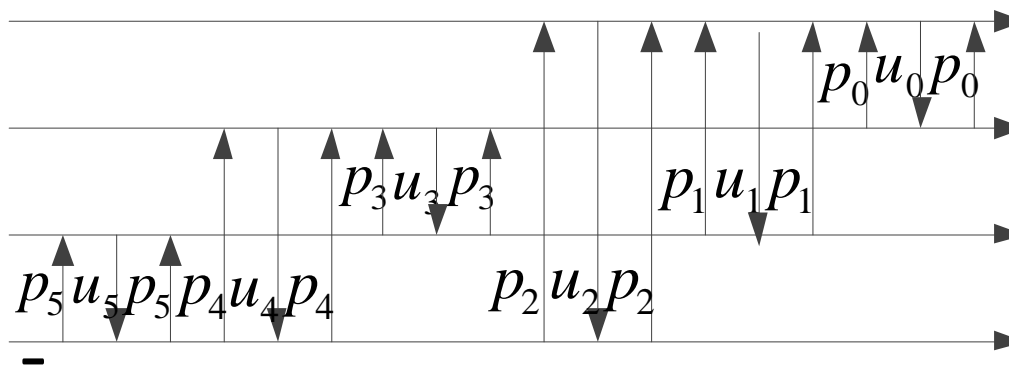
- U, V can be factored into combining of plane rotations.





# U, V by lifting steps

- The plane rotations can be implemented using lifting steps.







# Complexity Comparisons

	4x4		8x8	
	Mul.	Add.	Mul.	Add.
MDDT	16	12	64	56
BSTM	8	8	32	32



# Experimental Settings

- JM11.0/KTA2.4, High Profile, I Frame only,
- $QP = 22, 27, 32, 28, 42,$
- CABAC, RDO, MDDT
- Class A, B, C, D and E
- Column matrix for mode 0 and row matrix for mode 1 is not simplified. (2/18)

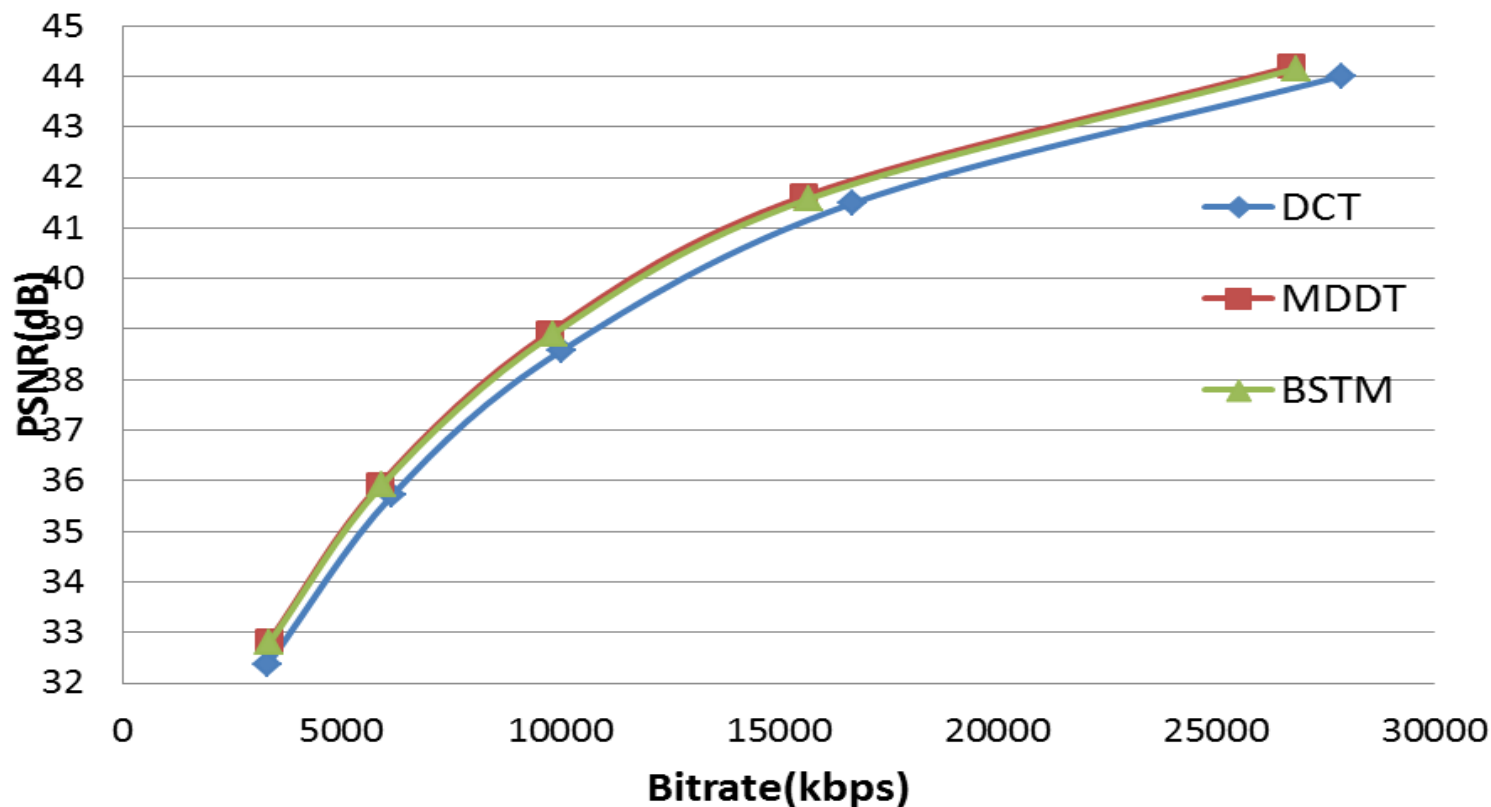


Class	Sequence	BDRate(%)	BDPSNR(dB)
E	BasketballPass	0.41	-0.03
	BlowingBubbles	0.93	-0.06
	BQSquare	0.08	-0.01
	RaceHorses	1.31	-0.09
	Average	0.68	-0.05
D	BasketballDrill	1.46	-0.07
	BQMall	0.85	-0.05
	PartyScene	0.50	-0.04
	RaceHorses	1.06	-0.07
	Average	0.97	-0.06
C	vidyo10	2.40	-0.12
	vidyo3	1.44	-0.08
	vidyo4	1.54	-0.07
	Average	1.79	-0.09
B	BasketballDrive	1.03	-0.03
	BQTerrace	0.79	-0.05
	Cactus	1.34	-0.05
	Kimono1	1.85	-0.06
	ParkScene	1.19	-0.05
	Average	1.24	-0.05
A	PeopleOnStreet	2.35	-0.13
	Traffic	2.17	-0.10
	Average	2.26	-0.12



# Coding Efficiency Comparisons

**vidyo3**





# Summary

- The proposed scheme approximate the MDDT matrices using butterfly structure
- The proposed scheme reduces the complexity without big coding efficient loss
- Integer transform
- Reversible transform



# Thanks