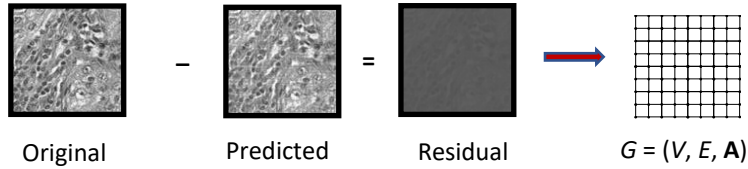


Graph Based Transforms based on Graph Neural Networks for Predictive Transform Coding

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Graph-Based Transform



• Undirected graph $G = (V, E, A)$

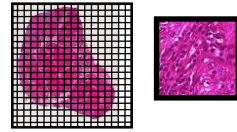
- V : set of vertices
 - v_i : residual value at pixel location i
- E : set of edges

A : symmetric weighted adjacency matrix

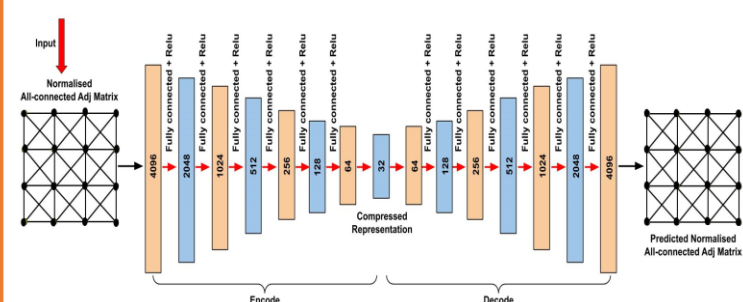
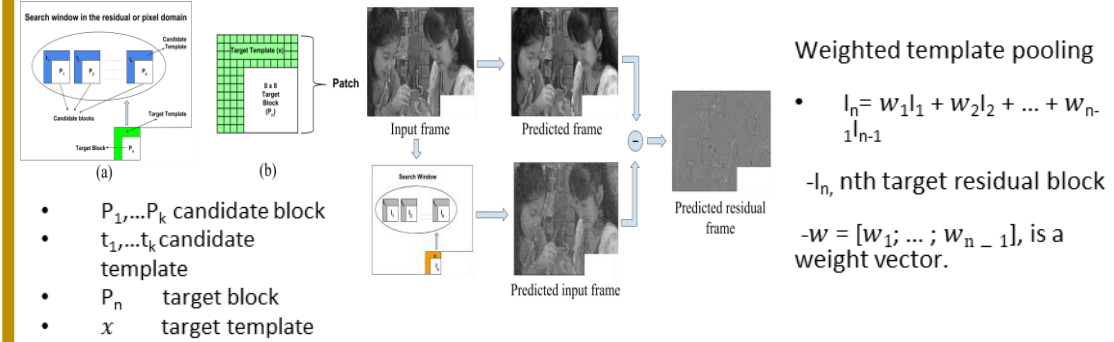
A_{ij} : weight of edge $e = (i, j)$ connecting pixel locations i and j with $A_{ij} = A_{ji}$

Summary

- A novel class of graph-based transform
- GBT-NN – Graph-Based Transform based on Neural Network
- Template-based prediction strategy
- Evaluation shows the GBT-NN outperforms DCT and DST



Template-Based Prediction strategy – Pixel Domain



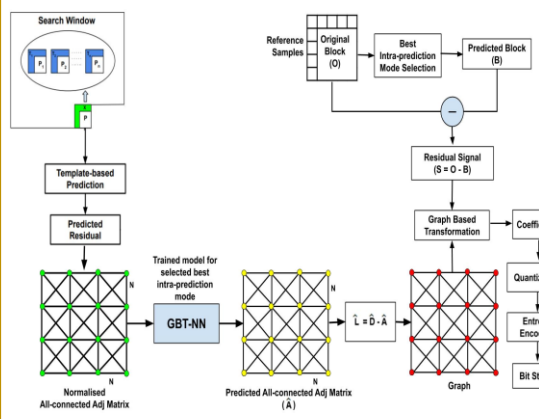
The Model :

- Graph encoding-decoding neural network
- Normalised all-connected adjacency matrix (\hat{A}) → Predicted normalised all-connected adjacency matrix (\hat{A})
- Encoding: $\mathbf{h}^{(l_e)} = ReLU(\mathbf{W}^{(l_e)} \mathbf{h}^{(l_e-1)})$
- Decoding: $\hat{\mathbf{A}} = ReLU(\mathbf{W}^{(l_d)} \mathbf{h}^{(l_d)})$
- Loss function: $L = L_{recon} + \alpha L_{sym} + \lambda \|\mathbf{W}\|_1$

Video Encoding

GBT-NN is computed based on predicted residual value

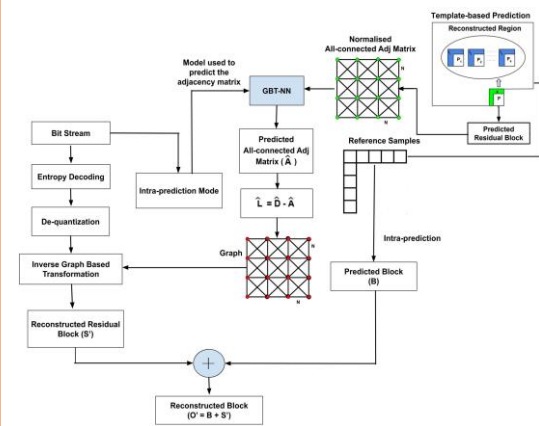
- predicted residual values → GBT-NN → predict graph
- predict graph applied to actual residual block



Video Decoding

No need to send graph information to decoder

- predicted residual → normalized all connected adjacency matrix → GBT-NN → predict graph
- Predicted graph → inverse GBT
- inverse GBT applied to dequantized coefficients

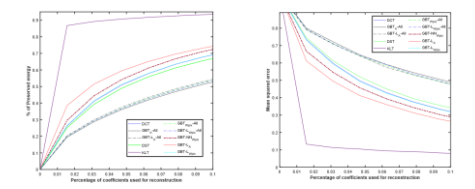


Performance Evaluation

Average preserved energy (PE-%) and MSE using a percentage of largest coefficients

	Percentage of coefficients used									
	1%		3%		5%		7%		10%	
	PE	MSE	PE	MSE	PE	MSE	PE	MSE	PE	MSE
KLF	55.51	44.59	69.00	11.44	90.85	10.22	92.13	09.18	93.56	07.97
DCT	16.84	82.99	39.97	60.88	52.11	48.38	60.43	40.40	69.07	32.03
DST	16.14	83.69	38.19	62.22	50.18	50.64	58.35	42.43	66.88	34.24
GBT _{1%} -All	12.47	87.23	28.05	72.84	37.14	63.57	44.22	56.88	52.66	49.64
GBT _{3%} -All	13.07	83.69	29.26	62.28	38.62	50.64	45.90	42.43	54.42	34.24
GBT _{5%} -All	12.71	86.78	28.68	71.87	38.00	62.85	45.27	55.91	53.86	47.79
GBT-NN	18.97	78.72	43.29	55.57	55.43	44.46	63.75	36.98	72.40	28.94
GBT _{10%} -All	12.79	86.91	28.67	71.72	37.77	63.21	44.97	56.43	53.58	48.05
GBT _{1%} -A	24.71	75.17	50.48	50.44	60.47	40.21	67.16	33.82	74.28	26.47
GBT _{10%} -A	17.01	82.82	40.25	60.50	52.58	47.93	60.55	40.09	69.18	31.86

Performance Curves



GBT-NN framework outperforms:

- DST by 10.46%
- DCT by 6.37%