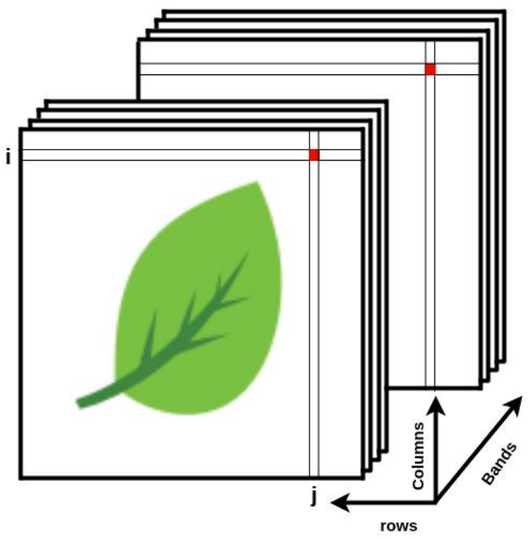
A Novel Hyperspectral Image Compression Scheme Using Graph Fourier Transform

Indrit Nallbani
Behçet Uğur Töreyin
Signal Processing for Computational Intelligence Group (SP4CING)
Informatics Institute
Istanbul Technical University

Abstract

We propose a novel method for compressing images using Graph Fourier Transform (GFT) and Discrete Wavelet Transform (DWT). Our method preserves the image quality when compressing to very low bitrates.

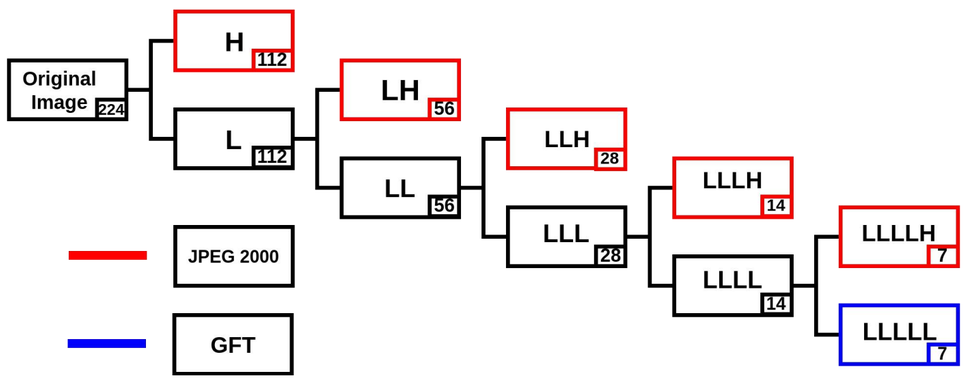
Methodology



- HSI are large images with large correlated pixels.
- Images are compressed by spectrally decorrelating using DWT and spatially using GFT.

Fig.1: Hyperspectral Image

We apply a five-level DWT on the original image and compress them using JPEG 2000 and apply GFT to the lowest approximation coefficients.



On the last seven bands, we transform the images into graphs where nodes containt pixel intensities and edges connecting the nodes describe the similarity between them.

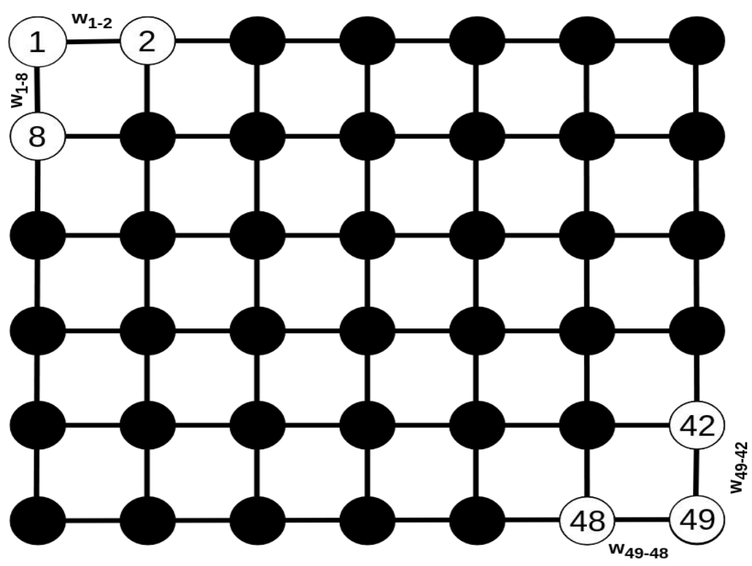


Fig.2: Graph representation of an 7x7 image

We formulate the Graph Laplacian for each image and use the Graph Fourier to transform them in order to save only a few coefficients of the graph spectrum.

$$L_{i,j} := \begin{cases} \deg(v_i) & \text{if } i = j \\ -1 & \text{if } i \neq j \text{ and } v_i \text{ is adjacent to } v_j \\ 0 & \text{otherwise} \end{cases}$$

Graph Fourier transformed is defined after we eigen decompose the Laplacian as follows:

$$\boldsymbol{L = U \Lambda U^{-1}}$$

and

$$\boldsymbol{F = U^{-1}}$$

The original signal is reconstructed by taking the inverse of the Graph Fourier.

Early Results

Jasper Ridge Hyperspectral Image			
	BPS = 0.1	BPS = 0.3	BPS = 0.5
DWT + GFT	59.15 dB	63.60 dB	65.77 dB
BCS PL-2DBS + 2DDWT	50.60 dB	54.18 dB	57.11 dB
BCS SPL-2DBS + 2DDWT	50.30 dB	53.67 dB	56.45 dB
CPPCA	30.20 dB	71.31 dB	76.40 dB
LASSO	59.30 dB	70.67 dB	73.17 dB
TFEMPR	70.99 dB	80.55 dB	83.51 dB

Fig.3 : Comparison of the result with different methods

Conclusion

- Our method can compress the images while preserving quality.
- Reducing the computational complexity of solving the Graph Fourier Transform will compress the image further while maintaining the quality.

Acknowledgment

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