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MULTISPECTRAL IMAGE COMPRESSION USING DISCRETE COSINE TRANSFORM

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Abstract— **Compression plays a key role in reducing transmission and storage requirements. Compression of Multispectral data is important as it demands lots of memory space for storage. In the present work, the paper proposes transform coding techniques such as different Discrete Wavelet Transform (DWT) for compressing the multispectral data. The transform coding techniques are applied for multispectral input data and are compared with respect to Compression Ratio (CR) and Peak Signal to Noise Ratio (PSNR). The technique proposed is implemented individually on various bands of multispectral image.**

Keywords— **Multispectral image, Bands, Discrete wavelet transform, Compression**

I. INTRODUCTION

Image compression is a type of data compression applied to digital images, to reduce their cost for storage or transmission. Its aim is to reduce the number of bits required to represent an image by removing the spatial and spectral components to lowest possible level. The redundancy and irrelevancy that is present in the image will be reduced during image compression. It aims in reducing the size of multispectral image using image compression techniques. The objective is to reduce the transmission and storage requirements of image data. The two types of compression which describes image compression are Lossless compression and Lossy compression

Multispectral image captures image information in specific wavelength ranges across the spectrum. Wavelengths can also be separated by filters or detected by the use of devices that are sensitive to specific wavelengths, as well as varying actinic radiation, i.e. infrared and ultraviolet. Spectral imaging allows for the extraction of more information, which the human eye fails to capture with receptors that look for red, inexperienced, and blue. It was originally developed for military target identification and intelligence operation. Early space-based imaging platforms incorporated multispectral imaging technology to map the planet's contact with coastal boundaries, vegetation and landforms. Multispectral imaging was additionally used in document and painting analysis. Multispectral imaging measures the lightness of the spectral bands slightly (usually three to 15). One image band in multispectral picture usually occupies several megabytes which is very huge for storage and transmission.

Fig 1: Multispectral image

In Digital Image Processing applications, Discrete Cosine Transform (DCT) plays an important role in the area of Image compression. Discrete cosine transform (DCT) is one of the transforms that plays important role in image processing. It's usually used for compression because of its ability in high energy packing capabilities. DCT has many helpful properties and involves solely real elements. Basically DCT is a major technique for converting the special domain image into frequency domain image. It’s known for representing an image as a curve of variable magnitudes and frequencies. The DCT has the property that, for a typical image, most of the visually important data regarding the image is focused in barely few co efficient and less important co efficient are distributed that can be represented with less number of data, for this reason the DCT is usually employed in compression techniques.

Two dimensional DCT (2-D)
For analyzing the two-dimensional (2D) signals like images, we need a 2 dimensional DCT. The 2 dimensional DCT for an n x m matrix is computed for input s. First 1 dimensional DCT is applied to each row of s and then it is applied to each column of the result obtained. The transform of s is given as follows,

$$S(u,v) = \frac{2}{\sqrt{nm}} C(u)C(v) \sum_{y=0}^{m-1} \sum_{x=0}^{n-1} s(x,y) cos\frac{(2x+1)u\pi}{2n} cos\frac{(2y+1)u\pi}{2m}$$

$$u=0,\ldots,n \quad v=0,\ldots,m \qquad ---(1)$$

Where

$$C(u) = \begin{cases} 2^{-1/2} & for\ u=0 \\ 1 & otherwise \end{cases} \qquad (2)$$

Hence the 2 dimensional DCT will be computed by applying 1 dimensional transform separately to the row and to the column, therefore we can say that the 2D DCT is separable in the two dimensions.

Like in the one-dimensional DCT, each element S(u, v) of the transform will be the inner product of the input and a basis function, but in two dimensional DCT the basis functions are n X m matrices. These two-dimensional basis matrix will be the outer product of two different one-dimensional basis vectors. Each basis matrix can be considered as an image. The 64 basis images in the array are shown in following figure.

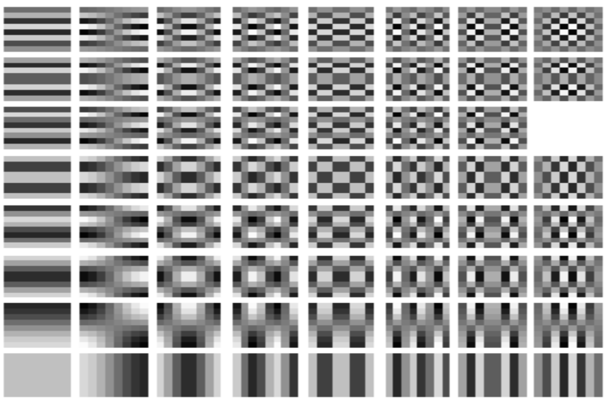

Fig 2: Discrete Cosine Transform

The 8 x 8 array of basis images for two-dimensional discrete cosine transform. Horizontal and a vertical spatial frequency is characterized in each matrices. These matrices are arranged left to right and bottom to top in the order of increasing frequencies.

There are multiple bands present in multispectral images so first we have to read band by band separately. After reading the first band divide that into 8X8 blocks, apply DCT to each and every block, after applying the DCT, apply masking to reduce the pixels then we will get compressed image. Apply same procedure to all bands.

The contribution made by different authors are presented to understand the research gap. A.M.Raid, W.M.Khedr, M. A. El-dosuky and Wesam Ahmed presented a survey paper on lossy image compression using Discrete Cosine Transform, quantization, entropy encoding. Jin Li, Fei Xing, Ting Sun, and Zheng You presented a research paper in which a compression algorithm based on distributed source coding (DSC) combined with image data compression (IDC) approach recommended by CCSDS for multispectral images. Arto Kaarna and Jussi Parkkinen presented three methods for the lossy compression of multispectral images are developed. It compares the properties of those methods by applying them to several multispectral images. Bhagya Raju, Dr. K. Jaya Sankar, Dr. C. D. Naidu and Srinivas Bachu presented a paper on improved SPIHT algorithm and fuzzy based SR image reconstruction. The method incorporated a new way to overcome the limitation that was prevalent with compression and transmission. The fuzzy based approach is more effective and proves to be likely applicable for multi spectral images. S. Boopathiraja, P. Kalavathi presents a near lossless compression method used for multispectral images. Three-Dimensional Discrete Wavelet Transform is used for decomposition and the Huffman coding followed by thresholding is used for encoding. The results of our proposed method for the multispectral LANDSAT images are discussed and compared with other existing methods in terms of PSNR and SSIM. R. Kavin Rajesh, C.Heltin Genitha discussed about compression techniques using DWT, SPIHT and Huffman coding and reconstruction of image by using Inverse operations. M. Klimesh presented two algorithms Karhunen–Loeve transform (KLT) in the spectral dimension, the discrete cosine transform (DCT) for spatial decorrelation of the resulting bands, and the DCT on the residual. H S Prasanrha and others discussed about Image compression using SVD for image compression. M J Raghavendra and others discussed about image compression using hybrid combinations of DCT and RLE.

The rest of the paper is organized as follows. Proposed Methodology are explained in section II. Experimental results are presented in section III. Concluding remarks are given in section IV.

II. PROPOSED ALGORITHM

A. Discrete Cosine Transform

Discrete cosine transform (DCT) is one of the most popular transforms in image processing. It is widely used for image compression because of its high energy packing capabilities. The spatial domain image is converted into frequency domain image using DCT. Image is represented as a sum of sinusoidal of varying magnitudes and frequencies. At high data compression ratio, DCT is capable of achieving higher quality. This property is termed as energy compaction. Lossy image compression uses discrete cosine transform for image compression.

For compression each spectral band is divided into 8x8 blocks and DCT is applied. After masking most of the values in the block becomes zero. Masking is done to remove the high

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frequency component in order to reduce the pixels and to save memory. For reconstruction unmasking and inverse DCT is applied.

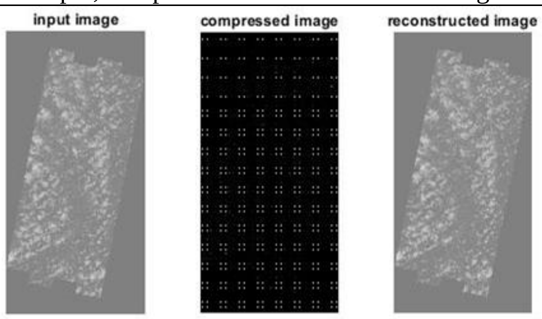
The different steps involved to compress the image are

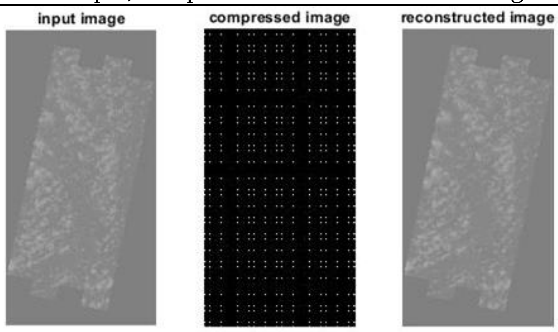
1. Read single band at a time for applying DCT.
2. Thresholding is a way of partitioning an image. It is a simple way. But here we are using it for removing the pixel of the image to compress the image.
3. After thresholding we will get compressed image.
4. Follow same steps for all the bands

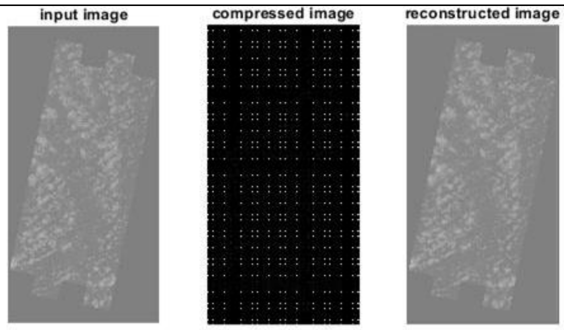
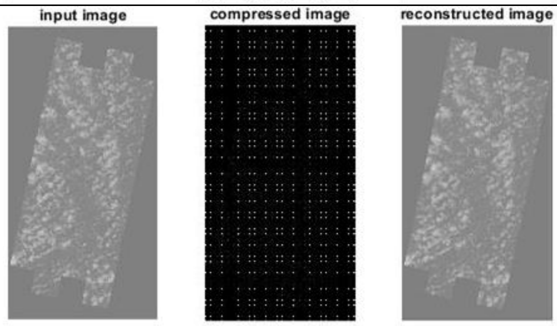
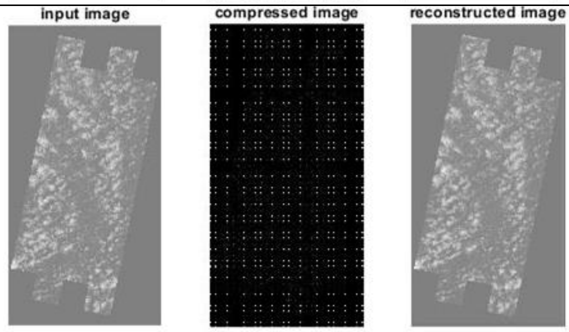
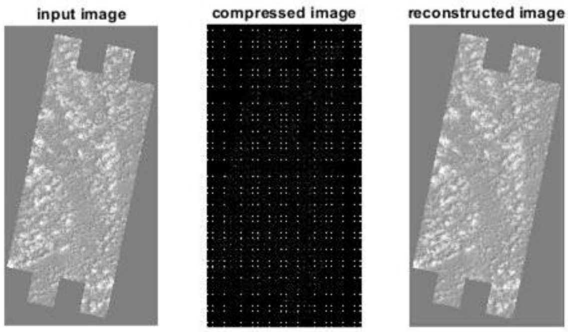
If we want to get the original image at the receiver we have to use invesre discrete wavelet transforn (IDWT).

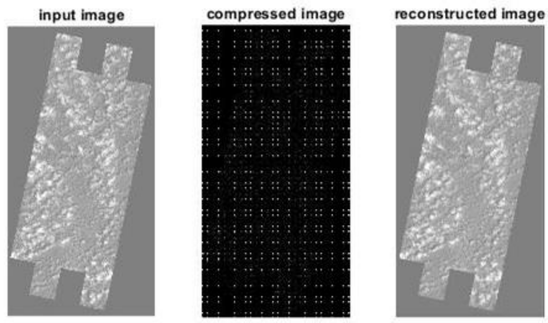
III. Experiment and Result

The test set for this evaluation experiment is performed on MATLAB 7.0 software platform and the PC for experiment is equipped with an Intel P4 2.4 GHz Personal laptop and 2GB memory. The input datasets are obtained from USGS website which publicly known test dataset. The obtained dataset is in the TIFF format and consists of 10 different bands. Band 1 has resolution-5251X10321 and size 103 Megabytes. The other bands have the resolution of 1751X3441 and size 11.5 Megabytes. DCT is applied for the given input for each band

Band	Input, compressed and reconstructed Image
1	

Band	Input, compressed and reconstructed Image
2	

3	
4	
5	
6	

7	

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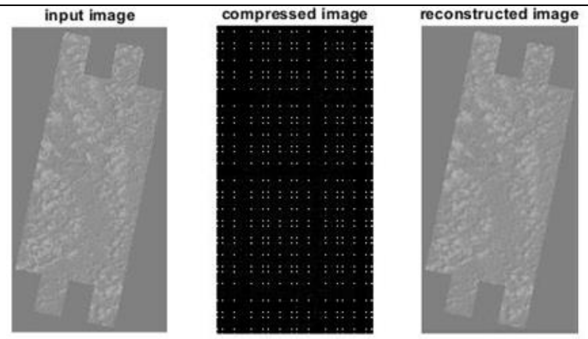
8	

The figure 3 shows the result obtained for the given multispectral image (band 1) by applying different wavelets. It is seen that the PSNR of 25 dB is maintained for all the cases which is reasonably good quality to maintain. Also the Table 1 shows the Compression ratio obtained for different composition levels for different wavelets for band 1. Compression ratio (CR) is defined as the ratio of output to the input in bytes and experiment is conducted for all 8 bands of the given input. The result is displayed for band 1 for detailed discussion

Table1: CR obtained for different decomposition level (band1)

BANDS	Compression Ratio	PSNR
Band1	87.4983	34.1299
Band2	87.4783	35.5121
Band3	87.4783	34.8367
Band4	87.4783	33.2574
Band5	87.4783	31.2872
Band6	87.4783	29.3735
Band7	87.4783	29.0737
Band8	87.4783	33.9684

IV. CONCLUSION

Multispectral image compression is implemented using both Discrete Wavelet Transform and Discrete Cosine Transform techniques and simulated using MATLAB software. Multispectral image is separated into various spectral bands and then the algorithm is applied. The techniques are applied for all bands of the multispectral image and reconstruction is obtained and the results are tabulated. Compression ratio and PSNR are also obtained for each band for better understanding.

Further it is possible to obtain compression for the entire multispectral image instead of individual bands. Also other techniques such as SVD, Hadamard transform, etc. can be tried for compression and obtain comparative study of the compression techniques.

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