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Title

A COMPARATIVE STUDY OF DIFFERENT WAVELET FUNCTION BASED IMAGE COMPRESSION TECHNIQUES FOR ARTIFICIAL AND NATURAL IMAGES

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Abstract:

This Paper analyses and compares different wavelet function based image compression techniques for artificial and natural images. This paper compares Daubenchies, Coieflet, Discrete Meyer wavelet for Artificial and Natural images. From the results, we observed that, Classifying images as Artificial and Natural and then applying compression techniques, affect the quality and compression ratio of images remarkably.

Keywords- Compression, Artificial and Natural Images, Daubenchies, Coiflet, Discreter meyer, Biorthogonal wavelet.

I. Introduction:

Aristotle has rightly said, "Thought is impossible without an image" and is vindicated by the large use of images in day to day life. Contemporary images contain large amount of information that requires much storage space, large transmission bandwidths and long transmission times therefore, it is advantageous to compress the image by storing only the essential information to reconstruct the image effectively and precisely. Since image comprises a matrix of pixel (or intensity) values therefore the compression of image could be possible by exploiting the redundancies identified in the areas where there is little or no change between pixel values. Therefore images having large areas of uniform colour will have large redundancies, and conversely images that have frequent and large changes in colour will be less redundant and harder to compress.[4]

Image compression is essential for applications such as transmission and storage of databases. Artificial and Natural images are inherently voluminous therefore, efficient data compression techniques are essential for their archival and transmission of data. In recent time, wavelet transform (WT) has emerged as a popular technique for image compression applications. The wavelet transform has high de-correlation and energy compaction efficiency. The blocking artifacts is absent in a wavelet-based coder due to their overlapping basis functions. The wavelet transform can be composed of any function that satisfies requirements of multi-resolution analysis. In wavelet-based image compression, the compression performance depends on the choice of wavelets, image content, thresholding and number of decompositions.[5] While the advancement of the computer storage technology continues at the rapid pace the means for reducing the storage requirement of Artificial and Natural image is still needed in most of the situations. Most of the researches are based on the compression techniques which do not contain the remedy for selection of appropriate wavelet for compression of Artificial and Natural images based on different factors. So it is necessary to analyze different wavelet functions to provide a good reference for application developers to choose a superior wavelet compression system for their application [1]

II. Discrete Wavelet Transform (DWT):

Wavelet analysis can be used to divide the information of an image into approximation and detail sub-signals. The approximation sub-signal shows the general trend of pixel values, and three detail sub-signals show the vertical, horizontal and diagonal details or changes in the image. If these details are comparatively insignificant then they can be set to zero without significantly changing the image quality. The value below which the details are considered to be small enough to be set to zero is known as the threshold. The greater the number of zeros the greater the compression that can be achieved. The amount of information retained by an image after compression and decompression is known as the energy retained and this is proportional to the sum of the squares of the pixel values. If the energy retained is 100% then the compression is known as lossless, as the image can be reconstructed in the original form. This occurs when the threshold value is set to zero, meaning that no detail been changed. If any value is changed then energy will be lost and this is known as lossy compression. Ideally, during compression the number of zeros and the energy retention will be as high as possible. However, as more zeros are obtained more energy is lost, so a balance between these two needs to be found.

Discrete wavelet transform (DWT) has emerged as popular technique for image compression. The wavelet function is localized in time domain as well as in frequency domain, and it is a function of variable parameters.[6] Wavelet Theory deals with both discrete and continuous cases but DWT is more efficient and has the advantage of extracting non overlapping information about the signal. In DWT, there exists very wide choice of wavelet functions. The choice of wavelet depends on contents and resolution of image. Here we are defining two category of images viz. Artificial and Natural Image Fig 1(a & b). Artificial image stands for images on which enhancement techniques have been applied e.g Wallpapers, cartoons whereas Natural image is an image on which no enhancement technique has been applied e.g image captured directly by camera, scanned images etc.[21]

	
Fig.1.a.Tabboo (Artificial Image)	**Fig.1. b. Field (Natural Image)**

Image compression is extremely important for efficient transmission and storage of these images. Demand for communication of these images through the telecommunication network and accessing them through Internet is growing explosively. With the use of digital cameras, requirements for storage, manipulation, and transfer of digital images have grown rapidly. These image files can be very large and can occupy a significant memory space. A gray scale image comprising 256 x 256 pixels requires 65, 536 elements to store, similarly a typical 640 x 480 color image requires nearly a million therefore, downloading of these files from internet can be very time consuming task. Image data comprise of a significant portion of the multimedia data and they occupy the major portion of the communication bandwidth for multimedia communication. It is therefore imperative to develop efficient techniques for image compression.

III. <u>Image Compression using different wavelet transforms:</u>

The lossy compression algorithms are proposed by different researchers for the natural images, which include low frequency component and few components of high frequency and higher derivatives. The compression is done in two steps where in the first step, the image is classified as Artificial and Natural image depending up on image content, while in second step, wavelet based image compression techniques are applied to the images. For detailed investigations Debaunchies (db1, db2, and db5), Coiflet, De-meyer & Biorthogonal wavelet on the test images are being studied.

a. **Debaunchies**: Named after Ingrid Daubechies, the Daubechies wavelets are a family of orthogonal wavelets defining a discrete wavelet transform and characterized by a maximal number of vanishing moments for some given support. With each wavelet type of this class, there is a scaling function (also called father wavelet) which generates an orthogonal multi-resolution analysis.

b. **Coiflets:** are discrete wavelets designed by Ingrid Daubechies, at the request of Ronald Coifman, to have scaling functions with vanishing moments. The wavelet is near symmetric, their wavelet functions have N / 3 vanishing moments and scaling functions N / 3 − 1, and has been used in many applications using Calderón-Zygmund Operators.

c. **Demeyer :** Starting from an explicit form of the Fourier transform $\hat{\phi}$ of ϕ, meyer computes the values of $\hat{\phi}$ on a regular grid, and then the values of ϕ are computed using instdfft, the inverse nonstandard discrete FFT.

IV. EXPERIMENTAL RESULT AND ANALYSIS:

Each wavelet family can be parameterized by N integer that determines filter order. Bi-orthogonal wavelets can use filters with similar or dissimilar orders for decomposition (Nd) and reconstruction (Nr). In our examples, different filter orders are used inside each wavelet family. The following sets of wavelets: DW- N with N= 1,2,5 CW-N with N=1,2,3,4, and BW-N with N=1,2,3 are being used. Daubechies Wavelet (DW) and Coiflet Wavelets (CW) are families of orthogonal wavelets that are compactly supported. Compactly supported wavelets correspond to finite-impulse response (FIR) filters and, thus, lead to efficient implementation. Only ideal filters with infinite duration can provide alias-free frequency split and perfect inter-band de-correlation of coefficients. Since time localization of the filter is very important in visual signal processing, hence arbitrarily long filters cannot be used. A major disadvantage of DW and CW is their asymmetry, which can cause artifacts at borders of the wavelet sub-bands. DW is asymmetrical while CW is almost symmetrical. Symmetry in wavelets can only be obtained by compromising either compact support or orthogonality of wavelet (except for HW, which is orthogonal, compactly supported, and symmetric). If both symmetry and compact support in wavelets is desired, the orthogonality condition and allow nonorthogonal wavelet functions are to be relaxed as appears in the family of bi-orthogonal wavelets that contains compactly supported and symmetric wavelet.

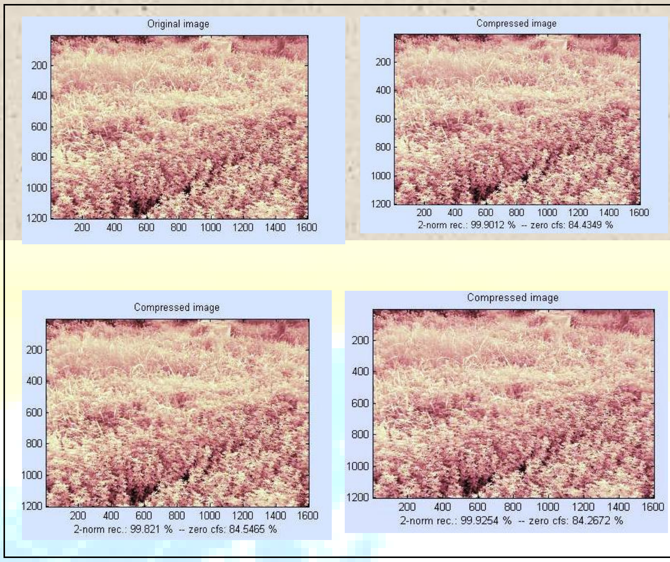

fig. 2. Original Field image and db1, db2, db5 compressed field image

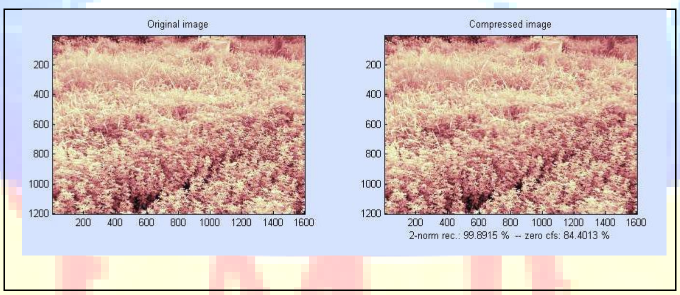

fig. 3. Original Field image and coiflet compressed field image

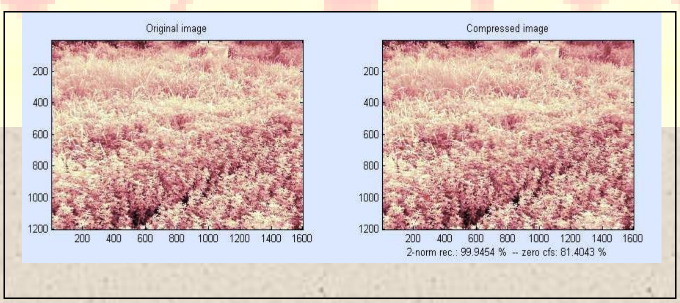

fig. 4. Original Field image and de-meyer compressed field image

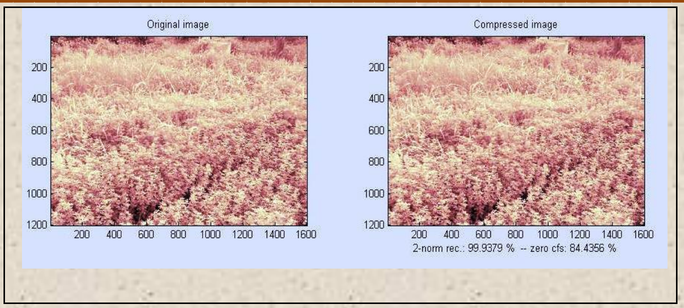

fig. 5. Original Field image and Bi-orthogonal compressed field image

Fig 6.Original Tabboo image and db1, db2,db5 compressed field image

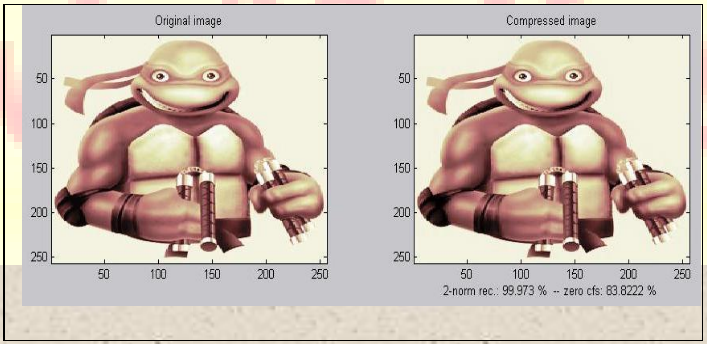

Fig 7.Original Tabboo image and coiflet compressed field image

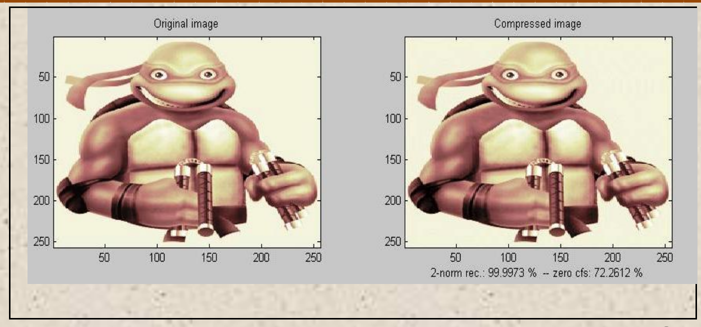

Fig 8.Original Tabboo image and de-meyer compressed field image

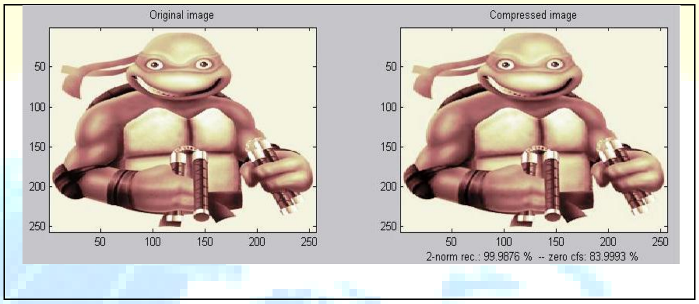

Fig 8.Original Tabboo image and Biorthogonal compressed field image

Table1. Compression ratio obtained for different Wavelet Functions

Wavelet Functions	Field Image	Tabboo Image
	Compression Ratio	
db1	84.43	83.99
db2	84.54	83.82
db5	84.26	83.29
Coiflet	84.40	83.82
De-meyer	81.40	72.36
Bi-orthogonal	84.40	83.99

IV. CONCLUSION:

In the present study, the test images are categorized into Natural and Artificial images on the basis of image content. Different wavelet based image compression techniques are applied to the test images. The results thus obtained show that, db2 provides best compression ratio (84.54 %) for field image while db1 and biorthogonal function provide superlative compression ratio (83.99 %) for Tabboo image. However, for both the images, the performance of De-meyer function is quiet less significant as compared to other wavelet functions used. Hence it can suggested that classification of image on the basis of image content and selection of mother wavelet can provide a better reference for application developers to choose a good wavelet compression system for relevant application.

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