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OPTIMAL IMAGE COMPRESSION TECHNIQUE BASED ON WAVELET TRANSFORMS

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ABSTRACT

This Paper proposes a novel method of classifying Artificial and natural images and investigates and compares numerous wavelet function based image compression techniques for artificial and natural images. This paper compares Haar, Daubenchies, Coieflet and Discrete Meyer wavelet for Artificial and Natural images. From the results, we can conclude that, categorizing images as Artificial and Natural and then applying wavelet based compression techniques, influence the quality and compression ratio of images extraordinarily.

Keywords: Compression, Artificial and Natural Images, Haar, Daubenchies, Coiflet, Discreter meyer.

INTRODUCTION

It is rightly said that, "An image is worth ten thousand words." But you need to know how to analyze the picture to gain any understanding of it at all. Present-day images include hefty information that necessitates much storage space, huge transmission bandwidths and extended transmission times therefore, it is beneficial to compress the image by storing only the indispensable information to reconstruct the image effectively and precisely.[4]

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 crucial to develop competent techniques for image compression.

Here we are defining two category of images viz. Artificial and Natural Image Fig 1(a & b). Artificial image stands for Computer generated images 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. Artificial and Natural images are intrinsically capacious, therefore efficient data compression techniques are essential for their archival and transmission of data.

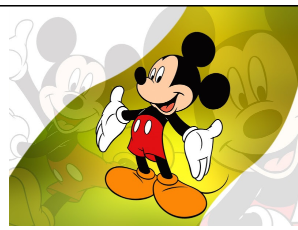

Fig.1.a. (Artificial Image)

Fig.1. b. (Natural Image)

NOVEL CLASSIFICATOR

The rationale of an image classification system is to separate images into different classes. An ideal system should be able to discern various images with no hesitation just like an human being. Unfortunately, sometimes the categorization task is hard and indistinct even for a human. This makes the problem even more challenging.

In this paper, a novel classifier is developed. The two classes involved in the classification are Natural and Artificial images. Given an image, the classifier extracts and investigates some of the most relevant features of the image and combines them in order to generate an opinion. The manually labelled images dataset has been created downloading random images from the internet. The images have been selected with the aim of having a rich and considerable dataset and it has been tried to avoid redundant data. Images compressed with a lossy method such as JPEG have some of their features transformed. Because of this modification of the pictures, performances of some of the classifiers differ from the ideal case and thus, the error rate is higher in compressed images.

For example, images are usually compressed and resized in the web environment. Due to the interpolation used in the resizing process, the number of unique colours could greatly increase. So the performance of the feature using the number of colours would degrade significantly.

When we think of the main differences between photographs and graphics, we can see that something very simple comes into our mind: graphics are typically generated using a limited number of colours and usually containing only a few areas of uniform colours. Moreover, highly saturated colours are more likely to be used. Sharp edges also are typical feature characterizing Artificial images that can be used by an image classifier. It is possible to easily spot these characteristics in maps charts, logos and cartoons. On the other hand, very often a photograph depicts real life objects and subjects. These have usually textures, smooth angles and larger variety of colours but less saturated pixels. Because of the way a photograph is acquired and the way a camera works, natural pictures also results in being more noisy.

For a human being, distinguishing between a photograph and a graphic image is almost always an easy task. It is often just matter of a glance. Unfortunately it is not for a computer. Noisiness, sharpness of the edges and saturation must be derived from the raw data available. These features must be then combined together in order to build a solid classifier since if used individually, they can lead to poor or even wrong results.
Summarized steps in order to classify an image are

Step 1: Extract different features that give an individual classification.
The different features considered are

a. Entropy
b. Colour
c. Spatial Distance
d. Gray Histogram
e. Saturation average
f. Highly saturated pixels

Step 2: Combine them together using a classification method in order to boost the performance of the single classifier.

Step 3: Compare the output and assign the image to a category.

Fig. 2 shows the steps involved in Classification

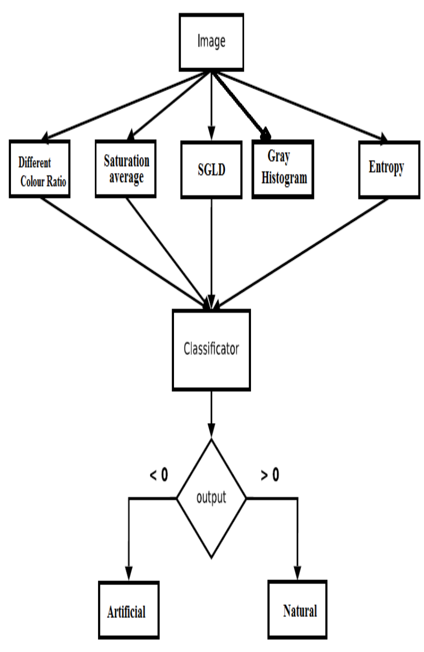

Fig.2: Novel Classificator

This Classificator provides efficient results with error rate as low as 10%.

DISCRETE WAVELET TRANSFORM (DWT)

In recent time, wavelet transform (WT) has emerged as a popular method for image compression applications. While the advancement of the computer storage technology continues at the rapid speed, the means for reducing the storage requirement of Artificial and Natural image is still needed in most of the situations. Most of the investigations 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]

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.

IMAGE COMPRESSION USING DIFFERENT WAVELET TRANSFORMS

The lossy compression algorithms are proposed by different investigators for the Natural and Artificial images, which include low frequency component and few components of high frequency and higher derivatives. The compression is done in two steps. In the first step, the image is classified as Artificial or Natural depending up on image content while in second step, wavelet based image compression techniques are applied to the images. For detailed investigations *Haar, Debaunchies (db1, db2, and db5), Coiflet and De-meyer* wavelet functions are applied and analyzed on three hundred test images.

a. **Haar & 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.

INVESTIGATIONAL RESULTS AND ANALYSIS

a. Classification Stage

Each single parameter for classification described here, has been tested and tweaked changing thresholds and input parameters so that its accuracy is as high as possible. Then the aggregate classifier was tested in order to evaluate the global performance of the system on the data set. Some base classifiers have been implemented and tweaked for the maximum individual accuracy. Single features are combined together using different algorithms with different performances. A common dataset of 300 manually labeled natural/Artificial images has been used as test set. This set has been lately resized to perform the same tests on resized images. In the best case, the performances achieved are on par or slightly better than previous works. The proposed classificatory provides the error rate of as low as 10%.

b. Compression stage

In Compression stage, each wavelet family can be parameterized by N integer that determines filter order. Wavelet functions 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 non-orthogonal wavelet functions are to be relaxed as appears in the family of Daubenchies wavelets that contains compactly supported and symmetric wavelet.

CONCLUSION

In the present study, three hundred test images are categorized into Natural and Artificial images using Novel Classificatory. Aforesaid wavelet function based image compression techniques were applied to the test images. The results thus obtained show that, db2 provides best compression ratio (87.54 %) for Natural images while db1 (Haar Wavelet) function provide superlative compression ratio (88.29 %) for Artificial images. However, for both the images, the performance of De-meyer function is quiet less significant as compared to other wavelet functions used.

Table1. Compression ratio obtained for different Wavelet Functions

Wavelet Functions	Natural images	Artificial images
	Avg. Compression Ratio for 300 images	
db1(Haar)	86.43	88.29
db2	87.54	82.82
db5	83.23	83.22
Coiflet	83.40	83.82
De-meyer	82.40	73.36

Hence it can be concluded that, the classification of image on the basis of image content as Artificial & Natural 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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