Effective Preserving and Sharing a Nation's Cultural Heritage Information Using Data Compression

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Abstract—*Preserving nations cultural heritage helps to generate a unique identity, civic pride and foster a sense of empowerment in the nation. Cultural heritage refers to any artifacts, cultural relics, history, monuments, customs, traditions found in a nation. In this digital age, effective storing, safeguarding and sharing of this voluminous cultural heritage information is a challenge and a responsibility to the nation's citizens. In this paper we propose a method for effective storage and transmission of the voluminous data. The images are first compressed using a wavelet filter based compression algorithm. The compressed data can then be encrypted if security is desired during transmission. Experimental results demonstrate that the proposed algorithm produces reconstructed data of better quality in comparison to the jpeg compression. Our algorithm achieves a compression ratio of 60-90 and a PSNR of 30- 45 db***.**

Keywords: - compression; encryption; transmission; sub band; wavelets; quantizer.

I. Introduction

The culture of a nation revolves around the way of life of the people of the nation. The different languages spoken, dances, religions, music, architectures, food, traditions and customs followed differ from place to place within the country. Sometimes the monuments, relics, traditions preserved for generations are so valuable that the information on them should be stored effectively at all costs, due to their significance or uniqueness.

John Ruskin, a writer and an art critic, stated that nothing from the present should disturb the remnants of the past. His book titled "The Seven Lamps of Architecture" (first published in 1849), discusses the qualities, authenticity and values of historic buildings and structures. Ruskin in his book also stresses to [p. 196] count the stones of a heritage monument as if you are counting the jewels on a crown.

A historic structure, an archeological site, a historic landscape, an art object have the potential to represent a particular period or periods in history. For this an enthusiastic has to acknowledge that fact and browse through the stored volumes of information.

Preserving the cultural heritage of a nation since inception up to present will help our generations yet unborn in understanding the rich cultural, social, political and educational values their country possessed. The National museum is one place where monuments, sketches, carvings, artifacts are being preserved in a physical form. Very often photography too is not allowed in these museums. Thus understanding and sharing the cultural heritage information is a problem. While storing and transmitting the cultural heritage related information, every effort must be made to maintain the character, integrity and authenticity of the information.

We live in an age of information and in this digital age, the effective storage and secure transmission of nation's heritage information is a significant challenge and a great responsibility to its citizens. We have a large amount of data, which is prone to the risk of being lost, due to the fleeting nature of data, software and hardware. Data compression helps to effectively store the large volumes of image data and data encryption helps to make sure the confidential heritage data is transmitted securely across a digital network.

Data compression refers to encoding information using fewer bits than an unencoded representation, thus reducing the physical capacity required on storage systems as stated in Wikipedia definition [1]. In turn if data can be effectively compressed, significant improvements of data throughput can be achieved.

As elaborated by [5], Image compression can be lossless or lossy. Lossless compression is preferred for archival purposes and often for medical imaging, technical drawings, and clip art. Lossy compression methods, when used at low bit rates, produce a significant amount of compression, however introduces compression artefacts. According to the online Wikipedia source of information; Lossy methods are especially suitable for natural images such as photographs in applications where a small loss of fidelity is acceptable to achieve a substantial reduction in bit rate.

A. Benefits of Compression:

It provides a potential cost saving associated with sending less data over the network.

It reduces storage requirements and also overall execution time.

It also reduces the probability of transmission errors since fewer bits are transferred.

It provides a level of security against illicit monitoring.

II. Wavelet Transforms

According to [4], the wavelet transform is based on the concept of sub band coding. In sub band coding, the image is analyzed to produce the components containing frequencies in well-defined bands called sub bands. Subsequently, quantization and coding is applied to each of the bands as explained by [3].The quality of a compression method is usually measured using Peak signal-to-noise ratio.

The jpeg 2000 compression standard too uses the discrete wavelet transform (DWT) for the decomposition and reconstruction of images along with an efficient encoder. Lawson and Zhu [6] stated that, the use of wavelets implies the use of sub band coding in which the image is iteratively decomposed into high and low frequency bands.

This allows us to perform different signal processing tasks and use different quantization strategies on each sub band.

As surveyed online by vision systems, it is seen that today wavelet compression is gaining popularity in digital video and image processing as a result of its implementation in low-cost silicon integrated circuits (ICs) and the wide availability of software development tools. It is observed that wavelet compression offers greater symmetry, more scalability, higher precision, more error tolerance, and higher compression ratios than current image-compression methods.

III. Performance Measures

Knowing the quality of a reconstructed image is an important task after a compression process. Some of the commonly used measures as explained in [7] are:

A. PSNR (Peak signal to Noise Ratio)

PSNR is used to measure the quality of reconstruction of compressed data. It is measured in logarithmic decibel scale and is defined using the mean squared error (MSE). Higher the PSNR value, better the reconstruction.

Given a noise free (original) m*n monochrome image I and its noisy (compressed) approximation K,

$MSE = 1/mn \sum \sum [I(i,j) - K(i,j)]^2$

$PSNR = 10 * Log_{10} (MAX_I^2 / MSE)$

Where MAX_I is the maximum possible pixel value of the image.

B. Data Compression Ratio

Data Compression ratio is used to quantify the reduction in data representation size produced by a data compression algorithm. It is the ratio between the uncompressed size and the compressed size.

Compression ratio = Uncompressed file size/ Compressed file size

C. Space Savings

Defined as the reduction in size relative to the uncompressed size.

Space savings = 1 – Compressed file size/ Uncompressed file size

IV. Proposed Methodology Algorithms

The proposed algorithms use wavelet transform and an error metric for compressing an image.

A. Algorithm : Compression and Encryption of images depicting cultural heritage data (WCP)

Inputs : Original image
Output : Compressed and encrypted image

1. Load image.
2. Compute wavelet transform of image.
3. Partition wavelet transformed coefficients into sub bands.
4. For each sub band, apply error metric and find rate and distortion for each quantizer.
5. Find the bit allocation that minimizes image distortion.
6. Pass the compressed data through an encryption function.
7. Write compressed and encrypted data to output file.

B. Algorithm : De-compression of image data

Inputs : Compressed and encrypted image,
compression ratio
Output : Original image

1. Pass the encrypted data through a decryption algorithm.
2. Read image and compression ratio.
3. Carry out a wavelet transform.
4. For each sub band, apply a quantizer and the error metric.
5. Read, decode and dequantize coefficients for each sub band.
6. Invert transform.
7. Save the reconstructed image.

V. Implementation

The algorithms were implemented using Microsoft Visual Studio 2008 and C++ on a Pentium IV, 2 GHz machine. 25 images were used. The resolution of images varied. For Jpeg compression we used the encoders that come with Adobe Photoshop version 7.0 and ACDSee for windows and for comparison we looked at compression ratios from 4:1 to 9:1. PSNR was then calculated using Matlab 7.0 to evaluate the quality of the test images.

VI. Experimental Results & Analysis

On implementation of the wavelet based compression algorithm (wcp) and the jpeg compression, the following observations were being made:

The file sizes before and after the compression process (for 2 test images) at a 90% compression percentage are as shown in Table 1 .

Table 1. File size at 90 % compression

Sr. No.	Original name & filesize	Wcp compressed filesize	De compressed filesize	Jpeg file size
1	Ledwig(265 kb)	27 kb	265 kb	16 kb
2	pic (5.18 mb)	5.18 kb	5.19 mb	4.48 kb

Figure 3 below shows 2 sample test images used in our tests, compressed with the wavelet based compression algorithm (wcp) and Jpeg compression at a compression ratio of 9:1.

Fig. 1 (a):

Fig. 1 (b):

Fig. 1 (c):

Fig. 1 (d):

Fig. 1 (e):

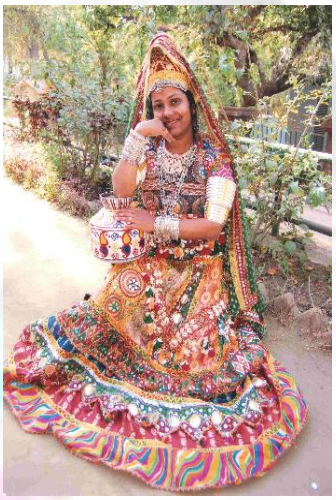

Fig. 1 (f):

Figure 3. Comparison of visual image quality for the test image ledwig.bmp and pic.bmp at a compression ratio of 9:1. (a) & (d) Original image (b) & (e) wcp compressed image (c) & (f) Jpeg compressed image

The performance of the proposed algorithm is evaluated using the following metrics: PSNR (peak signal to noise ratio), compression ratio and Saving space. The results are as shown in table 2 below.

TABLE 2. Comparison of the WCP and JPEG compression algorithms

Sr. No.	Image name	Compression %	PSNR(WCP)	PSNR(JPEG)	Compression ratio (WCP)	Saving space (WCP)	Compression ratio (JPEG)	Saving space(JPEG)
1	Ledwig.bmp	90	40.12 db	32.37 db	9:1	90 %	16:1	94 %
2	pic.bmp	90	35.18db	30.41 db	9:1	90 %	11:1	92 %

It is thus seen that images compressed - decompressed using the proposed wavelet based compression algorithm (WCP) produces images of better visual quality and a higher PSNR (Peak signal to noise ratio) than the jpeg compression algorithm at the same compression percentage. A few artifacts could be seen in the jpeg compressed images at a compression ratio of 9:1. Jpeg compression produced a better compression ratio and higher saving space; however it results in a lower PSNR value

VII. CONCLUSION

In this paper we have proposed a methodology using image compression and encryption for the effective storing and transmission of voluminous data (images). This methodology uses a wavelet transform, an error metric and an encryption algorithm. We tested its performance on various images and also compared the results with the jpeg compression format. PSNR was used to test the quality of the reconstructed images. Our comparison showed that the

proposed algorithm (WCP) is more robust and produces images of a better quality than Jpeg compression for the same compression percentage. It was seen that the proposed wavelet based compression algorithm gives better results according to both visual quality and the peak signal to noise ratio (PSNR).

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