SATELLITE IMAGE COMPRESSION ALGORITHM BASED ON THE FFT

Khaled Sahnoun and Noureddine Benabadji

University of Sciences and Technology of Oran- Algeria, department of physics
Laboratory of Analysis and Application of Radiation

ABSTRACT

Image compression is minimizing the size in bytes of a graphics file without degrading the quality of the image to an unacceptable level ,the reduction in file size allows more images to be stored in a given amount of disk or memory space, it also reduces the time required for images to be sent over the ground This paper presents a new coding scheme for satellite images. In this study we apply the fast Fourier transform and the scalar quantization for standard LENA image and satellite image, The results obtained after the (SQ) phase are encoded using entropy encoding, after decompression, the results show that it is possible to achieve higher compression ratios, more than 78%, the results are discussed in the paper.

KEYWORDS

Encoding Entropy, Fast Fourier transform, Compression, SQ.

1. INTRODUCTION

Satellites image compression is used to minimize the amount of memory needed to represent this image [1], satellites images often require a large number of bits to represent them, and if the image needs to be transmitted to the ground or stored, it is impractical to do so without somehow reducing the number of bits for this data [2][3]. In this study we have developed a technique of satellites image compression based on the FFT “Fourier transform” and SQ “scalar quantization” to compression and decompression Satellites image, with satisfactory quality of the reconstructed image.

2. FFT

The Fourier transform (FFT), also known as frequency analysis or spectral involved in the implementation of many digital techniques for processing signals and images [4] It is found in applications such as direct harmonic analysis of musical signals and vibrations, but also reduces the rate coding of speech and music, compression, and digital transmissions Applying a Fourier transform give a complex image [5], we calculated the module Fm and the phase Fp of the original image, and we represent the module. These 02 images can be defined as following:

$$Re\big(F(f)(x,y)\big) = Fm(x,y)\cos\big(Fp(x.y)\big) \rightarrow (1)$$

$$Im\big(F(f)(x,y)\big) = Fm(x,y)\sin\big(Fp(x.y)\big) \rightarrow (2)$$

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Where Im, Re denotes the imaginary and real parts, one then finds that Fp is not unique in general, to represent the transform, it is only the module

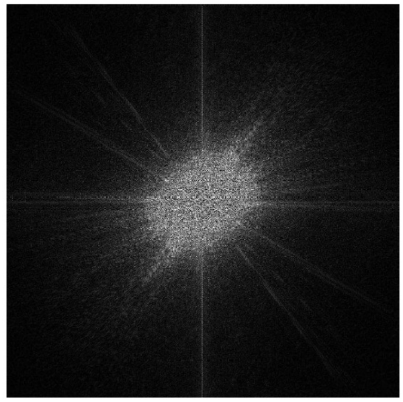

Figure 1. Module blue channel butterfly

The image is square, we completed the butterfly image with black to make it square. In addition, we work more frequently with square image [6]

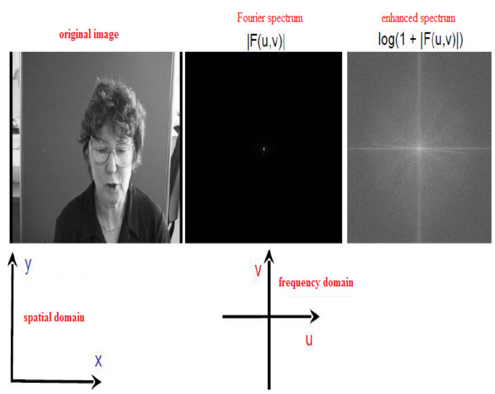

Figure 2. Fourier Transform (FFT).

The FFT of a real image can be expressed as follows

$$F(u,v) = \frac{1}{mn}\sum_{x=0}^{m-1}\sum_{y=0}^{n-1} f(x,y).\, e^{-2\pi i\left(\frac{ux}{m}+\frac{vy}{n}\right)}$$

With u, v = 0..N-1 → (3)

Reverse:

$$f(x,y) = \sum_{u=0}^{m-1}\sum_{v=0}^{m-1} F(u,v).\, e^{2\pi i\left(\frac{ux}{m}+\frac{vy}{n}\right)}$$

With x, u = 0..N-1→ (4)

The variables u, v used in the equation (3) are variable frequency x, y used in the equation (4) are variable in the spatial domain, F(u,v) Is often represented by its amplitude and phase, the formula is given by:

$$amplitude\left(F(u,v)\right) = \sqrt{R^2(u,v) + I^2(u,v)} \rightarrow (5)$$
$$phase\left(F(u,v)\right) = \tan^{-1}\left[\frac{I(u,v)}{R(u,v)}\right] \rightarrow (6)$$

3. PROPOSED APPROACH

The main philosophies of our image compression technique based on the fast Fourier transform (FFT). The general scheme of the algorithm relied on the steps shown in the following figure

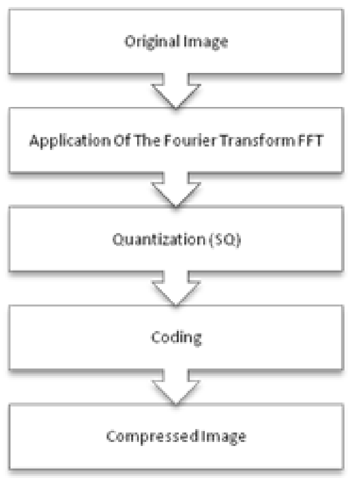

Figure 3. The steps of the proposed algorithm

3.1. Read the image source

The input image is satellite picture, the size will be equal to 2^n, in our case it is 2^8

3.2. Calculate the FFT

The data returned by the FFT is complex which contains real and imaginary parts, in this method only the amplitude is concerned, which is the only party represented in the displays of the results.

3.3. Quantization

The compression by quantization can be improved either by acting on the step of constructing the dictionary or by acting on the quantization step of the input pixels. In this method, an improvement of the second step has been proposed. The SQ of each is the approximate value of the signal x(t) by a value that belongs to a set of codes {y1, y2, ..., yl}, at any amplitude x in the interval [xi-1, xi], there corresponds a quantized value yi situated in that Interval [8]

3.4. Coding

The image coding by R.L.E algorithm coded the sequence of identical gray pixel values, assigning the three parameters the position (x, y) of the first pixel in the sequence and the gray value of the first pixel, the length of the sequence. The Huffman algorithm is applied finally which is a compression algorithm capable of generating variable length codes to a whole number of bits, this algorithm can achieve good results, but it should be kept the codebook used between the compression/decompression algorithm [9]

4. EXPERIMENTAL RESULTS

4.1. Evaluation of compression

Compression ratio (T%):

$$Q = \frac{\text{initial size}}{\text{final size}} \rightarrow (7)$$

$$T = \frac{1}{Q} \rightarrow (8)$$

Compression gain:

$$G = \frac{\text{initial size} - \text{final size}}{\text{final size}} \rightarrow (9)$$

Mean Squared Error:

$$\text{MSE} = \frac{1}{N}\sum_{i=0}^{N-1}(ncomp(i) - n(i))^2 \rightarrow (10)$$

Peak Signal to Noise Ratio PSNR

$$PSNR = 10 \log_{10}\frac{255^2}{MSE}\, db \rightarrow (11)$$

A powerful algorithm has a gain of maximum compression (T) and a minimum mean square error [7] ,the compression ratio and MSE error, PSNR are calculated by equations (8), (6) and (11). The proposed algorithm has been tested by Lena picture and satellite image.

Figure 4. Original satellite image (1)

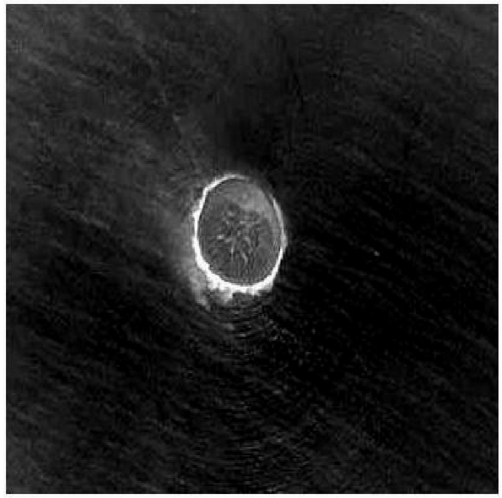

Figure 5. Satellite image reconstructed (2)

Figure 6. Original Lena image

Figure 7. Reconstructed Lena image

Figure 8. Original satellite image (2)

Figure 9. Satellite image reconstructed (2)

Table 1. Table of results with Lena and satellite image.

Image	Lena	Satellite (1)	Satellite (1)
MSE	11.67	9.92	8.87
PSNR (db)	37.49	38.20	33.79
T (%)	65.52	87.27	76..3

5. CONCLUSIONS

In this paper we have presented an algorithm for satellite image compression based on the Fourier transform (FFT) and the scalar quantization (SQ), the compression/decompression algorithm that we have presented in this study is able to compress image with high quality compression and better quality, tests on Lena imagei show the superiority of this algorithm.

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