Color Image Watermarking Application for ERTU Cloud

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Abstract

Color image is one of the Egyptian Radio and Television Union (ERTU)'s content should be saved from any abuse from outside or inside the organization alike. The application of saving color image deploys the watermarking techniques based on Discrete Wavelet Transform (DWT). This application is implemented by software that suits the ERTU's cloud besides many tests to insure the originality of the photo and if there is any changes applied on. All that provides the essential objectives of the cloud to overcome the limitation of distance as well as provide reliable and trusted services to Authorized group.

Keywords: Cloud Computing, DWT, ERTU, Watermarking.

1. INTRODUCTION

Saving the contents of any cloud using watermarking demands high robustness against any attack. Maintaining these demands requires a good algorithm that can face the problems or attacks besides do the essential purpose which is saving it from any abuse. There is a contribution to protect contents by watermarks using Arabian letters where it has multipoint. From this advantage, it can be embedded 2 Byte instead of one Byte and there is no increase in the payload of the signal and it still maintains its imperceptibility [1]. The Digital Right Management (DRM) is one of aspect that studies how to control the cloud and the contents contained in. one of this contained type is multimedia where encryption, watermarking and distributing through wireless channel like mobile or through internet connection is important issue that many studies are deployed. Applying the management for this multimedia is discussed in [2]. Proposing a watermarking algorithm to embed the watermark into the original image by using complete complementary code method is introduced in [3]. A novel color hardcopy watermarking embedding is described. The proposed color embedding provides high transparency by modulating the watermark into the value and saturation color components of the document. After the color document is printed and distributed, the message is decoded by scanning the document and applying the proposed post processing based on a Laplacian of Gaussian whitening filter [4]. An improved and more robust digital image watermarking algorithm based on traditional W-SVD algorithm is proposed. It is presented a novel HVS-based watermarking scheme. Firstly, to increase robustness of the scheme, the watermark is refined by a watermark strength regulation factor. Then a secret message is scrambled using Arnold transform and modified into a watermark template. Finally, the watermark template will be embedded in the low-frequency coefficients of the host image, after a 2-level DWT handling [5]. This paper is organized as follow: Defining the parameters and algorithm used in section 2. The numerical results are presented in section 3. Finally, in section 4, the conclusion of results is summarized.

2. FORMULATIONS OF PROBLEM

Watermarking image need to be measured and determined the qualities to decide how much it is effective. In the following, various metrics will be defined and explained to understand why it has been used in evaluation and the factors that must be considered.

The normal distribution is measure for probability of the data containing through the image and the distribution of it. It can be described as:

$$\mathbf{f(x)} = \frac{\mathbf{1}}{\boldsymbol{\sigma}\sqrt{\mathbf{2\pi}}}\mathbf{e}^{-\frac{(\mathbf{x}-\boldsymbol{\mu})^2}{\mathbf{2}\boldsymbol{\sigma}^2}} \tag{1}$$

The parameter μ in this formula is the mean or expectation of the distribution. The parameter σ is its standard deviation; its variance is therefore σ^2. A random variable with a Gaussian distribution is said to be normally distributed and is called a normal deviation.

Spectrogram is a graph which indicates the frequencies of image versus time. It is used to get visual indication and comparison between the original and processed image. Distribution of the signal gives the distribution of the signal's amplitude and it becomes a good comparison tool between processed and original image. Histograms show the distribution of data values across a data range. It may be divided to many categories:

a) Cartesian coordinates: shows the distribution of the elements in Y as a histogram with equally spaced bins between the minimum and maximum values in Y.

b) Matrix input argument: when Y is a matrix, histogram creates a set of bins for each column, displaying each set in a separate color.

c) Specifying number of bins: interpret their second argument in one of two ways as the locations on the axis or the number of bins. When the second argument is a vector x, it specifies the locations on the axis and distributes the elements in length(x) bins.

d) Using data cursors: when the data cursor tool is used on a histogram plot, it customizes the data tips it displays in an appropriate way. Instead of providing x, y, and z-coordinates, the data tips display the following information: number of observations falling into the selected bin, the x value of the bin's center and the lower and upper x values for the bin

Scatter plots (also called scatter diagrams) are used to investigate the possible relationship between two variables that both relate to the same "event". A straight line of best fit (using the least squares method) is often included. The Scatter diagram helps to identify the existence of a measurable relationship between two items by measuring them in pairs and plotting them on a graph. Things to look for:

a) If the points cluster in a band running from lower left to upper right, there is a positive correlation (if x increases, y increases).

b) If the points cluster in a band from upper left to lower right, there is a negative correlation (if x increases, y decreases).

c) Imagine drawing a straight line or curve through the data so that it "fits" as well as possible. The more the points cluster closely around the imaginary line of best fit, the stronger the relationship that exists between the two variables.

d) If it's hard to see where the draw a line, and if the points show no significant clustering, there is probably no correlation.

The DWT is performed using multilevel filter banks. The one level of decomposition can mathematically be expressed as follows [6]:

$$\mathbf{y_{high}(k) = \sum_n x(k)g(2k - n)} \tag{2}$$

$$\mathbf{y_{low}(k)} = \sum_n x(k)h(2k - n) \tag{3}$$

Where y_{high} (k) and y_{low} (k) are the outputs of the high pass a low pass filters, respectively, after subsampling by two. For images, the DWT is performed row by row and then, column by column. The image after wavelet decomposition is divided into four bands; a low frequency band LL, and three high frequency bands LH, HL and HH. Peak Signal to Noise Ratio (PSNR) is the measure for estimate of the quality of reconstructed image with the original one. It is go to by computing, the error between cover image with size $(N_1 \text{ x } N_2)$ pixel and watermarked image. Therefore, Means Square Error (MSE) is obtained Firstly then gets Root MSE (RMSE) and PSNR in (dB) is given by [7-8]:

$$\boldsymbol{PSNR = 20 \ \log_{10} \frac{\text{max pixel}}{\sqrt{\frac{1}{N_1 N_2 \sum_i \sum_j (h(i,j) - h'(i,j))^2}}}} \tag{4}$$

Where $h(i,j) \text{ and } h'(i,j)$ are the intensity of the $(i,j)^{th}$ pixel before and after watermarking respectively. Correlation coefficient is used for similarity measurement. It give an indication that how the original and watermarked image are identical. There is of course threshold to decide the presence the watermark absence [7- 9]. It can be calculated as:

$$\mathbf{C = \frac{\sum_{r=1}^{H} \sum_{c=1}^{W} \left(I_1(r,c) - \bar{I}_1\right)\left(I_2(r,c) - \bar{I}_2\right)}{\sqrt{\left[\sum_{r=1}^{H} \sum_{c=1}^{W} \left(I_1(r,c) - \bar{I}_1\right)^2\right]\left[\sum_{r=1}^{H} \sum_{c=1}^{W} \left(I_2(r,c) - \bar{I}_2\right)^2\right]}}} \tag{5}$$

Where $I_1(r,c)$is the value of the pixel at the point (r, c) in the original image. $I_2(r,c)$is the value of pixel at (r,c) in the encrypted image, $\bar{I}_1$ is the mean of the original image and $\bar{I}_2$ is the mean of the encrypted image that is calculated as follows:

$$\boldsymbol{\bar{I} = \frac{1}{W*H} \sum_{r=1}^{H} \sum_{c=1}^{W} I(r,c)} \tag{6}$$

Similarity is a measure to detect the presence of watermark in the image. It calculates the intensity of the pixel for original and extracted watermark. If the image has not been watermarked, then it can be modeled as zero mean random variable if there is a slight different, then this image has been watermarked. So this metric give an indication for presence or absence of water mark, the degree of similarity give a picture for the amount of information that has been added besides the presence of attacks if any. It is at also considered as a measure for the robustness of the watermark against attack [9]. The layout of watermarking process is introduced in Fig. 1 and Fig. 2 shows the GUI of the software package.

3. NUMERICAL RESULTS

In this work, the targeted image is transformed using wavelet decomposition and the watermark image is inserted in the image. The watermark image is added to the original image by a factor. Then the reconstructed process is performed to get the original image containing the watermark image. The original images besides watermark used in this work are displayed in Fig. 3.

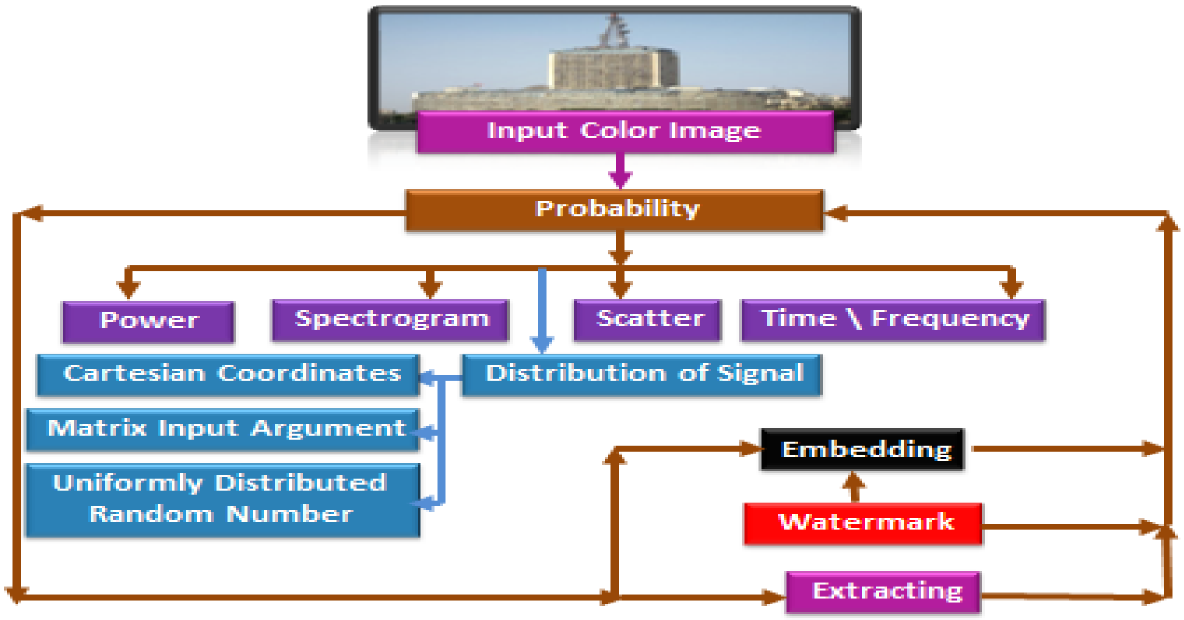


FIGURE 1: The Layout of Processing of the Watermarking.

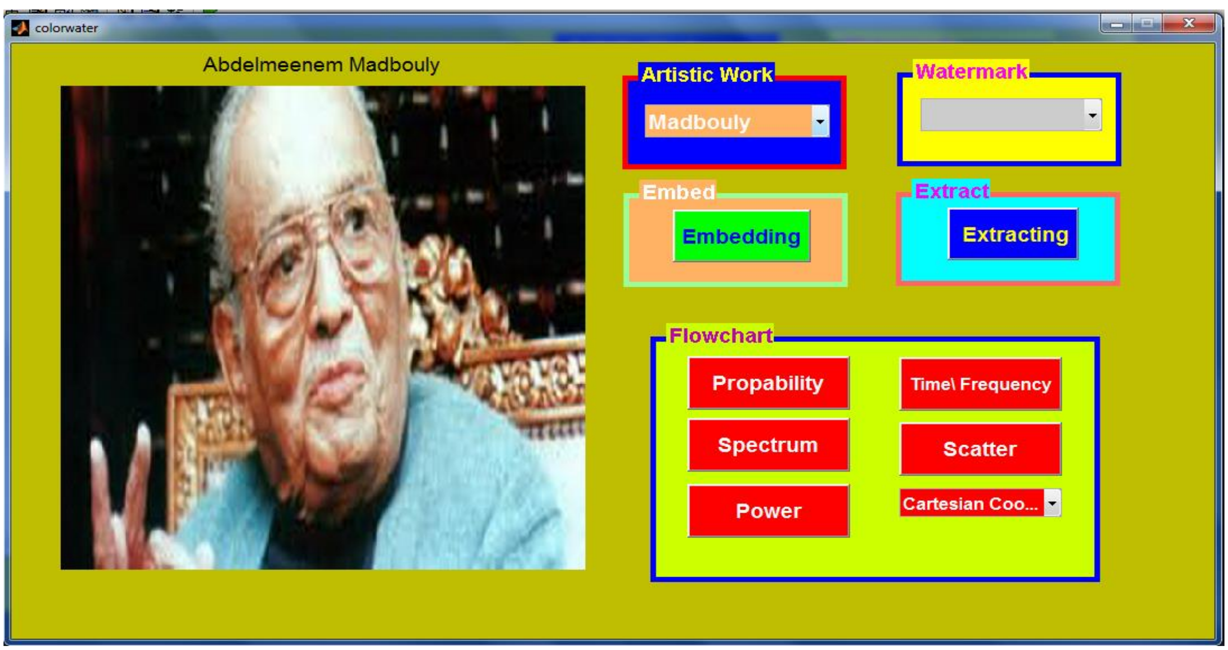


FIGURE 2: GUI for Color Image Watermarking Package for ERTU Cloud.

3.1. Embedding Process

In embedding process, a watermarking image is inserted into the content. Then, the new image is reconstructed to be like the original one containing the watermarking image. In Fig. 4, the original and watermarked images are showed where it is similar to the original. The normal distribution that displayed in Fig. 5 indicates the invisible change in watermarked image than original. Fig. 6 shows the spectrogram of each. The power of each image is monitored in Fig. 7 where it has almost unchanged in lower frequency and a small change in higher frequency. In Fig. 8 display the distribution of the images. It indicates a change in small value of data and almost no change in high value of the image. Fig. 9 represents the data contained in original and watermarked in time and frequency domain where it shows how much it is similar. From all above, this technique can suite the cloud for color image and save the content without any remarkable change in processed image. The scattering between the original and the watermarked is represented in Fig. 10 where it gives an indication how the correlation between them is high.

(a) (b)

FIGURE 3: (a) The original image used (Madbouly) and (b) Watermark image.

(a) (b)

FIGURE 4: The original image (a) before watermarking and (b) after watermarking.

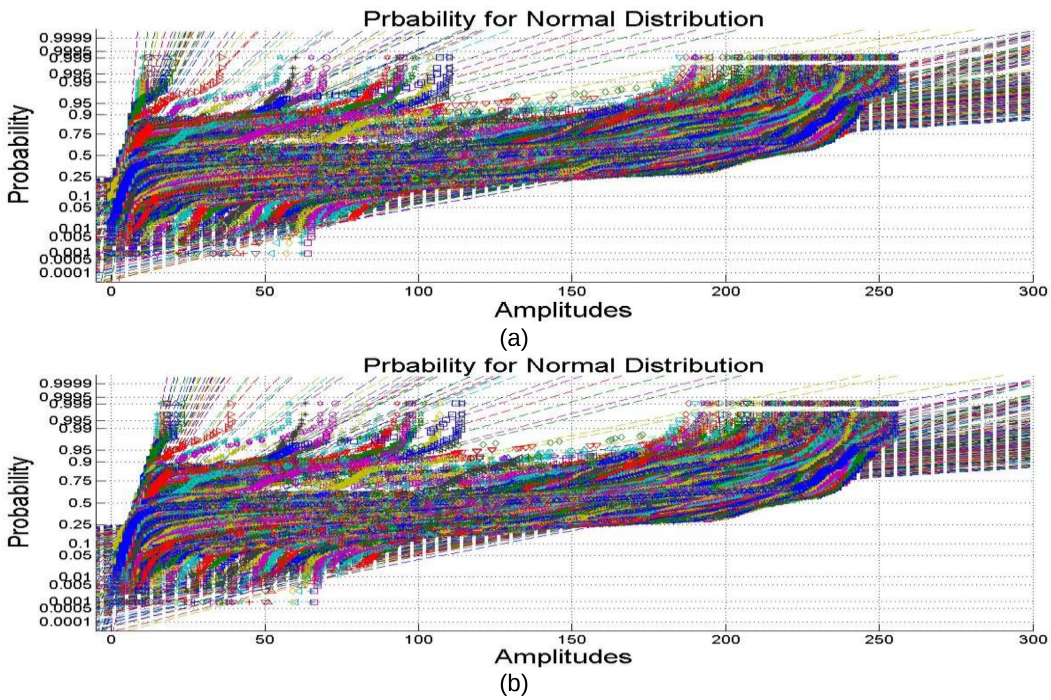


FIGURE 5: The normal distribution of the original image (a) before watermarking and (b) after watermarking.

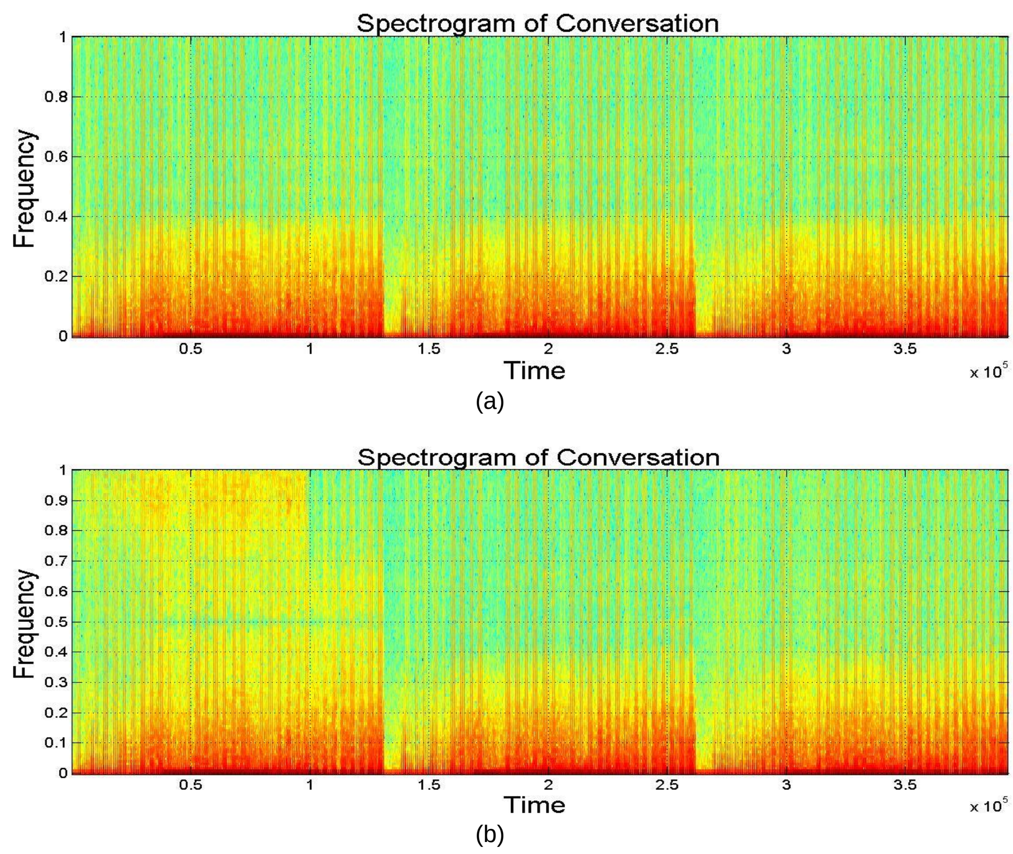
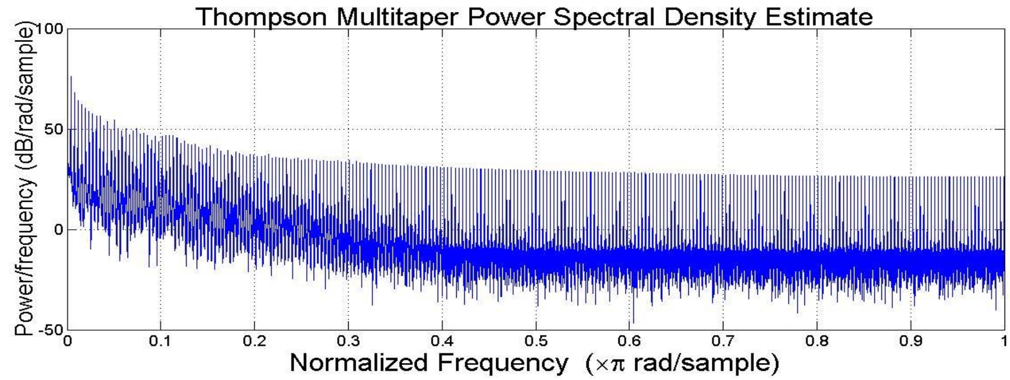
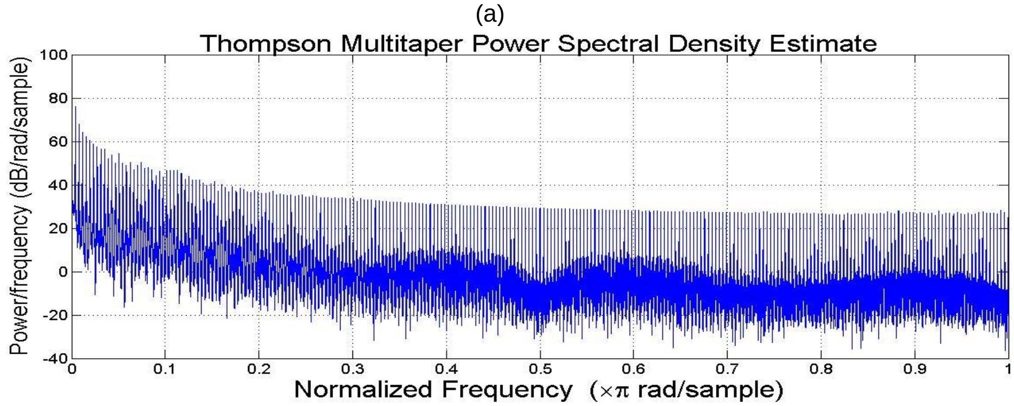


FIGURE 6: The spectrogram of the original image (a) before watermarking and (b) after watermarking.

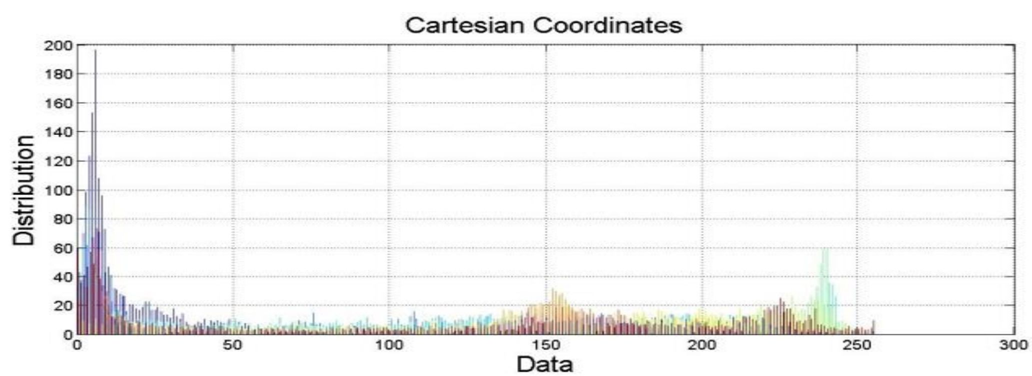


(a)

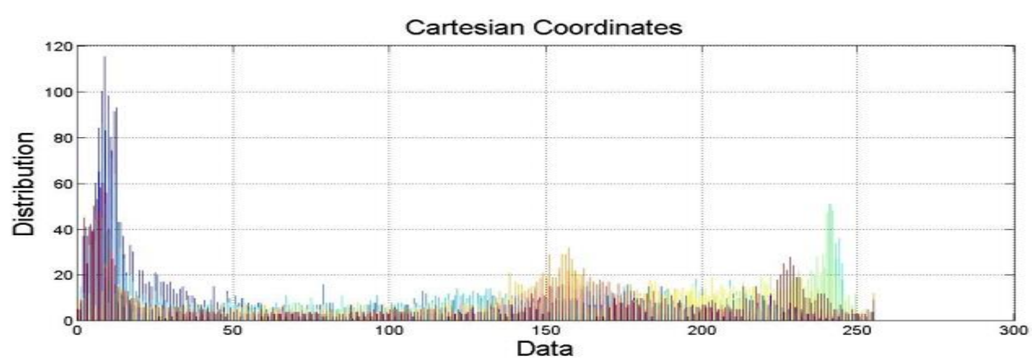


(b)

FIGURE 7: The power of the original image (a) before watermarking and (b) after watermarking.



(a)



(b)

FIGURE 8: The distribution of the original image (a) before watermarking and (b) after watermarking.

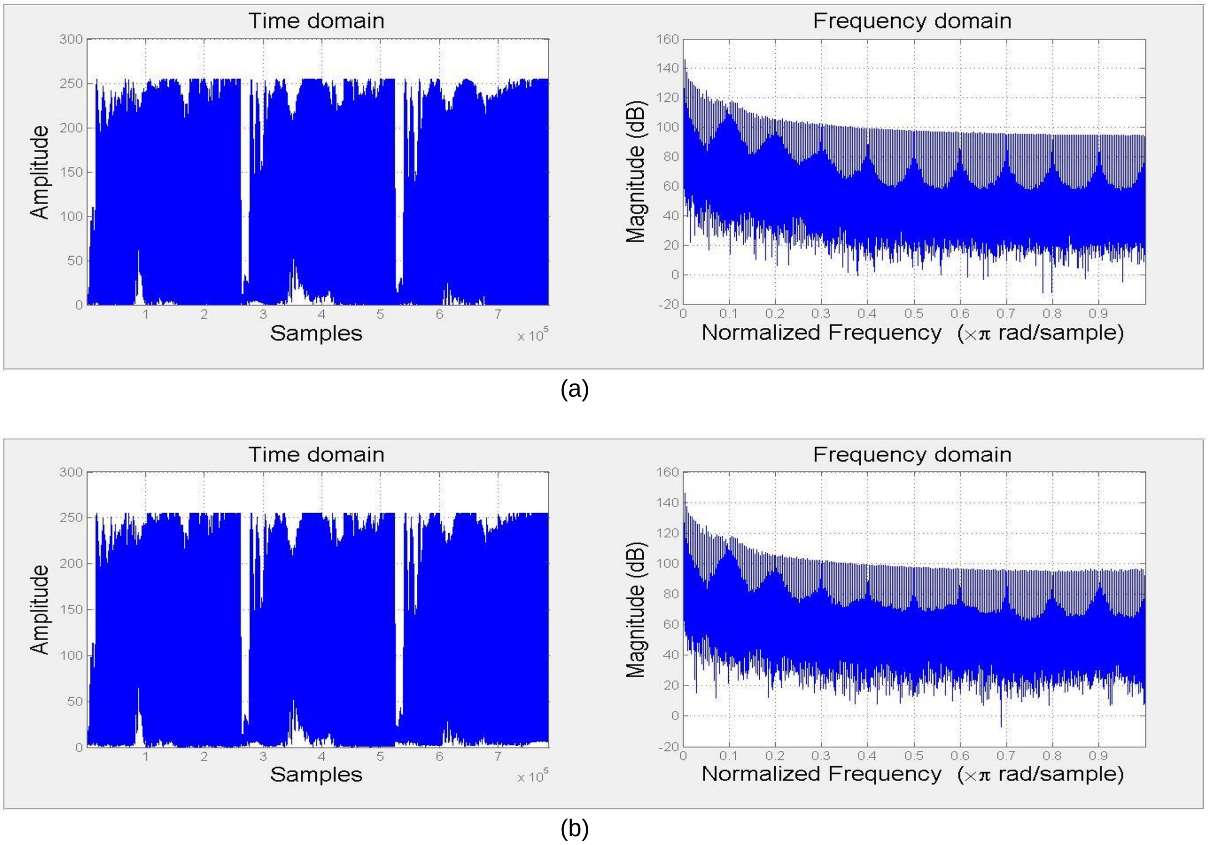


FIGURE 9: The Time/Frequency domain of the original image (a) before watermarking and (b) after watermarking.

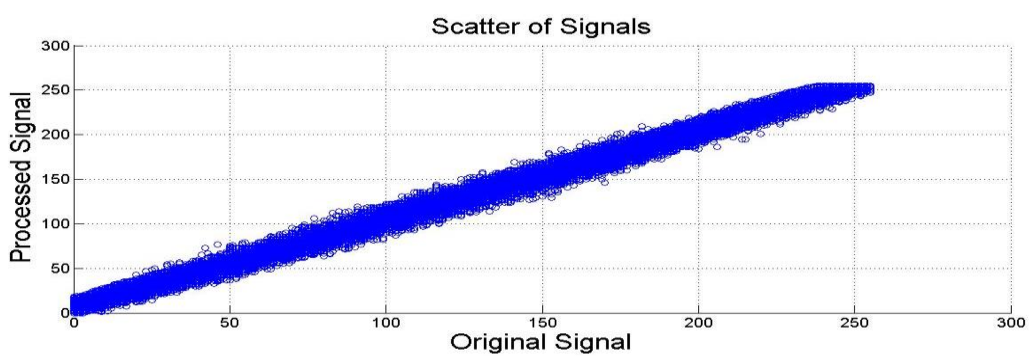


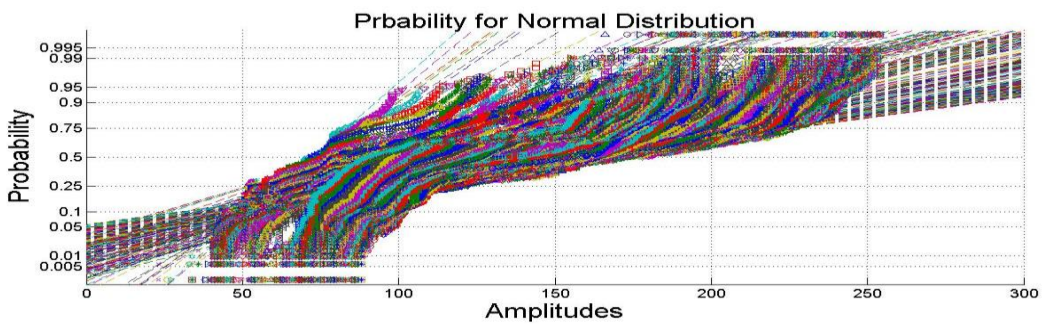
FIGURE 10: The scattering between the original image and watermarked image.

3.2. Extracting Process

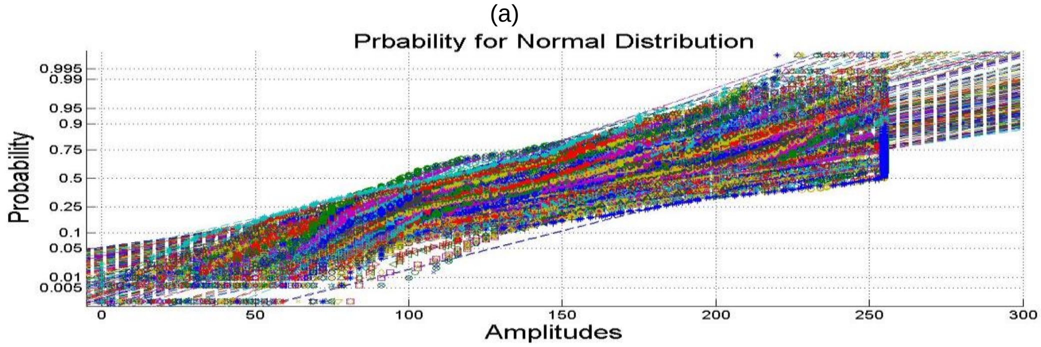
In this case, the inserted image is extracted and the resulted is compared with the original to determine the best algorithm that suit the cloud and give high performance. In Fig. 11, the original and extracted watermark images are showed where extracted has distinguishable change from the original but still can be recognized. The normal distribution, which displayed in Fig. 12, indicates the change in watermarked image than original and it is visible change especially in medium amplitudes. Fig. 13 shows the spectrogram of each which indicates the relation between the image amplitude and the frequency and how much it is close to the original. The power of each image is monitored in Fig. 14 where a small change but visible occur in low and medium frequencies and big change happen in high frequencies. In Fig. 15 display the distribution of the images where it almost has the same value and a remarkable change in high value from the original. Fig. 16 represents the data contained in original and watermarked in time and frequency domain where it shows the similarity between both. The scattering between the original and the extracted is represented in Fig. 17 where it gives an indication how the correlation between them is high.

(a) (b)

FIGURE 11. The watermark image (a) original and (b) extracted.

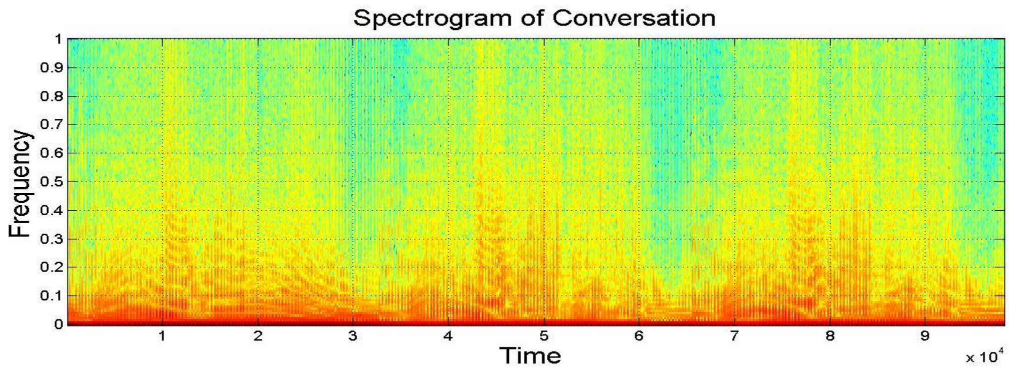


(a)

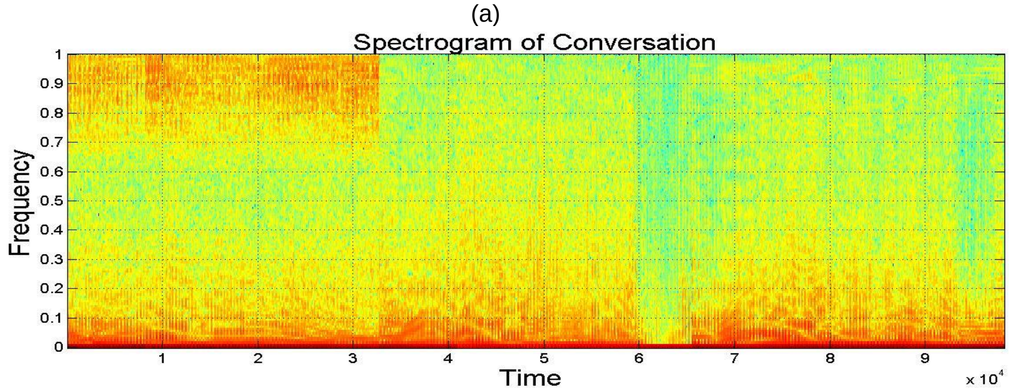


(b)

FIGURE 12. The normal distribution of the watermark image (a) original and (b) extracted.

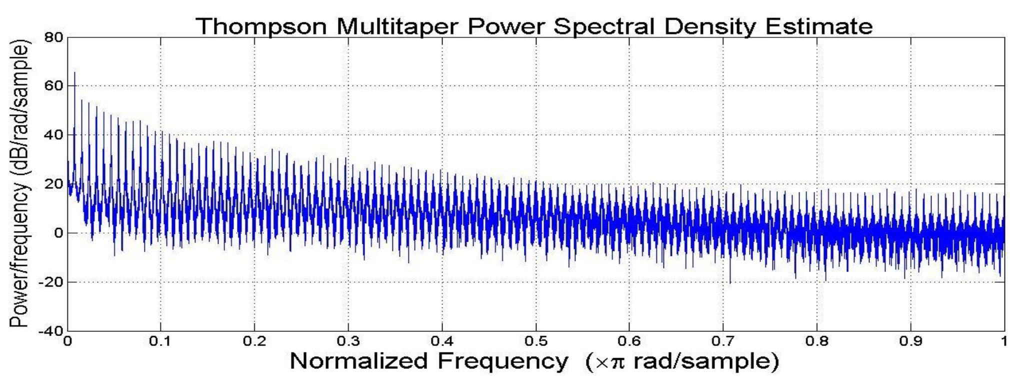


(a)

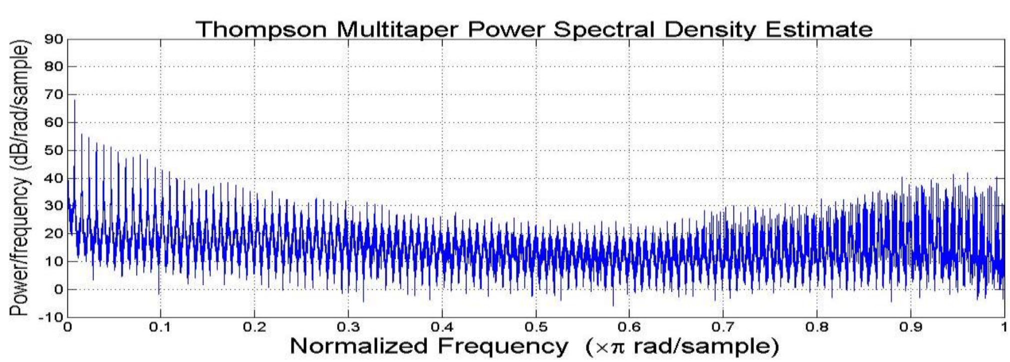


(b)

FIGURE 13. The spectrogram of the watermark image (a) original and (b) extracted.

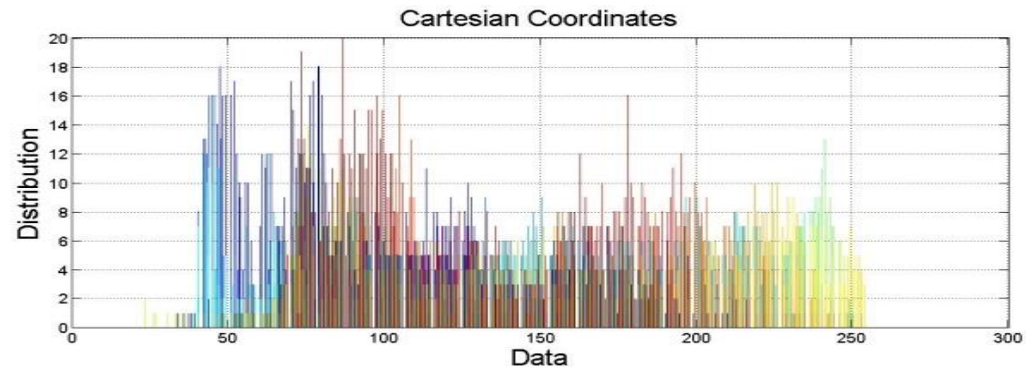


(a)

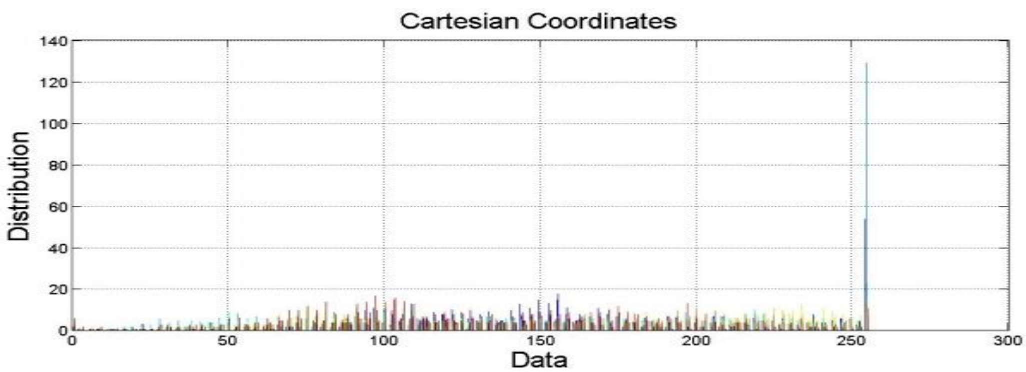


(b)

FIGURE 14. The power of the watermark image (a) original and (b) extracted.

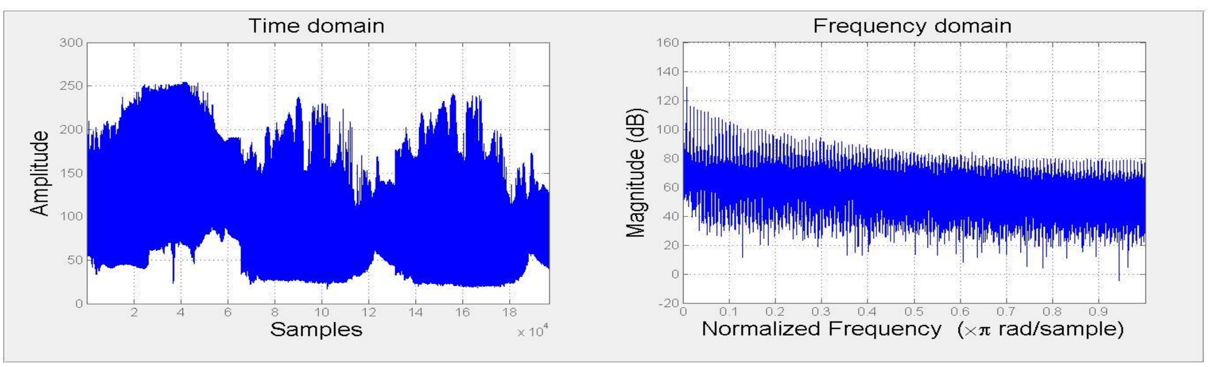


(a)

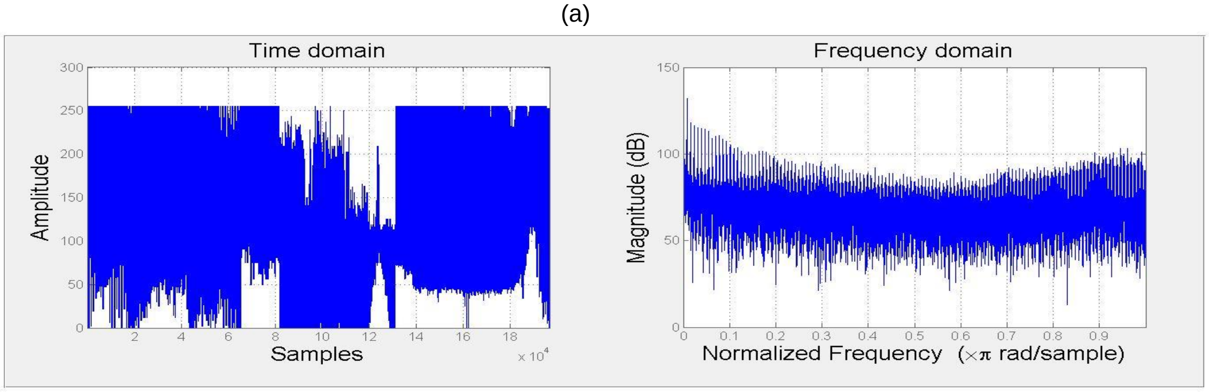


(b)

FIGURE 15. The distribution of the watermark image (a) original and (b) extracted.



(a)



(b)

FIGURE 16. The Time/Frequency domain of the watermark image (a) original and (b) extracted.

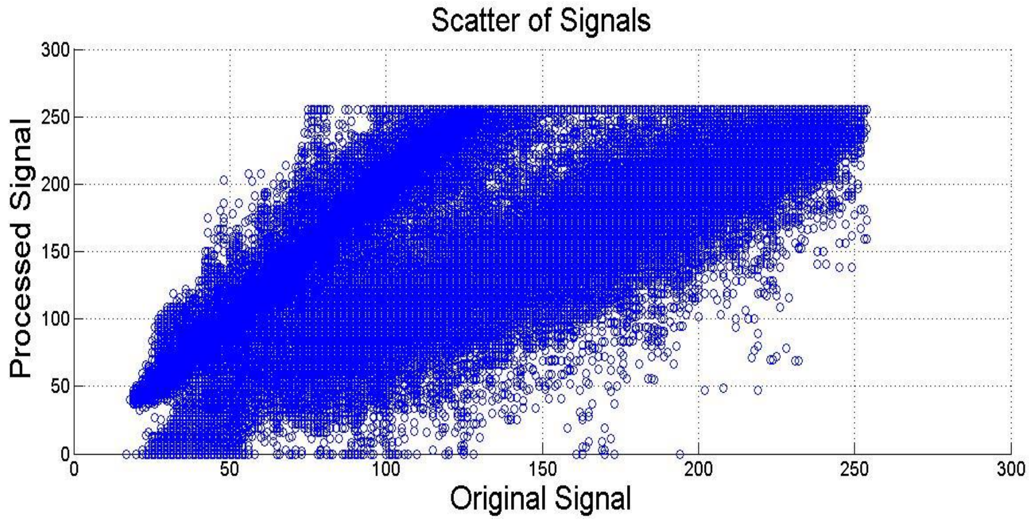


FIGURE 17. The scattering between the original watermark image and extracted image.

4. CONCLUSION

This technique provide a good solution for watermarking a color image and has good performance in embedding process but it has some drawback in extracting process where it has a remarkable change but it still can be distinguishable. This solution can maintain the security required for ERTU cloud and then protect the entire content of the cloud. It is used for insure the privacy of the content in the cloud. It is also can maintain the requirement for any department of according to its function and the policies of the cloud.

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