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New Techniques of Watermark Images using Bit Plane Slicing and Cubic-spline Interpolation

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Abstract

A watermark is a pattern or image defined in a paper that seems as different shades of light/darkness when viewed by the transmitted light which used for improving the robustness and security. There are many ways to work Watermark, including the addition of an image or text to the original image, but in this paper was proposed another type of watermark is add curves, line or forms have been drawn by interpolation, which produces watermark difficult to falsify and manipulate it. Our work suggests new techniques of watermark images which is embedding Cubic-spline interpolation inside the image using Bit Plane Slicing. The Peak to Signal Noise Ratio (PSNR) and Mean Square Error (MSE) value is calculated so that the quality of the original image before and after the data embedding is evaluated.

Keywords: Watermark, Cubic-spline Interpolation (CSI), Bit Plane Slicing (BPS), Mean Square Error (MSE) and Peak Signal to Noise Ratio (PSNR).

1. Introduction

Grayscale of a digital image is an image in which the color information for each pixel is a monochrome signal. This type of image is usually colored by grayscale in varying degrees between black at the weakest color and white color for the strongest color tones. It consists of 8 bits or 255 levels, any type of data can be embedded in one of these bits which makes the composite image look the same as the original image but may actually include a hidden image or a hidden message, one of the embedding methods is called "watermark" [1].In general, the watermark is only a shadow of a picture with a slight change in darkness/lightness of the image. In this paper, we have been proposed a new method of creating the watermark. Rather than create the watermark in traditional methods which insert image or text inside an image, the watermark does create from Cubic-spline curve that is embedded inside the image using Bit Plane Slicing. The goal of a watermark is to achieve the legitimacy, reliability, integrity of data and ownership marks, control determinants, content protection.

2. Related work

With the development of watermark techniques, the means of attacking have evolved to try to delete them or modify them to achieve the illegitimate copies. There are numbers of studies about Ramchandra Dare [2]. proposed method, first decomposing an original image into wavelet coefficients, then, embedding watermark through the algorithm. Mayukh Das [3]. Presented an effective method to embed text using bit plane and inside Grayscale images. Prajanto Wahyu Adi [4]. Presented a new approach to improve CRT watermark by using interpolated wavelet coefficient for determining the appropriate location to embed on the host image.

3. Watermark

Watermark is a new field of security whose task is to verify the relativity of digital information spread across different means of information transmission. It protects the static digital image or moving images from theft or hacking. It gives the legitimate owner of the files estimated to verify that these files are legitimate copies or have been changed without authorization from their owner [5]. Watermark technology hides an image inside the original image to protect it from manipulation and losing data. Grayscale of a digital image consists of 8 bits per pixel, let's call it "Pi", some of these bits remain unchanged (call unch) while the remaining bits (Pi-nuch = ch) that are used to embed the watermark as shown in **Figure 1.** [6].

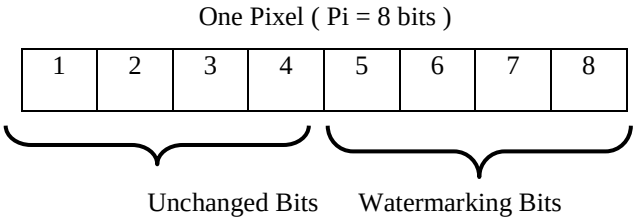


Figure 1. Bit Information of a pixel for Watermarking**.**

4. Cubic-spline Interpolation

The objective of cubic spline interpolation is to obtain an interpolation formula that is continuous in both the first and second derivatives, both within the intervals and at the interpolating nodes [7]. The simplest form of spline interpolation is a linear interpolation. The curved form is a straight line connecting the boundaries of the partial areas, i.e. the focal points, which constitutes a broken curve. But most studies, especially physical ones, require certain properties in the curve, such as being smooth satin, in other words requiring continuity and the ability to derive. To derive a mathematical model of a cubic spline, suppose the data are $\{(x_i , f_i)\}_i^n = 0$,where, as for linear splines [8]. From the (n) point can be defined curve. The greater the number of points, the more accurate the representation of the curve [9]**.**

$$a = x_0 < x_1 < \ldots < x_n = b , \quad h \equiv max_i|x_i - x_{i-1}|.$$

A cubic spline $s_{3,n}(x)$ is a C^2 piecewise cubic polynomial. This means that:

- $S_{3,n(x)}$ is piecewise cubic; that is, between consecutive knots x_i ,

$$s_{3,n}(x) = \begin{cases} p_1(x) = a_1 + b_1x + c_1x^2 + d_1x^3, & x \in [x_0, x_1], \\ p_2(x) = a_2 + b_2x + c_2x^2 + d_2x^3, & x \in [x_1, x_2], \\ \vdots & \\ p_n(x) = a_n + b_nx + c_nx^2 + d_nx^3, & x \in [x_{n-1}, x_n]; \end{cases}$$

- $s_{3,n}(x)$ is a C^2; that is, $s_{3,n}(x)$ is continuous and has continuous first and second derivatives everywhere in the interval [a,b], in particular, at the knots.

5. Bit Plane Slicing

Digitally, an image is represented in terms of pixels. These pixels can be expressed in bits. The grayscale image contains an eight-bit binary value; hence an image can be sliced up into 8-bit planes which give a sequence of binary images. In **Figure 2.** we can see that a grayscale image "man" is considered as a combination of eight bit-planes where each bit-plane can be represented by a binary matrix. Plane 1 contains the lowest order bit of all the pixels in the image, while plane 8 contains the highest order bit of all the pixels in the image [10].

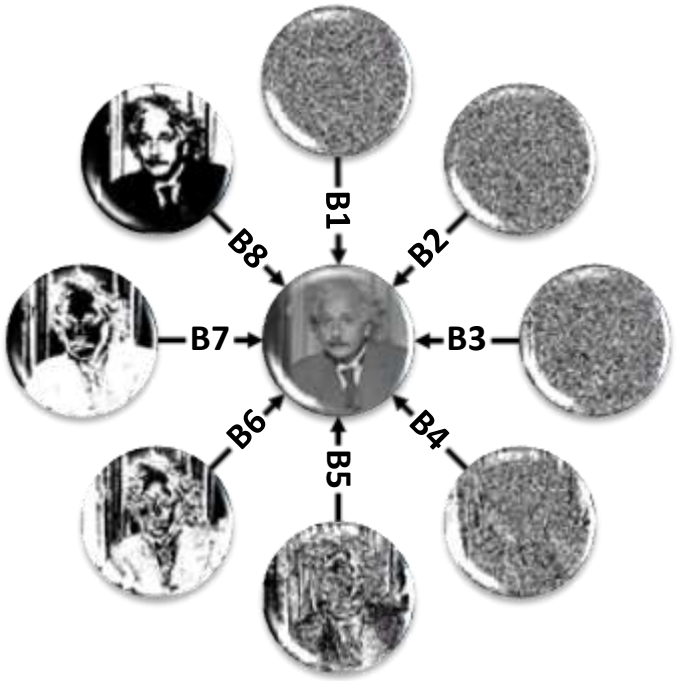


Figure 2. BPS of a grayscale image "man".

6. Mean Square Error and Peak Signal to Noise Ratio

MES is the measurement of mean square error between both cover and stego image. Its value should be minimization while PSNR used for measure the quality of stego image. Its value should be high. Both of them are standard measurement used in steganography technique for the sake of test the quality of the stego images. MSE is computed as follows: [11,12]

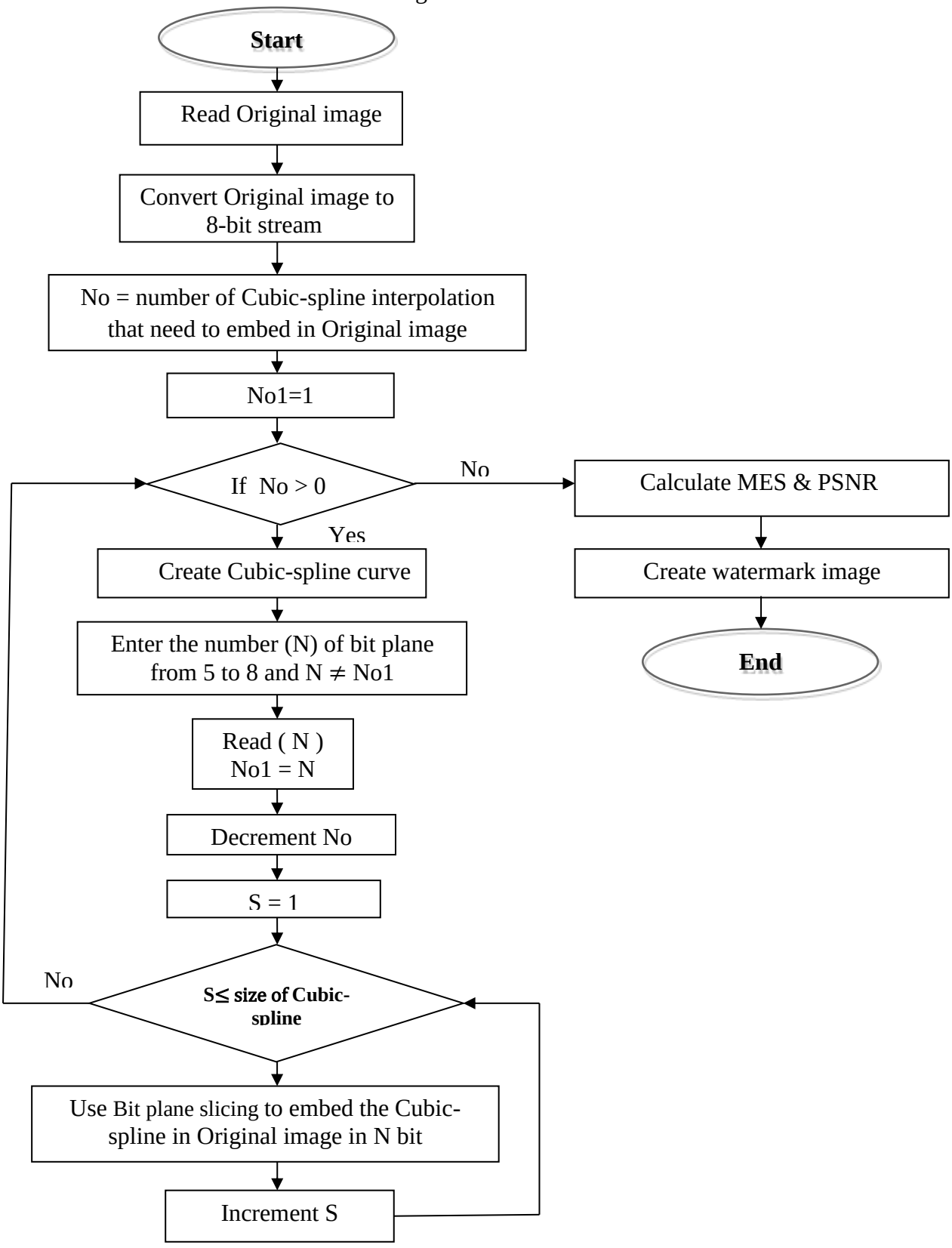
$$\text{MSE} = \frac{1}{nm}\sum_{i=o}^{n-1}\sum_{j=0}^{m-1}[X(i,j) - Y(i,j)]^2 \quad (1)$$

Image X which is n×m monochrome with noisy approximation Y.

$$\text{Where: PSNR} = 10\log_{10}\frac{255^2}{\text{MES}} \quad (2)$$

7. Proposed Method

The proposed work is making watermark by using BPS and one types of Interpolation called Cubic-spline. In this work, we first determine whether to embed one or two CSI in the original image. Then determine the value of Bit plane to embed the CSI in the original image which is from 5 to 8 to create a final image.



Flowchart 1. Proposed system design.

8. Results

This model has implemented in MATLAB 2013a using BPS technique. We used TIF images as the original image and CSI as an embedded image to get TIF images which represent watermark image.

First experiment

We have created two CSI, the first one has been embedded inside grayscale image "Tech.TIF" and the second interpolation has been embedded inside grayscale image "map.TIF". Both of them using embed algorithm which must determine the value of Bit plane to embed the CSI in the original image which is from 5 to 8 to create a final image "watermark.TIF".

Second experiment

Both of these interpolations have been embedded inside grayscale image "tiger.TIF." using embed algorithm which embedded the CSI in the original image which in bit 6 and 7 sequentially to create a final image "watermark. TIF".

Then we calculate both MES and PSNR to know the quality of the resulting image by comparing it with the original image.

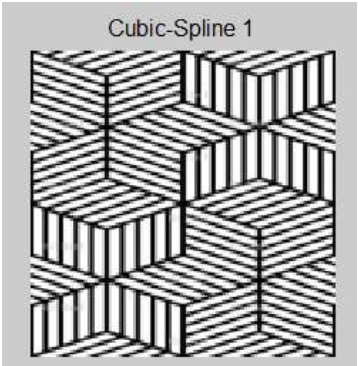


Figure 3. First Cubic-spline which will be embedded.

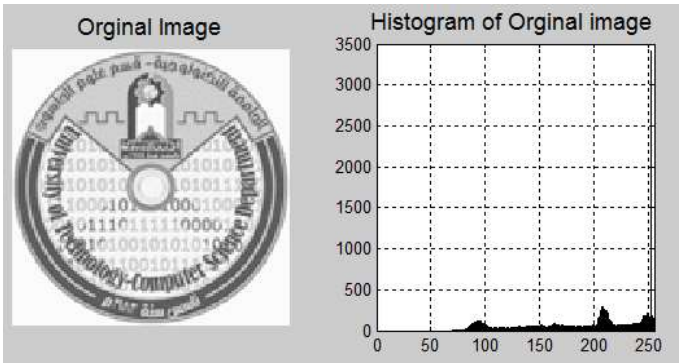
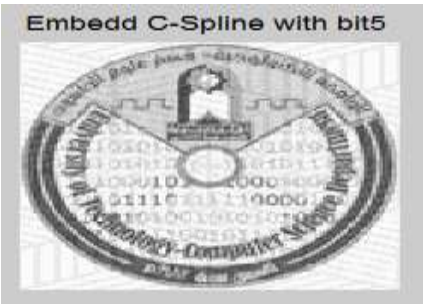
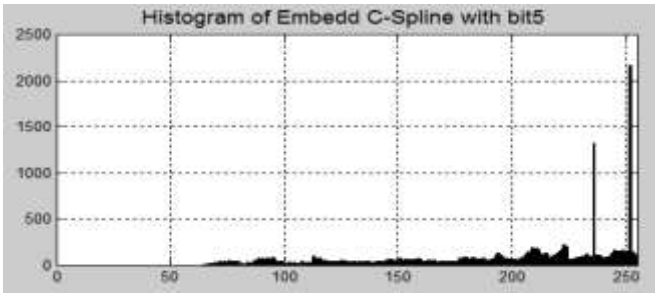
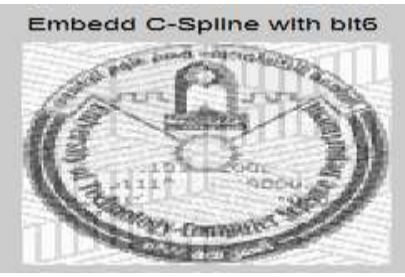
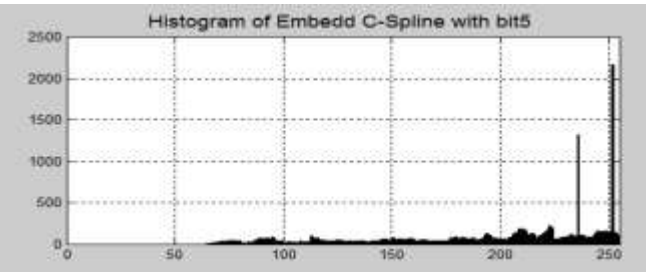


Figure 4. Tech image with its histogram.









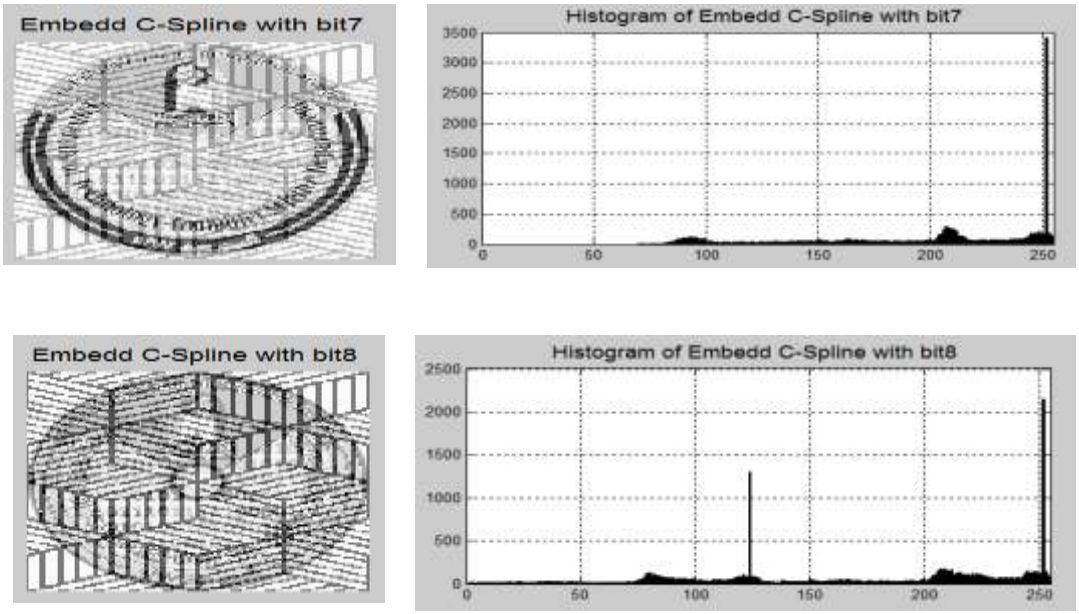


Figure 5. Watermark images with them histogram where First Cubic-spline was been embedded in, where shows all possibilities of watermark image when the value of Bit plane from 5 to 8.

Table 1. MSE and PSNR Results obtained different between the original image (Tech) and the final image (Watermark).

The number of bit plane which will be embedded in	PSNR and MSE
5	PSNR 28.6387 MSE: 88.963
6	PSNR 22.6615 MSE: 352.32
7	PSNR 18.4098 MSE: 937.77
8	PSNR 7.4705 MSE: 11642

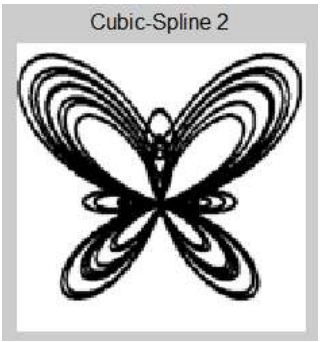


Figure 6. Second Cubic-spline which will be embedded.

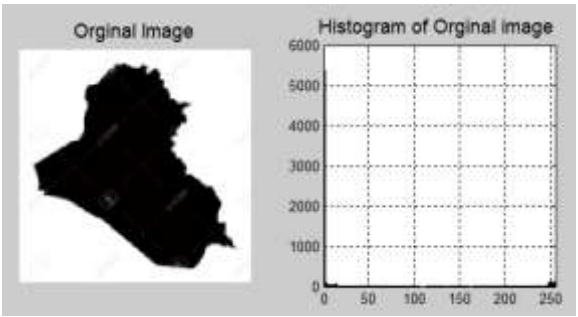


Figure 7. Map image with its histogram.

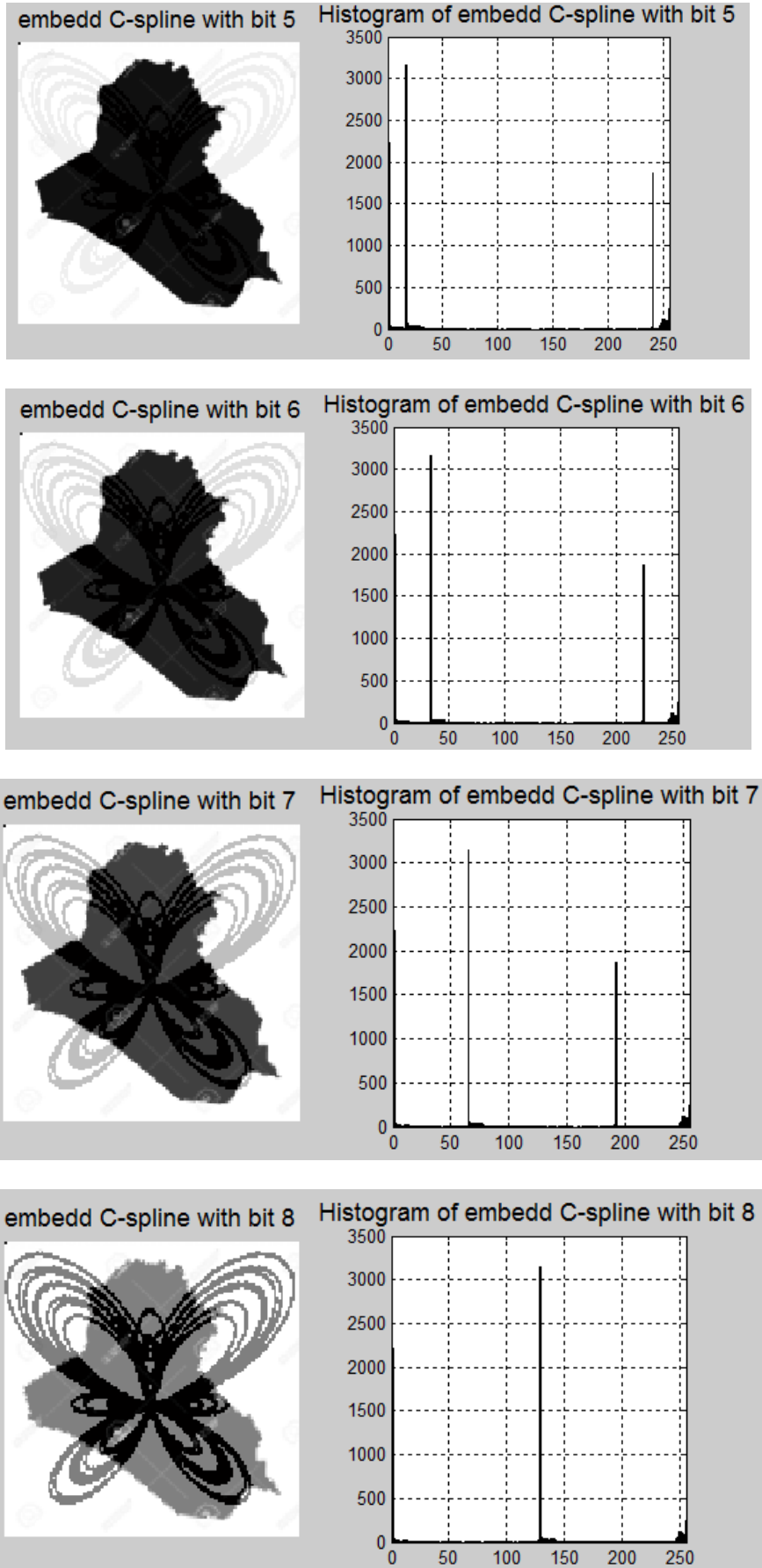


Figure 8. Watermark images with them histogram where Second Cubic-spline was been embedded in, where shows all possibilities of watermark image when the value of Bit plane from. 5 to 8.

Table 2. shows the results of MSE and PSNR obtained different between the original image (Map) and the final image (Watermark).

The number of bit plane which will be embedded in	PSNR and MSE
5	PSNR 28.6387 MSE: 88.963
6	PSNR 22.6615 MSE: 352.32
7	PSNR 18.4098 MSE: 937.77
8	PSNR 7.4705 MSE: 11642

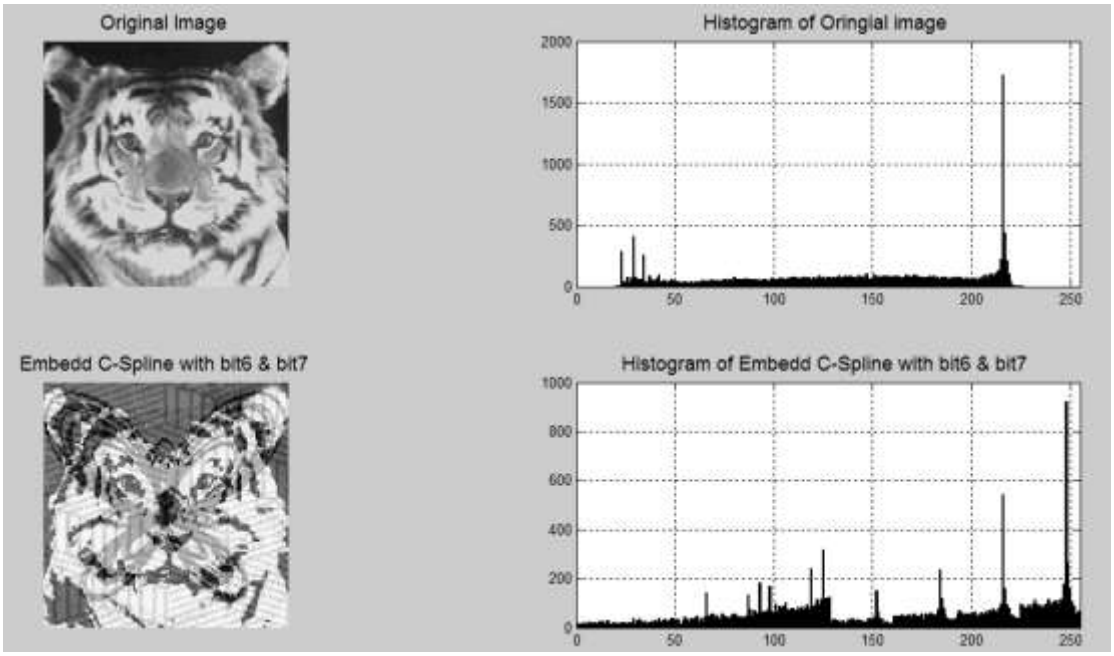


Figure 9. Original image (Tiger) and watermark image with them histogram where both of CSI were been embedded in, Bit plane 6 and 7.

Table 3.MSE and PSNR obtained different between the original image (Tiger) and the final image (Watermark).

The number of bit plane which will be embedded in	PSNR and MSE
6 and 7	PSNR 13.1388 MSE: 3156.4

9. Conclusion

Watermark is a shadow image with changing in darkness/lightness of the image. Watermarks can be visible or invisible which embedded within the image. Visible watermarks are using for protecting document copyrights and also using as logos, however, the invisible watermarks are using to security for example securities, stamps or passports. Also watermarking can be applying in forensic wherever the image should be protecting from the manipulate during transport or reception via wireless channels (noiseless as well as noisy).This work is implemented successfully when we used TIF images with various interpolation of Cubic-spline where embedded in any bit from 5 to 8, but when the values of bit equal 6 or more MSE becomes bigger while PNSR becomes smaller. Finally, we conclude

that the proposed approach gives a new technique for security when embedding more than one CSI inside a grayscale image.

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