Efficient Digital Watermark key Generation Using Hexagonal Structureand parametric Lagrange Curve

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Revised on:26/5/2014 & Accepted on: 8/1/2015

ABSTRACT

Digital watermarking provides copyright protection to digital image by hiding appropriate information in original image. Hence copyright protection has become essential to avoid unauthorized replication problem. In paper produce improvements on generate digital watermark key generation. Firstly add another parameter to increase the security features on the encryption stage, based on Lagrange polynomial under time condition to increase the robust in front of the attacker. Secondly proposed new improvement on gray watermark image (logo), that aim to reduce the logo size that embedded in the host image by analysis the feature and extract the sensitive positions only. The experimental results give efficient and acceptable result based on most popular image processing measures give approximately same efficient results with increase the security and complexity features.

Keywords: Watermark key, Lagrange polynomial, hexagonal structure (honey comb), PVD, Morphological border (MB).

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الخلاصة

العلامات المائيه الرقميه توفر حماية حقوق التأليف والنشر لصورة رقمية عن طريق إخفاء المعلومات المناسبة في الصورة الأصلية. وأصبح من الضروري حماية حق المؤلف لتجنب مشكلة نسخ غير مصرح بها. في هذا البحث تم اقتراح تحسين على توليد مفاتيح العلامات المائيه . الاولى اضافة متغير جديد لزيادة السريه في مرحله التشفير باعتماد لاغرانج متعدد الحدود تحت شرط الوقت لزياده القوه لمواجهه المهاجمات . ثانيا تم طرح تحسين على العلامات المائيه (شعار ذات اللون الابيض والاسود) التي تهدف الى تقليل حجم البيانات المخزونه فى صورة الاصليه وتسريع وقت التنفيذ عن طريق استخراج مواقع البكسلات الموثره في الصوره فقط. النتائج التجريبية تعطي نتيجة فعالة ومقبولة على أساس اعتماد مقايس معالجة الصور الأكثر شيوعا مع زيادة ميزات الأمان والتعقيد.

الكلمات المرشدة: مفتاح العلامه المائية,منحني لاغرانج متعدد الحدود , الاشكال السداسية , الحدود المفورلوجي

https://doi.org/10.30684/etj.33.2B.10
2412-0758/University of Technology-Iraq, Baghdad, Iraq

INTRODUCTION

The development of digital media is demanding as an urgent need for protect multimedia data in internet [1], hence copyright protection has become essential to avoid unauthorized replication problem. Digital watermark is a piece of information which is embedded in the digital media content in such a way that it is inseparable from its data. The watermark can be detected or extracted later to make an assertion about the object [1], it's not limited to only images; but there are also watermarking techniques for audio, video, and text data. Digital watermarking techniques provide high security to digital content by allowing only authorized person to modify or detect and the digital watermarking technique is proposed as a method to embed perceptible or imperceptible signal into multimedia data for claiming the ownership. Each watermarking application has its own requirements that determine the required attributes of the watermarking system and drive the choice of techniques used for embedding the watermark. The importance of hexagonal structure (HS) representation is that it possesses special computational features that are pertinent to the vision process. The HS has features of higher degree of circular symmetry, uniform connectivity, greater angular resolution, and which leads to reduce storage and computation in image processing operations, and Lagrange Interpolation having a better fit and a smooth well-behaved fitting function with higher the degree of the resulting polynomial, and therefore the greater oscillation it will exhibit between the data points. The watermarking algorithms that proposed in this paper combine between HSLPI (hexagonal structure) and (Parametric Lagrange polynomial interpolation), .The second stage MBPVD (morphological border and pixel value difference). The PVD provide both high embedding capacity and outstanding imperceptibility for hiding image [13]. The reason of applying two stages is to get good quality watermarked image for effective watermarking. And produce new improvement based on gray watermark image.*G.RoslineNesakumari,Dr.V.Vijayakumar, Dr.B.V.Ramana Reddy [10]*.Provides a new mechanism with two stages for efficient authentication based on Honey Comb Polynomial Interpolation (HCPI) and Morphological Border Sorted Pixel Value Difference (MBSPVD) scheme. A simple polynomial interpolation technique on new hexagonal structure called Honey Comb structure (HCS) is used for generating the key of the digital watermark. The polynomial interpolation gives a high secured key, which is difficult to break. HCS is used in the present paper to select pixel positions for generating the Digital Watermark key (DWK). And D.Phani Kumar, G.RoslineNesakumari, S.MaruthuPerumal"*Contrast Based* [11].The paper proposed robust and blind color based watermarking scheme is embeds color watermarks in color images using Langrage Polynomial Interpolation (LPI) in wavelet domain. Successful development of uniqueness of proposed method helps to develop a watermarking scheme that fulfills the requirement. The proposed watermarking technique embeds only the watermark keyin the diagonal part of the image. The watermark is a color logo and it not going to embed into the image. Only a tiny quantity of information is required to extract the watermark key.

Hexagonal structure:

Images are usually constructed by square lattices in computers and image capture devices. However, being square is not the only solution to construct images we can use another lattices like hexagonal lattices. [3] Out of the many advantages for the

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hexagonal structure in image processing, the primary one is its resemblance with the arrangement of photoreceptors in the human eyes. Due to the change in arrangement the amount of pixels required is very less. among these advantages are higher degree of circular symmetry, uniform connectivity, greater angular resolution, and a reduced need of storage and computation in image processing operations and on square lattices, the distances from a pixel to its eight adjacent pixels are not the same, and only the distances to its four adjacent pixels are the same. On the other hand, on hexagonal lattices, the distances to all six adjacent pixels are equal as show in figure (1). Consequently, a hexagonal lattice has higher isotropy in comparison to a square lattice. Even though there are many advantages, hexagonal grid is not widely used in image processing because it Lack of capturing and display devices in hexagonal grid [4].

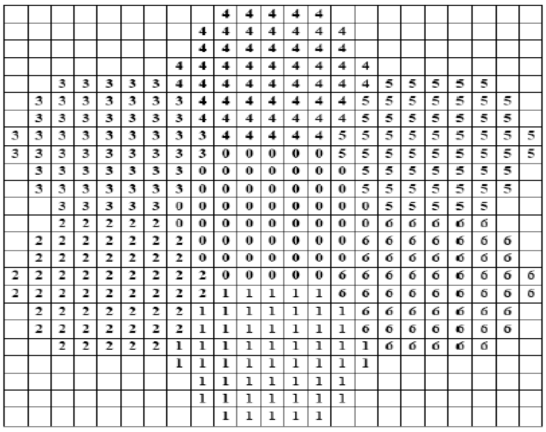

Figure (1) Hexagonal Structure

Lagrange Interpolation Polynomial (LPI)

Lagrange Interpolation formula is one of the most commonly used interpolation functions and its computation charge is inferior to the majority interpolation functions. An interpolation is defined as a function which contains independent variable and a number of parameters. When constructing interpolating polynomials, there is a tradeoff between having a better fit and having a smooth well-behaved fitting function. The more data points that are used in the interpolation, the higher the degree of the resulting polynomial, and therefore the greater oscillation it will exhibit between the data points. Therefore, a high-degree interpolation may be a poor predictor of the function between points, although the accuracy at the data points will be "perfect". [10]

The Lagrange Interpolating Polynomial can be defined as P(x), which is given in the Equation below: The Lagrange polynomial is the simplest way to exhibit the existence of a polynomial for interpolation with unevenly spaced data. The Lagrange interpolating polynomials $L_{N,K}$ has degree N and is one at $x = x_k$ and zero at $x = x_j$ where $j \neq k$.

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$$L_{N,K}(x)=\frac{(x-x_0)(x-x_1)\ldots(x-x_{K-1})(x-x_{K+1})\ldots(x-x_N)}{(x_K-x_0)(x_K-x_1)\ldots(x_K-x_{K+1})\ldots(x_K-x_N)} \quad \ldots. \quad (1)$$

$$=\frac{\prod_{\substack{j=0\\ j\neq K}}^{N}(x-x_j)}{\prod_{\substack{j=0\\ j\neq K}}^{N}(x_K-x_j)}$$

Note that $\prod_{K=1}^{N} K = 1.2.3\ldots N.$

The interpolating polynomial may be written:

$$P_N(x)=\sum_{K=0}^{N} y_k L_{N,K}(x)=y_0L_{N,0}(x)+y_1L_{N,1}(x)+\ldots+y_NL_{N,N}(x) \quad \ldots \quad (2)$$

It is just a linear combination of the Lagrange interpolation polynomials $L_{N,K}(x)$ with the y_K as the coefficients.

Mathematical Morphological

Mathematical morphological which started to develop in late of 1990's stand as relatively separate part of image analysis. The word of morphological commonly denoted a branch of biology that deals with form and structure of the animal and plaints, use the same word here in content of mathematical morphological as a tool for extraction image component that are useful to represent and description the region shape, such as boundaries, Skelton and context hull, we are interested also in morphological technique for pre-or post-processing such as morphological filtering, thinning [5].

The basic operation of morphological is dilation and erosion this operation in fundamental to morphological processing such as opening and close….etc.

Erosion is done by scanning the image (A) with the structuring element (B) When the structuring element fits completely inside the object, the probe position is marked. The erosion result consists of all scanning locations where the structuring element fits inside the object. The eroded image is usually a shrunken version of the image, and the shrinking effect is controlled by the structuring element size and shape [6]

E(A,B)=A⊖B …..(3)

Dilation involves fitting a probe into the complement of the image. Thus it represents a filtering on the outside of the object, whereas erosion represents a filtering on the inside of the object, as depicted in figure (2)[6].

D(A,B)=A⊕B …(4)

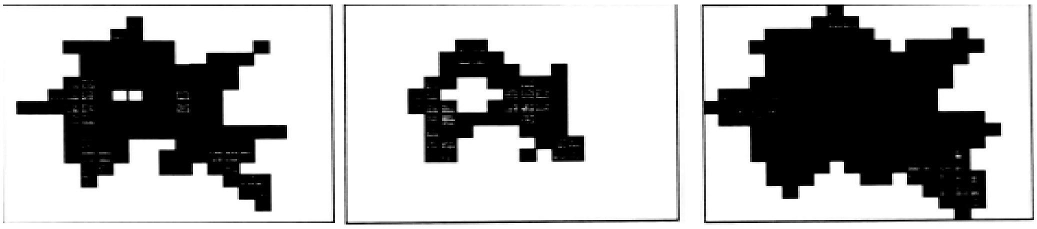

Figure (2) (a) original image (b) erode image (c) dilation image

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Morphological edge detection algorithm selects appropriate structuring element of the processed image and makes use of the basic theory of morphology including erosion, dilation, opening and closing operation and the selection of structuring element decides the effect and precision and the result. Therefore, the keys of morphological operations can be generalized for the design of morphological filter structure and the selection of structuring element. Must select appropriate structuring element by texture features of the image. And the size, shape and direction of structuring element must been considered roundly. Usually, except for special demand, we select structuring element by 5×5 square [9].

The morphological gradient of image A is computed using dilation and erosion and can be defined using the following equation:

$$G(A) = (A \oplus B) - (A \ominus B) \quad \ldots(5)$$

Pixel Value Difference (PVD) Method:

In Wu-Tsai's method, a pixel-value differencing (PVD) method is used to discriminate between edged areas and smooth areas. And the capacity of hidden data in edged areas is higher than that of smooth areas. However, to take account of the capacity of hidden data in the smooth areas, the image is partitioned into non-overlapping blocks of two consecutive pixels, states *pi* and *pi*+1. From each block we can obtain a different value *di* by subtracting *pi* from *pi*+1. All possible different values *di* range from -255 to 255, then |*di*| ranges from 0 to 255. Therefore, the pixel *pi* and *pi*+1 located within the smooth area when the value |*di*| is smaller and it will hide less secret data. Otherwise, it is located on the edged area and embeds more data. From the aspect of human vision it has a larger tolerance that embeds more data into edge areas than smooth areas. In Wu-Tsai's method, first, the range table has to be designed and to fabricate a range table with *n* contiguous ranges. The *n* contiguous ranges, say *Ri* where *i*= 1*;* 2*; … ; n*. The range table ranges from 0 to 255. The lower and upper bound values of *Ri*, say *li* and *ui*, then *Ri 2* [*li; ui*]. The width of *Ri*, say *wi*, then (wi=ui-li +1).How many bits were hidden in two consecutive pixels depended on *wi*, respectively. Considering the aspect of security, the fabricating range table is useful, because *Ri* of the range table is variable. So that, it cannot extract the identical secret data without the original range table [8].

Table (1) Range table showing hiding capacity

Range	li	ui	wi	Bi=log(wi)
T1=[0,7]	0	7	8	3
T2=[8,15]	8	15	8	3
T3=[16,31]	16	31	16	4
T4=[32,63]	32	63	32	5
T5=[64,127]	64	127	64	6
T6=[128,255]	128	255	128	7

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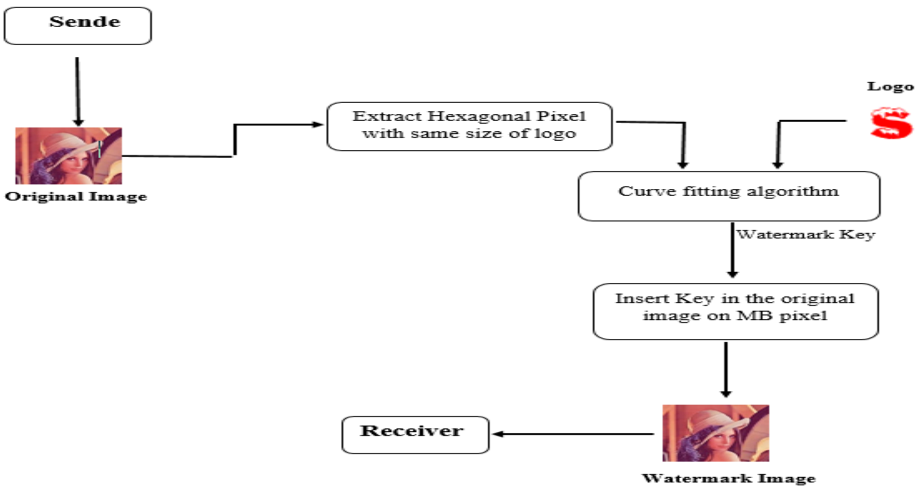

Figure (3) Embedded in traditional technique

The proposed improvements:

In this section produce new improvement on watermark key generation techniques based on efficient secure parameter to increase the robust for watermark key generation Parametric forms can be developed for a wide variety of curves. A parametric suggests the movement of a point through value of time (t) two function (x(t), y(t)) as the position of the particle at time t. to increase the security in polynomial generation and for more effort for attacker. Where dealing with Lagrange polynomial from two dimension (2D) to three dimension (3D) as show in equation below:

$$P(t) = \sum_{i=1}^{n} pi(t) \quad \ldots(6)$$

Where:

$$pi(t) = yi \prod_{k=1,k\neq 1}^{n} \frac{x-tk}{ti-tk} \quad \ldots(7)$$

Improvement watermark key generation based on parametric Lagrange polygonal:

The value of (ti) generate by using random generation to get the value of (t) more random and Difficulty guessing by attacker.

T(i)= t(i-1) *a +b …(8)

Where

a and b integer random value and b change in by this equation ((b+2)mod i) to get more randomization for (t) value and prevent redundancy for t value. And increased the isolation of the polynomial coordinates. The modification on the Lagrange polynomial investigate it by Y(i) is the pixel of hexagonal take by using traditional method of hexagonal structure that explain in section 3.1 and [14].

In this section we illustrated the complete proposed algorithms to descript the first improvement on key watermark key generation.

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Algorithm (1): ***"Embedding algorithm based on parametric polynomial"***

Input: Original image, Logo image
Output: Watermark image
Processing:

Step1: input the host image and extract HS from the image with same size of logo, range this pixel in table (HST) as X(HSi)table where i=1,2,….,n (n size of logo) and range the pixel of logo in table too as Y(logoi) table. in this case size of logo 32*32

Step2: digital watermark key (DWMK) Generation using Parametric Lagrange interpolation algorithm according equation-1. And generated t vector by random generation, y(i) is hexagonal pixel.

$$k(t) = yi \prod_{k=1,k\neq 1}^{n} \frac{x-tk}{ti-tk} \qquad \text{….(1)}$$

DWKT is generated by matching the obtained values of function K(t) with logo table. If there exists an x, in K(x) =(logoj) then store x to the jth entry of DWKT

Step3: extract edge pixel of host image by using the Morphological border technique to extract image border locations then using this location to store the key in the next step **except** the region that extract HST not detect edge and not store any value of key in this region .

Step4: embedded the DWMK into host image in edge pixel extract from step3 by Pixel Value Difference method (PVD), watermark is inserted in the group of two pixels, After converting the values of pixels of the watermark key to a stream of binary form if its values after inserting watermark are less than the next group of values.

Step5: End

Algorithm (2): "Extraction algorithm"

Input: Watermark image
Output: Logo image
Processing:

Step 1: From the watermarked image, detected the border G(A) by using morphological border.

Step 2: Perform PVD to extract watermark key table from watermark image border G(A).

Step 3: extract new HS from the watermark image with same size of logo and store it in table.

Step 4: Using HST table and DWKT values generation the watermark logo by implementing Parametric Lagrange Polynomial, generated only position of white pixel.

Step5: redraw the logo using the result of Parametric Lagrange polynomial (step4).

Step6: End

Improvement watermark key generation improvement based on black and white logo:

In this section description the second improvement that aim to overcome on the watermark logo size with black and white logo by extract only the Impressive pixel in watermark logo, by scanning the logo image and determined the Impressive pixels (white pixel) and use of the position of this pixel not the value and neglect of other

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pixel. In the following the complete algorithm descript the second improvement on key watermark key technique.

Algorithm (3):" The embedding algorithm based on black and white logo"

Input: Original image, Logo image
Output: Watermark image
Processing:

Step1: extract the position (xi,yi) of Impressive pixel in watermark logo (white pixel) only from logo and neglect of other pixel as following

```
        Do while (I <= logo.width  and j <= logo . height )
            {   If  pixel (i,j) =255 then
                    X(k)=I : Y(k)=j
                            k=k+1
                End if
Next i: Next j
}
```

Step2: input the host image and extract HS pixel from image with same number of white pixel of logo treat it as x(i) for Lagrange algorithm.

Step3: digital watermark key Generation (DWMK) using Lagrange interpolation algorithm according equation bellow. The input of algorithm position of white pixel (xi, yi) of logo and HST pixels.

$$k(t) = yi \prod_{k=1,k\neq 1}^{n} \frac{x - xk}{xi - xk}$$

DWKT is generated by matching the obtained values of function K(t) with logo table. If there exists an x, in K(x) =x(logoj) and K(y) =y(logoj) then store x,y to the jth entry of DWKT

Step4: extract edge pixel of host image by using the Morphological border technique to extract image border locations then using this location to store the key in the next step **except** the region that extract HST not detect edge and not store any value of key in this region ..

Step5: embedded the DWMK into host image in edge pixel extract from step4 by Pixel Value Difference method (PVD).

Step6: End.

Algorithm (4): "Extract algorithm"

Input: Watermark image
Output: Logo image
Processing

Step 1: From the watermarked image, detected the border G(A) by using morphological border.

Step 2: Perform PVD to get watermark key table from watermark image border G(A).

Step 3: extract new HS from the watermark image with same size of logo and store it in table.

Step 4: Using HST table and DWKT values generation the watermark logo by implementing Lagrange Polynomial, generated only position of white pixel.

Step5: redraw the logo by putting the value of white value ('255') in the position from step4 and other position put black value ('0') value.

Step6: End.

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Experimental Results:

In our experiments, the performance of the proposed algorithm is evaluated with respect to watermark imperceptibility, and robustness by MSE, SNR, PSNR and similarity. We will use two images for experiments Lena and baby image ,with gray-level watermark logo and color logo considered for the experiments with logo of size 32 * 32 as shown in Figure(5).

Figure (4) Gray logo image

Figure (5) Original image

1 The result of Watermark key generation on parametric Lagrange polygonal:

- Gray logo

Table (2) Fidelity criteria between extract gray logo and original gray logo With parametric

Test image	MSE	PSNR	Similarity
Lena (350*350)	32.08	40.20	0.99
Child	0	58.13	1

Table (3) Fidelity criteria between original image and watermark image with parametric algorithm

Test image	MSE	PSNR	SNR	Similarity
Lena (350*350)				
R	0.029	63.45	1184	0.999
G	0.041	61.90	2991	0.998
B	0.058	60.47	2094	0.998
child				
R	0.031	63.11	1063	0.999
G	0.031	63.14	8277	0.999
B	0.028	63.57	7345	0.999

- **Color logo**

Figure (6) Color logo image

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Figure (7) Original image

Table (4) Fidelity criteria between extract color logo and original color logo with parametric

Test image	MSE	PSNR	similarity
Lena (350*350)			
R	**34.51**	**32.75**	**0.999**
G	**2.06**	**44.97**	**0.999**
B	**11.39**	**37.56**	**0.999**
Barbra			
R	**0**	**58.13**	**1**
G	**33.06**	**32.93**	**0.999**
B	**30.54**	**33.28**	**0.999**

Table (5) Fidelity criteria between original image and watermark image with parametric

Test image	MSE	SNR	PSNR	similarity
Lena (350*350)				
R	0.10	3168	57.72	0.999
G	0.168	7448	55.68	0.999
B	0.164	7414	55.95	0.999
Barbra				
R	0.32	6309	52.97	0.999
G	0.25	4891	54.04	0.999
B	0.43	2583	51.71	0.999

2 –The result of Watermark key generation on black and white logo:

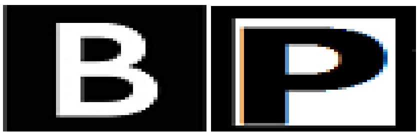

Figure (8) black and white logo image

Table (6) Fidelity criteria between original logo with return logo

Test image	MSE	PSNR	Similarity
Lena (with logo 1)	0	58.13	1
Lean (with logo 2)	26.01	33.97	0.99

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Table (7) Fidelity criteria between original image and watermark image

Test image	MSE	SNR	PSNR	similarity
Lena (with logo 1)				
R	0.036	9452	62.47	0.999
G	0.046	1953	60.05	0.999
B	0.07	1726	59.62	0.999
Lena(with logo 2)				
R	0.059	5862	60.40	0.999
G	0.11	1059	57.39	0.999
B	0.108	1126	57.77	0.999

Comparison results between the traditional method and proposed methods:

Table 8,9compares the PSNR values after inserting the watermark key y the *traditional method* and pressed method with Lina and baby image with gray logo image

Table (8) compares the PSNR between extract logo and original logo

Host image	Traditional method	Key generation based on parametric Lagrange	Key generation on black and white logo
Lina	34.33	40.20	*58.13*
Another test image	39.95	58.13	33.97

Table (9) compares the PSNR between original image and watermark image

Host image	Traditional method	Key generation based on parametric Lagrange	Key generation on black and white logo
Lina			
R	63.33	63.45	62.47
G	60.84	61.90	60.05
B	60.98	60.47	59.62
Another test image			60.40
R	61.77	63.11	57.39
G	61.72	63.14	57.77
B	62.02	63.57	

Conclusions:

In this paper, we have proposed an image watermarking technique that combines between the curve fitting algorithms and hexagonal structure for generating watermark key**.** And improvement the key watermark efficiency is based on parameterization features, which allows a trusted authority to proving the ownership of watermark image. We using HS (Hexagonal Structure) that have more feature than Square structure, and exploiting a suitable Lagrange polynomial interpolation (LPI). The Lagrange polynomial interpolation given a high secured DWK, which is difficult to break and this method is used in implementing the robust watermarking.The decryption process requires Lagrange interpolation method, HST and DWK tables.The experimental results on various images the proposed technique provides good image quality and robustness when compared to other methods, at the same time by providing higher robustness, high payload, imperceptibility, it produces high

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quality watermarked image. The improvement this method first by using parametric Lagrange interpolation to increase the security of the key generated and make it difficult to indicate by attacker, and the other case process the problem of logo size and time of execution by using black and white logo then encryption only the white pixel. And the experimental results on various images to this two cases.

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