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# Image Encryption with (General Singular Values Decomposition) via logistic function by Encryption key only real number (method-2)

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**ABSTRACT**

In this algorithm the development of a previous algorithm was a master's thesis by researcher Maher AL-Bashkani. Where he used a technique (gsvd) with Logistic function to encrypt the image through a composite key which is two keys ... The first is a real number and the second is a picture. In this algorithm we will call it (MK-11) we will dispense with the second key (picture) and with only the first key (real number). We will generate a 3D matrix that represents another key we create through the work of our algorithm. This is a new method that has not been used by previous algorithms. We know nothing about this triple matrix we create by implementing the algorithm. Therefore, this algorithm is considered very excellent and possesses high immunity against hackers who try to break the encryption.

The work of this algorithm focuses on three steps: The first is to create an array with the same dimensions as the image we want to encode depending on the numerical components of the image matrix as we will see later. The second step is the first distraction of the image matrix by adopting the first encryption key (real number) and logistic function. Step 3 We apply GSVD between the resulting image matrix after the first encoding contained in the second step above and the matrix that was created in the first step above to perform a second encryption step, the final encryption is two steps of encryption which adds complexity to the image encryption makes it difficult to penetrate by hackers. The results we obtained by implementing this algorithm they were very excellent and compete readings for modern algorithms. It is superior to accuracy and quality. Therefore, this algorithm can be adopted in information security.

**KEYWORDS:** Image encryption; GSVD; logistic function

## 1 INTRODUCTION

Information security has been a concern of nations throughout history many specialists and researchers have worked in this field starting from the Roman state BC passing through a large number of countries and civilizations including the civilization of Mesopotamia and the civilization of the Nile

Valley and the Persian state Chinese, Indians and even spread this important science in all nations and countries of the world because of its importance in the management of military, financial, commercial and other affairs of the country. Throughout the march of this science and its development in the great current era it is a field of applied mathematics fields there is no any Problem in it. Because of the adoption of various mathematical methods in the dispersion of data after conversion to numerical values (Vectors or matrices) and encrypted so that it does not make it possible to penetrate. This science suffered many problems, including the lack of acceptance of some supervisors on the theses of master and doctoral any development of old algorithms and their total reliance on old methods and classical concepts the ballet algorithms obsolete and ended up at the time.

The second problem suffered by this science, specifically in modern times is dominated by specialists in the field of computers and the marginalization of the role of mathematics altogether on the other hand, the mathematicians did not object to this marginalization. You see that all the algorithms are within the encryption field in particular and the image processing field in general computer specialists rely on algebraic, topological, or other mathematical techniques, but they do not point to the virtue of this science (mathematics) on information security field. Specialists are mathematics who develop algorithms and improve according to the development of daily science and give it to computer specialists who deny the mathematicians this privilege. My words are specific to what is happening in my country because the spirit of selfishness beat the specialists of the computer because they believe themselves the finest level of mathematics. Where we often find committees that discuss theses of master and doctoral in the image processing field without a specialist in mathematics and this represents a scientific error fatal.

In my recent research, I have referred to the sequence of developing my algorithms in the field of image coding where we got to the last algorithm that we called (MK-10) which bore the title (Simulate a first-order Bézier curve in image encoding). This algorithm we will call (MK-11) which will carry the title of (Image Encryption with (General Singular Values Decomposition) via logistic function by Encryption key only real number (method-2)) it represents the development of a previous algorithm that we assisted Maher AL-Bashkani in his algorithm adopted the same principle with two encryption keys (real number and image). Here, in our algorithm, we dispensed with the picture and the key became a real number.

We will adopt all the algorithms in our last search (MK-10) to compare the results and readings we will get we will also use abbreviations in the same search for globally adopted standards, coding time and decoding time. I would like to point out at the end of the introduction that I will adopt two images in the application of the algorithm they are my personal image (I think it will be funny) and the image of the baboon monkey.

## 2 MATHEMATICAL TECHNIQUES USED IN THE ALGORITHM

We will suffice with a simple overview of the two techniques used in this algorithm, namely (General Singular Values Decomposition) and (logistic function).

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### 2.1 General Singular Values Decomposition (GSVD):

$\forall$ A_((m,p) ) and B_((n,p) ) are tow matrix have the same number of columns,but may have different

numbers of rows

$[U_{(m,m)},V_{(n,n)},X_{(p,\min(m+n,p))},C_{(m,p)},S_{(n,p)}]=gsvd(A_{(m,p)},B_{(n,p)})$

Such that:-

$$(U_{(m,m)})*(C_{(m,p)})*(X_{(p,\min(m+n,p))})^T=A_{(m,p)}$$

$$(V_{(n,n)})*(S_{(n,p)})*(X_{(p,\min(m+n,p))})^T=B_{(n,p)}$$

And $(C_{(m,p)})^T*(C_{(m,p)})+(S_{(n,p)})^T*(S_{(n,p)})=I_{(P,P)}$

The matrix $X_{(p,\min(m+n,p))}$ is a matrix that its column represents the eigenvectors of the symmetrical square matrix COV(A,B) after converting to orthonormal.

The matrix $C_{(m,p)}$ is a diagonal matrix that the main diameter values are square roots of the eigenvalues of the symmetrical square matrix $((A_{(m,p)})^T+(A_{(m,p)}))$ corresponding to the eigenvectors mentioned in the matrix $X_{(p,\min(m+n,p))}$ descending order, ie: -

$$c_{(1,1)}\le c_{(2,2)}\le c_{(3,3)}\le\cdots.\le c_{(q,q)} \qquad \text{wher } q=\min(m,p)$$

The matrix $S_{(n,p)}$ is a diagonal matrix that the main diameter values are square roots of the eigenvalues of the symmetrical square matrix $((B_{(n,p)})^T+(B_{(n,p)}))$ corresponding to the eigenvectors mentioned in the matrix $X_{(p,\min(m+n,p))}$ descending order, ie: -

$$s_{(1,1)}\le s\le s_{(3,3)}\le\cdots.\le s_{(r,r)} \qquad \text{wher } r=\min(n,p)$$

The matrix $U_{(m,m)}$ is a square matrix whose columns are calculated as follows: -

$$u_j=\frac{1}{c_{jj}}Ax_j$$

And it is converted to orthonormal.

Also the matrix $V_{(n,n)}$ is a square matrix whose columns are calculated as follows: -

$$v_k=\frac{1}{s_{kk}}Bx_K$$

And it is converted to orthonormal.

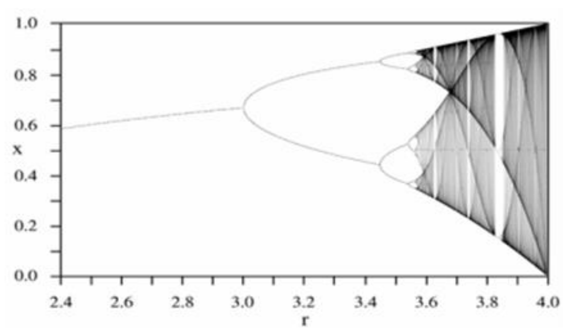
## 2.2 logistic function

Logistics function, it is one of the simplest types of chaotic functions known, it has been studied for the first time in 1960 when observed many interesting characteristics. As the specific values created by this function are completely random values in the form although it is among the borders, these values are not repeated even after a number of cycles. The most important characteristic of this function is its sensitivity to the initial value, this makes the function of high importance in encryption.. The mathematical representation of the function is

2.3$x_{(n+1)}=\gamma x_n (1-x_n)$ ..............(1)

2.4$X_n \in (0,1)$ and $\gamma>0$

$\gamma$ Determines the random behavior of the next generation, as for $x_0$ , it represents the initial value., the figure below shows the graph of the behavior of the hyperlink logistic function.

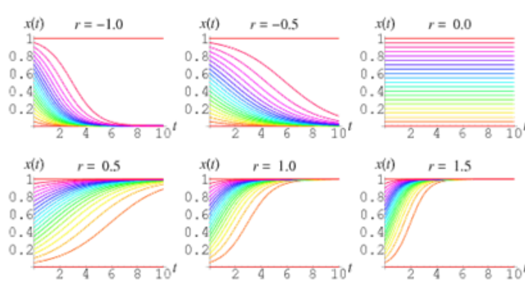



### 2.2.1. Logistical model of population growth

Is a common kind of "Squindwind" curve, The logistics function was given this name in one of 1844 or 1845 by Pierre François Fairhelst, who has studied the relationship of this population growth curve.

### 2.2.2 Importance

The equation is used to predict earthquakes and long-term climate changes.



We'll explain later the concept of logistics map with one-dimensional with illustrations through a graphical display program.

### 2.2.3. Logistics map

The logistics map is a one-dimensional map of the system (Separate model and model simple nonlinear).

The explanation is as follows:

$X_{n+1} = L(r, X_n) = r * X_n * (1 - X_n) \dots . (1)$

where r is parameter and $X_n \in [0,1]$ .

Considering the Majestic map L: $[0,1] \to [0,1]$ and from equation (1) r is within interval [0,4], and by going back to the Logistic function for r = 4, there will be a clear sensitivity to fit the first condition.

In order to show the chaotic properties of the logistics map, you should study Lyapunov and conduct a graph and install accounts and readings and all the details have.

To map the hyperlink graph relative to the logistic parameter (r) And accurately calculated.

Lyapunov logistics maps have been modified and re-calculated to map the special logistics parameter "r". It is specific and calculated.

The logistics map is chaotic if the parameter “r” belongs to the group [3.6, 4].

Through the process described below in equation (2) which represents a function equal to either g (x) or h (x) based on a conditional relationship about the value of $X_n$as follows: -

$X_{n+1} = f(X_n) = \begin{cases} g(X_n), & X_n < a \\ h(X_n), & X_n \geq a \end{cases} \dots (2)$

Where $X_n \in [0,1]$ and a ∈ (0 ,1)

There must be a major condition for segmental function f = {g. h} so that the process Lebesgue lead to the absolute value of the value of the local inclination is greater than one within the total domain .. Mean that any absolute of derivative for any part the function must be within the range greater than one as below.

$|f'(x)| > 1$ for : $x \in [0 , 1]$ …… … (3)

Regarding the logistics map the equation can be written in question according to the value of a = 0 · 5 as follows:-

$$X_{n+1} = L(r, X_n) = \begin{cases} g(X_n) = r * X_n * (1 - X_n).. & X_n < a \\ h(X_n) = r * X_n * (1 - X_n).. & X_n \geq a \end{cases} \dots (4)$$

It can be seen from equation (4) that is derived g (x) greater than one but the derivative of h (x) is not. This problem can be solved by using the properties of the conversion and symmetry to modify the equation h (x). In fact, we are adjusting the second part of the logistics map to improve her messy range in two ways [1]

### 2.2.4. Types of Logistic Function

Logistics functions are divided into types depending on the effect of the value of k based on the results obtained through the Matlab program to the following: -
$f(x)=kx(1-x)$ $k>0$ and $0 \le x \le 1$

This function is sensitive for the k and so will be the kinds of logistics function as follows: -
1. If k = 2.8: Stable one point.
2. If K = 3.2: Stable tow cycle point
3. If K = 3.8: Chaotic
4. If K = 4.1: Divergent

Behavior of Logistic Function

### 2.2.5. The behavior of logistic function(Dynamical Behavior with Value of k.

Logistics function is divided in terms of (behavior) according to the program MatLab to four cases, namely: -
Dynamic behavior of the logistic function depending on the value of k.
1. Stable Point $0 < k < 2$
2. Stable m − Point Cycle $2 < k < 3.5$
3. Chaos $3.5 < k < 4$
4. Unstable $k > 4$

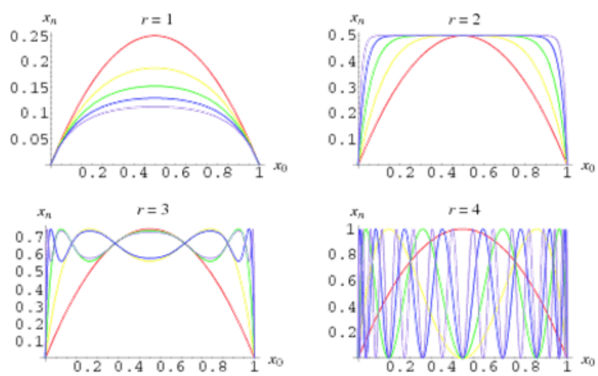



Figure 1 showing the logistic function number (1) above based on the value (r)

## 3 METHODOLOGY OF PROPOSED ALGORITHM OF ENCRYPTION AND DECRYPTION

Let A be an origin image matrix.

### 3.1. Encryption:-

Let k is real number (key)

cod=A>127.5

for example

$$\text{if } A = \begin{bmatrix} 127.4 & 130 & 111 \\ 95 & 127.8 & 127.9 \\ 120 & 128 & 145 \end{bmatrix}$$

$$\text{then cod } = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 1 & 1 \\ 0 & 1 & 1 \end{bmatrix}$$

$$Y = (k * A) * (255 - A)$$

$$AA_1 = k * A$$

$$AA_2 = -k * A$$

$$[u_1, v_1, x_1, c_1, s_1] = \text{gsvd}(AA_1, \text{cod})$$

$$[u_2, v_2, x_2, c_2, s_2] = \text{gsvd}(AA_2, \text{cod})$$

$$AAA_1 = u_1 * c_2 * x_1^T$$

$$AAA_2 = u_2 * c_1 * x_2^T$$

$$F = \begin{bmatrix} -AAA_1 \\ AAA_2 \end{bmatrix}$$

**3.2. Decryption**

Let F be an encryption image.
And we have the real number k is a key.

Well we have a matrix guide to choose the correct roots (cod)

$$AA_1 = -F\left(\left[1 : \frac{\text{end}}{2}\right], :\right)$$

$$AA_2 = -F\left(\left[\frac{\text{end}}{2} + 1 : \text{end}\right], :\right)$$

$$[u_1, v_1, x_1, c_1, s_1] = \text{gsvd}(AA_1, \text{cod})$$

$$[u_2, v_2, x_2, c_2, s_2] = \text{gsvd}(AA_2, \text{cod})$$

$$A = u_1 * c_2 * x_1^T$$

$$A = \frac{A}{k}$$

Of the elements of the matrix A are born a new matrix whose components are second-order equations on the following formula

$$k * x^2 - 255 * k * x + A = 0$$

For example

$$\text{let } A = \begin{bmatrix} A(1,1) & A(1,2) \\ A(2,1) & A(2,2) \\ A(3,1) & A(3,2) \end{bmatrix}$$

Matrix of equations that we generate it is:-

$$Y = \begin{bmatrix} x^2 - 255 * k * x + A(1,1) = 0 & x^2 - 255 * k * x + A(1,2) = 0 \\ x^2 - 255 * k * x + A(2,1) = 0 & x^2 - 255 * k * x + A(2,2) = 0 \\ x^2 - 255 * k * x + A(3,1) = 0 & x^2 - 255 * k * x + A(3,2) = 0 \end{bmatrix}$$

Then we solve these equations, We will get two values instead of each equation. One of them is correct.

**Example:** Let's take the default rootS matrix as follows:-

$$Y = \begin{bmatrix} \{126,180\} & \{199,20\} \\ \{112,200\} & \{128,127\} \\ \{20,244\} & \{251,32\} \end{bmatrix}$$

Using the matrix guide to choose the correct roots (cod)

To illustrate the example we assume:

$$\text{cod} = \begin{bmatrix} 1 & 1 \\ 0 & 1 \\ 1 & 0 \end{bmatrix}$$

$\because \text{cod}(1,1) = 1 \implies Y(1,1) \geq 127.5 \implies \text{the correct } Y(1,1) = 180$

$\because \text{cod}(1,2) = 1 \implies Y(1,2) \geq 127.5 \implies$

$\text{the correct } Y(1,2) = 199$

$\because \text{cod}(2,1) = 0 \implies Y(2,1) < 127.5 \implies$

$\text{the correct } Y(2,1) = 112$

$\because \text{cod}(2,2) = 1 \implies Y(2,2) \geq 127.5 \implies$

$\text{the correct } Y(2,2) = 128$

$\because \text{cod}(3,1) = 1 \implies Y(3,1) \geq 127.5 \implies$

$\text{the correct } Y(3,1) = 244$

$\because \text{cod}(3,2) = 0 \implies Y(3,2) < 127.5 \implies$

$\text{the correct } Y(3,2) = 32$

$$\therefore \text{ the correct } Y = \begin{bmatrix} 180 & 199 \\ 112 & 128 \\ 244 & 32 \end{bmatrix}$$

That is the image matrix after decryption

## 4 APPLICATION FOR THE PROPOSED ALGORITHM

We also note that we have used the MATLAB program to implement the algorithm and I have written the program myself to ensure the safety of the work and the accuracy of the results.

Below is the results of applying this algorithm to only two images (MK- image) and (Baboon)

Below are tables of readings and a figure for the results we obtained through programming algorithm by MATLAB program, has applied them to tow images are Baboon, and MK-image.

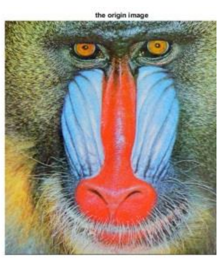
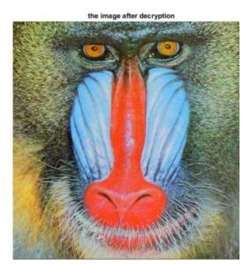
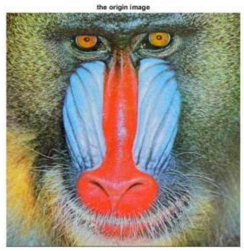
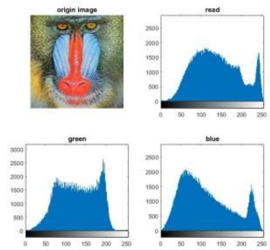
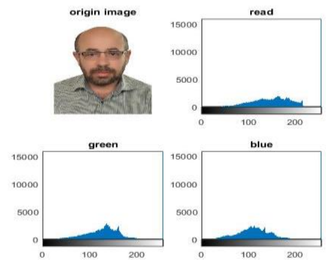
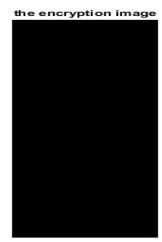
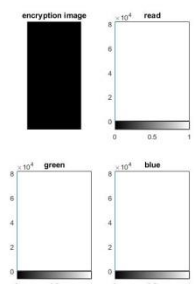
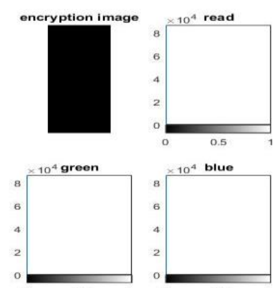
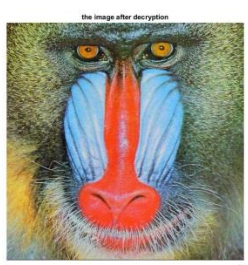
| Image Name | The original image | Encryption key | Cipher- image by gsvd & logistic function | Image after decoding |
|---|---|---|---|---|
| Baboon |  | 50 |  |  |
| |  | 100 |  |  |

Figure 2. Sample Data Base for tow images, Keys, cipher-images, and Images after decoding

| Image Name | Baboon | MK-image |
|---|---|---|
| The original image |   |   |
| Histogram before encryption |   |   |
| Cipher- image by gsvd & logistic function |   |   |
| Histogram for Cipher- image |   |   |
| Image after decoding |   |   |

Histogram after decryption

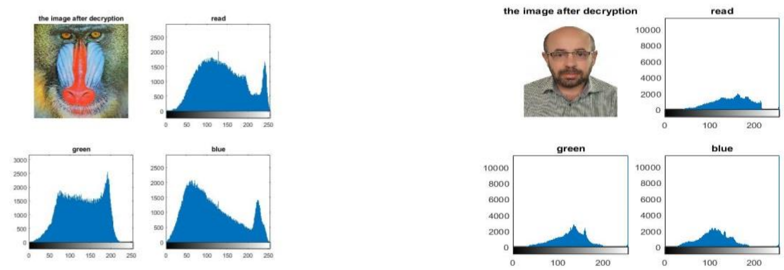



Figure 3: tow Images of Baboon and MK-image with histograms of each other before encoding, Cipher- image by gsvd & logistic function and after decoding

Very clear from the above figures high accuracy in the results of the MK-11 algorithm where the great match between the original image and the image after decoding. As well as the great convergence between the histogram of the original image and the image after decoding. The strength of encryption is also shown by the encrypted image where there is no hint to the original image it is a black palette with no color values and it is evidenced by her histogram which does not refer to the existence of any color values in them.

## 5 EXPERIMENT RESULT

Table 1. Encryption and decryption time, Mean error,(MSE)& (PSNR)* for (Baboon, and MK-image).

| Name of Image | Encryption time/s | Decryption time/s | Mean error | MSE | PSNR |
|---|---|---|---|---|---|
| Baboon | 1.3470 | 13.9530 | 3.4856e-12 | 2.3282e-22 | 156.2957 |
| MK-image | 1.2790 | 14.1790 | 3.7564e-12 | 2.5930e-22 | 156.0618 |

We note from Table (1) the encryption time and decryption time are not the same as the times recorded in the previous algorithms, where we find them larger than the previous times, especially the decryption time. The scientific explanation for this case is we are from through this the algorithm we work subject each color value to dispersion through a quadratic equation as well as the technique of GSVD. Which if were the dimensions of the image matrix (n × m × 3), we perform a process of dispersion through a quadratic equation (n × m × 3) from iterations as well as GSVD technology. This makes the encryption time more than one second.

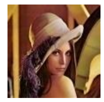
If we want to decryption and after reversing the GSVD technique, we work find the roots of the equation from second order (n × m × 3) from iterations. In each iteration we test the two roots accurate tested by the matrix cod contained in the algorithm above to determine the correct root value that representing the color value Correctly retrieved, this naturally takes a very long time.

From this we conclude that this algorithm is used only in very sensitive domains that require immunity and sobriety in the encryption where does not allow hackers any room to break the code.

To understand these statistical criteria, the research can be reviewed.

Table 2 shows no data loss after decoding, due to equal readings before and after decoding this is a clear indication of the quality of this algorithm.Conclusions should state concisely the most important propositions of the paper as well as the author’s views of the practical implications of the results.

Table 2: Readings for the global standards accuracy before encryption and after decryption for (Baboon,MK-image, Lena, Child, Suspension bridge, and Floating bridge) images.

| Name of Image | Baboon  | MK-image  | Lena  | Child  | Suspension bridge  | Floating bridge  |
|---|---|---|---|---|---|---|
| EBE | 0.0030 | 0 | 0.1416 | 0.0741 | 1.6775e-04 | 0.0074 |
| EAD | 0.0030 | 0 | 0.1416 | 0.0741 | 1.6775e-04 | 0.0074 |
| EEI | 0 | 0 | 0.1585 | 0 | 0 | 0.0037 |
| SDBE | 56.1909 | 69.3053 | 63.8309 | 67.8032 | 46.7713 | 55.4479 |
| SDAD | 56.1909 | 69.3053 | 63.8309 | 67.8032 | 46.7713 | 55.4479 |
| SDEI | 8.5072e+06 | 7.2548e+07 | 7.2565e+13 | 2.0737e+07 | 1.1000e+09 | 3.1444e+11 |
| CCOAD | 1 | 1 | 1 | 1 | 1 | 1 |
| CCOE | 0.1233 | 0.4295 | -0.2431 | -0.1404 | 0.4917 | -0.0390 |
| NPCR | 100 | 100 | 100 | 100 | 100 | 100 |
| UACI | 1.2841e+07 | 3.6473e+07 | 6.1623e+13 | 2.0499e+07 | 1.4230e+09 | 3.8840e+11 |
| Encryption time/s | 1.3470 | 1.2790 | 1.349 | 0.9680 | 0.8360 | 0.6910 |
| Decryption time/s | 13.9530 | 14.1790 | 14.0740 | 13.7530 | 11.3280 | 11.1270 |
| Mean error | 3.4856e-12 | 3.7564e-12 | 1.0312e-12 | 1.8097e-12 | 1.3721e-12 | 1.2464e-12 |
| MSE | 2.3282e-22 | 2.5930e-22 | 2.9489e-23 | 6.4074e-23 | 3.6006e-23 | 2.7508e-23 |
| PSNR | 156.2957 | 156.0618 | 160.7825 | 159.0974 | 160.3490 | 160.9335 |
| Key | 50 | 100 | 122112 | 67 | 543 | 8907 |

[1][EBE] : Entropy before encryption.
[2][EAD] : Entropy after decryption.
[3][EEI] : Entropy for encryption image.
[4][SDBE] : Standard deviation before encryption.
[5][SDAD] : Standard deviation after decryption.
[6][SDEI] : Standard deviation for encryption image.
[7][CCOAD] : Correlation coefficient between original image and image after decryption.
[8][CCOE] : Correlation coefficient between original image and

We have shown these symbols and what they indicate at the beginning of the research at the introduction.

In Table 3 below, we compare the encryption time and decryption time of our proposed algorithm MK-11 . with other algorithms as below:

- MIE (Mirror-like Image Encryption) [20].
- VC (Visual Cryptography).

- MK_1-4 (Mohammed al-Kufi—level 1-4)**.**
- MK_5**.**
- MKA_6**.**
- MKHAH_7**.**
- MK_8.
- MK-9.
- MK-10.

And in Table (4) below is a comparison between two criteria (MSE) and (PSNR) between this algorithm and other algorithms.

Table 3. Comparing the proposed algorithm with the last algorithms for 6 images (Lena, Baboon, MK-image, Child, Suspension bridge,and Floating bridge )

| Algorithm | Encryption time (Second) | | | | | | Decryption Time (Second) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Image | | | | | | Image | | | | | |
| | Lena | Baboon | MK-image | Child | Suspension bridge | Floating bridge | Lena | Baboon | MK-image | Child | Suspension bridge | Floating bridge |
| MIE | 5 | 9.23 | *** | *** | *** | *** | 5.16 | 9.23 | *** | *** | *** | *** |
| VC | 4.56 | 8.35 | *** | *** | *** | *** | **** | **** | *** | *** | *** | *** |
| MK-1 | 2.224 | 2.287 | *** | 2.126 | 1.67 | 1.535 | 3.11 | 3.166 | *** | 2.716 | 1.94 | 1.936 |
| MK-2 | 5.368 | 5.508 | *** | 4.882 | 3.384 | 3.318 | 6.013 | 6.104 | *** | 5.429 | 3.734 | 3.696 |
| MK-3 | 1.456 | 1.459 | *** | 1.425 | 1.066 | 1.073 | 2.138 | 2.159 | *** | 1.995 | 1.434 | 1.445 |
| MK-4 | 5.54 | 5.567 | *** | 5.115 | 3.532 | 3.574 | 6.265 | 6.382 | *** | 5.818 | 3.871 | 3.895 |
| MK-5 | 2.522 | 2.338 | *** | *** | *** | *** | 2.924 | 3.104 | *** | *** | *** | *** |
| MKA-6 | 7.95 | 8.24 | *** | *** | *** | *** | 2.13 | 2.07 | *** | *** | *** | *** |
| MKHAH-7 | 3.53 | 3.45 | *** | *** | *** | *** | 3.57 | 3.3 | *** | *** | *** | *** |
| MK-8 | 1.799 | 1.898 | *** | *** | *** | *** | 0.73 | 0.74 | *** | *** | *** | *** |
| MK-9 | 3.35 | 3.46 | *** | *** | *** | *** | 3.57 | 3.43 | *** | *** | *** | *** |
| MK-10 | 0.5650 | 0.5580 | *** | *** | *** | *** | 0.6090 | 0.5970 | *** | *** | *** | *** |
| Our algorithm MK-11 | 1.349 | 1.3470 | 1.2790 | 0.9680 | 0.8360 | 0.6910 | 14.0740 | 13.9530 | 14.1790 | 13.7530 | 11.3280 | 11.1270 |

Table 4.:Comparing the results of the global standards of accuracy (MSE) and (PSNR) with other works of image processing in general.

| Algorithm | MSE | | | | | | PSNR | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Image | | | | | | Image | | | | | |
| | Lena | Baboon | MK-image | Child | Suspension bridge | Floating bridge | Lena | Baboon | MK-image | Child | Suspension bridge | Floating bridge |
| SKM[27]JPEG | **** | **** | *** | *** | *** | *** | 21.2 | **** | *** | *** | *** | *** |
| SKM[27]BPP | **** | **** | *** | *** | *** | *** | 22.7 | **** | *** | *** | *** | *** |
| NKP[28] | **** | **** | *** | *** | *** | *** | 8.67 | 9.076 | *** | *** | *** | *** |
| DSA[29] | 3.81e-6 | **** | *** | *** | *** | *** | 54.18 | **** | *** | *** | *** | *** |
| TTV[30] | 0.078 | **** | *** | *** | *** | *** | 29.6041 | **** | *** | *** | *** | *** |
| AZA[31] | **** | 0.132977 | *** | *** | *** | *** | **** | 56.893054 | *** | *** | *** | *** |
| NDD[32] | 0.0012 | **** | *** | *** | *** | *** | 77.4586 | **** | *** | *** | *** | *** |
| MK-1[22] | 9.9137e-26 | 7.9003e-26 | *** | 1.7071e-25 | 2.6112e-24 | 1.126e-25 | 125.0188 | 125.5118 | *** | 123.8387 | 117.9158 | 124.7424 |
| MK-2[22] | 9.9137e-26 | 7.9003e-26 | *** | 1.7071e-25 | 2.6112e-24 | 1.126e-25 | 125.0188 | 125.5118 | *** | 123.8387 | 117.9158 | 124.7424 |
| MK-3[22] | 7.3078e-27 | 8.9787e-27 | *** | 2.5571e-26 | 2.2543e-25 | 2.1675e-26 | 130.6811 | 130.2339 | *** | 127.9612 | 123.235 | 128.3202 |
| MK-4[22] | 9.9137e-26 | 7.9003e-26 | *** | 1.7071e-25 | 2.6112e-24 | 1.126e-25 | 125.0188 | 125.5118 | *** | 123.8387 | 117.9158 | 124.7424 |
| MK-5[23] | **** | **** | *** | *** | *** | *** | 140.4432 | 143.2098 | *** | *** | *** | *** |
| MKA-6[24] | 0 | 0 | *** | *** | *** | *** | Inf | Inf | *** | *** | *** | *** |
| MKHAH-7[25] | 7.8839e-30 | **** | *** | *** | *** | *** | 145.5163 | **** | *** | *** | *** | *** |
| MK-8[26] | 5.0193e-20 | 4.4692e-21 | *** | *** | *** | *** | 144.6276 | 149.8797 | *** | *** | *** | *** |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MK-9[19] | 1.9491e-006 | 3.8846e-006 | *** | *** | *** | *** | 28.5598 | 27.1084 | *** | *** | *** | *** |
| MK-10[3] | 1.2532e-25 | 1.4184e-26 | *** | *** | *** | *** | 172.6407 | 177.3719 | *** | *** | *** | *** |
| Our algorithm MK-11 | 2.9489e-23 | 2.3282e-22 | 2.5930e-22 | 6.4074e-23 | 3.6006e-23 | 2.7508e-23 | 160.7825 | 156.2957 | 156.0618 | 159.0974 | 160.3490 | 160.9335 |

(***) In tables (3 & 4) means that the address is not calculated

## 6 CONCLUSION

We conclude from all those Figurs and tables that this algorithm (image Encryption with (General Singular Values Decomposition) via logistic function by Encryption key only real number (method-2)) for the scientific honesty we explain the strengths and weaknesses following:-

- We adopted an initial encryption key, is a real number to do the program, which represent the algorithm to create another encryption key, is a three-dimensional matrix we do not know it although we have encrypted. This mean, it is a secret encryption key even on the workers on encryption. This gives for the algorithm strength and immunity against hackers.
- The possibility of applying the algorithm on medical and military images and so on and all extensions.
- The algorithm can be used to encrypt text in all languages.
- Encryption time is acceptable and falls within common levels but it is not very ideal because the encryption process enters into very complex stages.
- The decryption time is very large and is unacceptable in the cases of normal encryption, but came because of the very complex operations that we perform for decryption, which we have shown through the search above on the sidelines of table (1) above, an unprecedented case. This means that our algorithm is unique in this way in the complex encryption and decryption and was not preceded by another. It is for this reason that this algorithm applies only in sensitive cases and special highly.
- The relationship between the original image and the image after decryption at its highest value is equal to (1) which indicates to be no loss of data during encryption and decryption.

## 7 DISCUSSION

- This the algorithm (General Singular Values Decomposition via logistic function by Encryption key only real number (method-2)) came she develop for the algorithm previous that we accomplished with a master student where the previous algorithm depend on two encryption keys (real number and image). Here, we only used the real number.
- The algorithm is very complex with evidence of decryption time, but can be complex more by combining it with other algorithms as we have pointed out in our previous research.
- The type of computer and the version of the program MATLAB, which we worked on identified the time of encryption and decoding time and although they are not ideal, but it can be changed by changing the computer and MATLAB version that we work on.

- As usual in our previous works we have been keen to be the image encrypted a matrix is a three-dimensional matrix did not care what will be this three-matrix and but appeared as a black plate. We did not abide by the old method of encryption: converting the original image into another image.
- The readings that appeared to the international accuracy standards confirm the quality of the algorithm and is modern algorithm that has privacy from the rest of the algorithms.
- Through the MATLAB program, we have been able to apply this algorithm to all types of images and all fields of scientific and practical.

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