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Robust Encryption System Based Watermarking Theory by Using Chaotic Algorithms: A Reviewer Paper

Robust Encryption System Based Watermarking Theory by Using Chaotic Algorithms: A Reviewer Paper

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Abstract: In the previous decade, the mixing between chaotic supposition and cryptography frames considers a significant field of data security. Chaos-based image encryption is given a lot of attention in the exploration of data security moreover a great deal of picture encrypting calculations have been proposed concerning chaotic maps. Because of some inveterate highlights of media like information limit and high information excess, the encryption of images not quite the same as that of texts; accordingly it is hard to deal with them by conventional encryption strategies. This paper presents a short review of robust digital watermarking systems that used chaotic algorithms such as Logistic, Tent, Baker, Hyper, Fibonacci, and Arnold maps for encryption of the data presented in several years.

Keywords: Logistic, Tent, Baker, Hyper, Fibonacci, Arnold.

1. Introduction

Versus the advancement of electronic devices and Web propels, a computerized substance can be adequately gotten to by methods for different transmission channels, for instance, Internet, remote frameworks. As a result of focuses of interest of computerized substance, flawlessly recreated and effectively changed, numerous issues have gotten more pressing than in simple occasions, for example, copyright assurance and substance confirmation. A watermark can be classified into two types depending on its capacity: the specific vigorous watermark for copyright protection, and delicate watermark for honesty check[1].

Some procedures should be possible either consecutively or arbitrarily. Arbitrarily picked pixels for covering up in the spread picture give preferable security over a successive way. In our proposed conspire spread picture, pixels are select arbitrarily by utilizing the chaotic arrangement created by the chaotic map. chaotic implies a state of disorder. In science, a map is an advancement work that gives a type of chaotic behavior. A discrete-time dynamical framework is called a map too[2].

Chaos signals are viewed as useful for practical use since they have significant qualities, for example, they are exceptionally delicate to introductory stipulations and framework parameters, they have a fake-irregular property and non-periodicity as the turbulent waves ordinarily commotion, and so on. Subsequently, the aggregation of chaotic theory and cryptography constitutes a significant field of data security. The qualities of chaotic signs make chaos framework a fantastic and strong crypto-framework against any statistical aggression [3].

Chaos-based picture encryption is given a lot of consideration in the examination of data security and a great deal of picture encryption calculations will depend on the chaotic form. There have been numerous watermarking encryption calculations dependent on chaotic maps like the Standard map, the Logistic map, the tent map, the Baker map, and some other types which present in this paper. The watermarking encryption systems are summarized as follows: host media are entered to encryption algorithms which are here chaotic algorithms to embed the information and give a high performance of security, efficiency, and robustness to it. On the other side, the extraction of the information follows the inverse same algorithm that mad in the embedding site and deduce the information with high quality. "Figure.1" shows the general block diagram for the watermarking system.

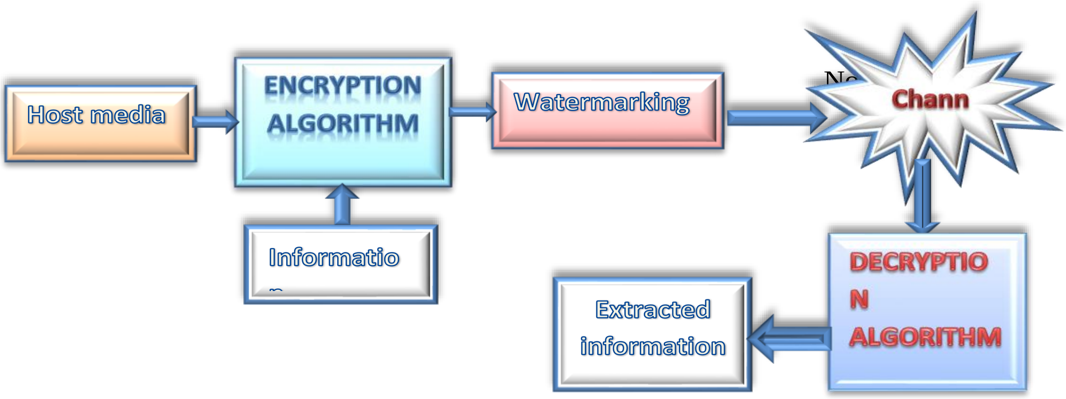

Figure.1 show the general block diagram for the watermarking system.

First of all, section1 of this paper gives an introduction about the watermarking and chaotic algorithms, section2 highlight survey to the maps that the researcher trending in watermarking encryption algorithms and the conclusion and references in the last section.

2. Chaotic Maps

This section, highlight the chaotic maps used in the embedding algorithms.

2.1 Logistic map

Chaotic maps are utilized for image encryption which includes highlights like non-deterministic, irregular, periodicity, and so on. the common one is a 1D logistic map, which was discovered in 1976 by Robert May[4]. Mathematically, the logistic map was written as seen in "Equation (1)":

$$x_{n+1}=\beta(x_n-x_n^2) \quad (1)$$

Where x_n is a number somewhere in the range of zero and one which is the initial value. The estimations for the parameter β are dependent on the user which generates chaotic

sequence and take place amidst 3 and 4. The random arrangement generated from equation(1) exhibits chaotic properties and used for encrypting the image. The basis of β value is:
1- 0< β <1 , the characteristics will be in a steady-state.
2- 1< β <3 , the characteristics will be rapidly increasing
3- 3< β <3.44949, the populace will be moved toward perpetual motions between two qualities.

4-3.44949< β < 3.54409 (around), from practically all underlying conditions the populace, will move toward perpetual motions among four qualities
5- With β expanding past 3.54409, from practically, all underlying conditions will be moved toward motions among 8 qualities.
6-When β ≈ 3.56995 (succession A098587 in the OEIS) the case is considered as the beginning of bedlam. The bifurcation chart of a calculated guide is pictured in "Fig.2" .The guide is in confused state when 3.57 < β ≤ 4 [4,5,6]. The disorderly state is shown by a concealed region. Right now express, the subsequent qualities seem arbitrary even though the framework deterministic [4].

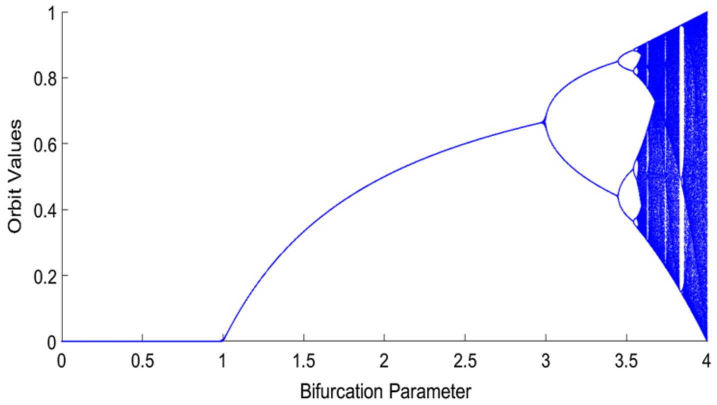

Figure.2 Bifurcation chart of a logistic map (Wikipedia)

Researchers [4-26] have used the logistic map in them watermarking algorithms to encrypt their information which was (image, audio, and text) as shown in "table 1". They were demonstrated How to be careful at the determination of the capacity seed in the generation of chaotic-watermarks. Dependence the on strength range alone isn't sufficient to decide the phantom properties of the watermarks created from the logistic map. The studies were introduced to show that although this method gives an effective strong watermarking procedure however it comes up short if the customer is unwise to choose capacity essential for the logistic map.

Table 1: Review of the Logistic map

References	Technique Used in the algorithm	Applications	Parameters evaluated
Kunal Kumar Kabi[4]	2D Logistic map	image	Number of Pixel Change Rate (NPCR)
Saswati Trivedy [5]	logistic map	image	The PSNR values
Rinaldi Munir [6]	Logistic Map	image	PSNR
Aidan Mooney [7]	logistic map	image	power spectral density (PSD)
Botta [8]	logistic+ Arnold map	image	----
Qiaolun Gu[9]	logistic map	image	PSNR and Accuracy Rate AR
Sajjad Shaukat [10]	Logistic map	image	Entropy and GLCM
Sriti Thakur [11]	Logistic map and DWT. DCT. SVD.	image	NC and SSIM
Song Wei[12]	logistic map	image	Peak signal noise ratio (PSNR) and bit error ratio (RPSN)
Xianyong Wu[13]	logistic and Chebyshev map	image	PSNR (dB) and BER (%)
S. Thakur [14]	logistic map + NSCT, RDWT and SVD	image	PSNR, NCNC,NPCRand UACI
Yassine Himeur[15]	logistic map+DWT-SVD	Video	comparison Ratio CR
Mariya Fatema[16]	Arnold and logistic	image	PSNR, SSIM, and MSE
Hegui Zhu[17]	hyper-chaotic and 2D Logistic map	image	NPCR and UACI
Ola N. Kadhim[18]	1D Logistic Map	image	PSNR and MSE
Gurjit Singh Walia[19]	Logistic and LUDO scan scheme.	image	PSNR
Milad Yousefi [20]	modified logistic map	image	PSNR and MSE
Zhao Dawei[21]	Wavelet and Logistic map	image	PSNR
Mahavir Shantilal [22]	Laplace Detector And Logistic Map	image	laplacian of Gaussian (LoG)
Shabir A. Parah[23]	Logistic and DCT	image	PSNR
Mamta Rani[24]	complex logistic map	Generation of fractals	-----
Hailiang Shi[25]	DWT-SVD and logistic map	Image	PSNR and CC
Chittaranjan Pradhan[26]	2D Logistic and (ECC) in the DWT domain	Image	PSNR

2.2 Tentmap

The tentmap is one of the least difficult chaoticmaps. It has a single dimension and a multi-definition function straight guide. The disorderly practices of the tent map were concentrated diagnostically as far as the invariant thickness and the force range, all through its chaotic region. It was understood: as the climax greatest is brought down, progressive band-parting changes in the disorganized locale and gather to the progress point into the non-clamorous area. Tentmap is topologically conjugate and along these lines its practices are right now under the cycle. It is given as in "Equation(2)":

$$a_{n+1} = f_{\mu}(a_n) = \begin{cases} \mu a_n & \text{for } a_n < \frac{1}{2} \\ \mu(1 - a_n) & \text{for } \frac{1}{2} \leq a_n \end{cases} \quad (2)$$

Where μ is a positive genuine steady =2 for instance, the effect of the function f_{μ} is the resulting interval choosing as (0,1/2) or (0,1). While, a_0 assumes to be a new ensuing position, a_n is generating sequence in (0,1). Higher thickness demonstrates an expanded likelihood of the (a) variable procuring that esteem for the given estimation of the μparameter as shown in "Fig. 3".

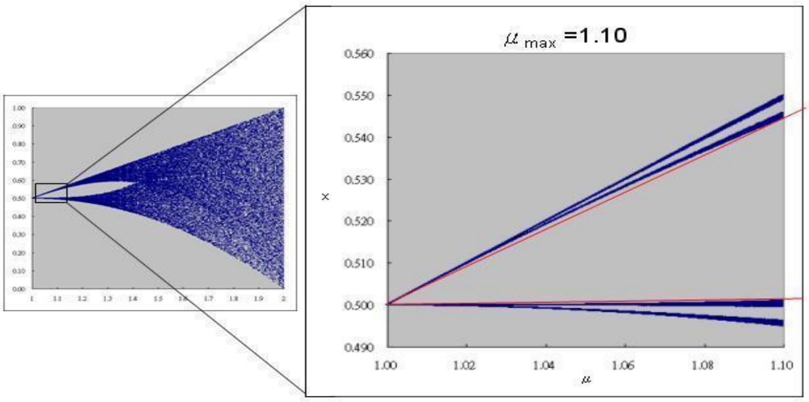

Figure.3 Bifurcation graph for the tent map.(Wikipedia image source)

Researchers[27-33] have used the tent map to encrypt their information through a system which has two principle phases: watermark embedding and extraction as indicate in "Table 2".

Table 2: Review of Tent map

References	Technique Used in the algorithm	Applications	Parameters evaluated
Joshua C. Dagadu[27]	tent map and IWT	Medical image	Correlation coefficient ,entropy, SSIM, PSNR, BER, NPCR
Hassan Elkamchouchi[28]	Tent map	image	PSNR , MSE
Sukalyan Som[29]	Tent and Logistic maps	image	MSE,PSNR,NPCR,UACI, entropy
Toshiki Habutsu[30]	Tent Map	Plaintext	information rate R
Yicong Zhou[31]	Tent - Sine Map	image	Correlation, entropy
R. Parvaz[32]	Tent - Sine Map	image	Correlation, entropy,NPCR and UACI
Jianhua Song[33]	Tent Mapping and SVD.	image	PSNR, NC

2.3 Baker map:

It is named after a plying activity that pastry specialists applied to a mixture: the batter is sliced down the middle, and the two parts are stacked on each other and packed. The disorganized Bakermap is notable to the image-processing network as a material of encryptions. It is a change based apparatus, which plays out the randomization of a square matrix dimensions by changing the pixel positions in the light of a mystery key. It allows a pixel to another pixel position ina goal way.

TheGeometrical portrayal of a baker map change is as per the following: The Phasespace(set of every conceivable condition of a dynamical framework) arrange. "Equation(4)" shows the general formula of the Baker's map:

$$B_{folded}(q,d) = \begin{cases} (2q, d/2) & \text{for } 0 \leq q \leq 0.5 \\ (2-2q, 1-d/2) & \text{for } 0.5 \leq q \leq 1 \end{cases} \quad (3)$$

Researchers [34-40] performed 1D,2D and 3D baker map algorithms to encrypted the information. ChaoticBaker map is utilized as a pre-preparing layer to expand the security level, "Table 3" show their studies.

Table 3: Review of Baker's map

References	Technique Used in the algorithm	Applications	Parameters evaluated
Waleed Al-Nuaimy [34]	Baker map and SVD	Audio	SNR
Mazleena Salleh [35]	Baker map	Image	----
Ahmed Elshamy[36]	Baker map	Image	MSE, PSNR
Muhammad Asif [37]	Baker Map	Plaintext	Bit Independent Criterion, Differential Approximation Probability
Ruisong Ye [38]	Baker Map - DWT	Image	PSNR ,NC
Fengling Han, [39]	Improve Baker Map	Image	histograms
Ruisong Ye [40]	improved Baker map	Image	PSNR

2.4Hyper-chaotic map

Cai GL et al. proposed a three-dimensional chaotic framework in 2007 as shown in "Equation(4)" .

$$\begin{cases} \dot{x} = a_1(y-x) \\ \dot{y} = a_2x + a_3y - xz \\ \dot{z} = x^2 - a_4z \end{cases} \quad (4)$$

Where a_1, a_2, a_3 and a_4 are framework parameters. At the point when "a_1= 20", "a_2 = 14", "a_3 = 10.6":, and "a_4 = 2.8", the framework is confused. Its greatest Lyapunov type is "2.355". This value is greater than that of Lorenzsystem (1.497) and Chen system (1.0742). As we as a whole know, large Lyapunov type implies quick directions division rate. Researchers[41-45] used the Hyper-chaotic map with other algorithms to produce a novel way for encryption as indicated in "Table 4".

Table 4: Review of Hyper-chaotic map

References	Technique Used in the algorithm	Applications	Parameters evaluated
Xiaopeng Wei [41]	hyper-chaotic maps	Image	NPCR , UACI
Xuanping Zhang1 [42]	hyper-chaotic map	Image	Histogram analysis
Yueping Li [43]	hyper-chaotic map and permutation	Image	Histogram analysis
Lihua Gong [44]	hyper-chaotic map and DFrRT	Image	Correlation coefficients, Histogram analysis
Abolfazl Niyat, [45]	hyper-chaotic map and cellular automata	Image	Histograms, Entropy, Correlation coefficients,

2.5 Fibonacci-chaotic map

The Fibonacci numbers 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, have been denominated by French-mathematician EdouardLuc in nineteenth-century after Leonard Fibonacci of Pisa, probably the best mathematician of the Middle Ages, who alluded to them in his book LiberAbaci (1202) regarding his hare issue. Fibonacci succession has interested the two novices and expert mathematicians for a considerable length of time because of their inexhaustible applications, and their pervasive propensity for happening in thoroughly astounding and irrelevant spots. Fibonacci numbers applied by the researcher[46-54] as in "Table 5" for data security from the year 2004 onwards. The Fibonacci numbers were generated by "Equation(5)" as follows:

$$f_a = \begin{cases} 0 & \text{if } a < 1 \\ 1 & \text{if } a = 1 \\ f_{a-1} + f_{a-2} & \text{if } a > 1 \end{cases} \quad (5)$$

Table 5: Review of Fibonacci map

References	Technique Used in the algorithm	Applications	Parameters evaluated
Min-Jen Tsai[46]	Fibonacci+ DWT	Image	Correlation
S. Ponni Sathya[47]	Fibonacci+ DWT+SVD	Video	PSNR and NCC
Jiancheng Zou[48]	Fibonacci map	Image	-----
Ali Akbar Attari[49]	Fibonacci+ DWT	audio	BER
Mehdi Fallahpour[50]	Fibonacci map	audio	SNR and ODG
Baisa L Gunjal [51]	Fibonacci+ DWT+SVD	Image	PSNR, NC
Yicong Zhou[52]	Fibonacci P-code	Image	Histogram
Nan Jiang[53]	Fibonacci and Arnold maps	Image	----
Ehsan Nezhadarya[54]	Fibonacci+ DWT+SVD	Video	PSNR and NCC

2.6 Arnold map

Arnold's catmap denominated after the effect show of Vladimir Arnold in the 1960s, who utilizing an image of a cat. it is a chaotic map from the torus into itself. The 2-dimensional Arnold'scat map is given by the "equation(6)".

$$\begin{bmatrix} d^- \\ q^- \end{bmatrix} = \begin{bmatrix} 1 & 1 \\ 1 & 2 \end{bmatrix} \begin{bmatrix} d \\ q \end{bmatrix} \text{modN}, \quad \text{Where d,q} \in \{0,1,2,\ldots,N-1\} \quad (6)$$

Arnold transform is utilized as a pre-treatment organization for watermarking, which makes the importance of full image as an inane one. It is a basic worry to have the spatial relationship diminished between the host image and the watermarked image. Wherein, d,q is the pixels organizes of the original image: so that d^-,q^- are the pixels organizes after iterative calculations mingling; N is the size of the image. The inverse converting of the "equation (6)" can be attained in "equation (7)":

$$\begin{bmatrix} d \\ q \end{bmatrix} = \begin{bmatrix} 2 & -1 \\ -1 & 1 \end{bmatrix} \begin{bmatrix} d^- \\ q^- \end{bmatrix} \text{modN} \ , d^-,q^- \in \{0,1,2,\ldots,N-1\} \quad (7)$$

The chaoticArnold map is employed to make the watermarking robust for different types of multimedia attacks as in the researchers [55-71] as indicated in "Table 6".

Table 6: Review of Arnold map

References	Technique Used in the algorithm	Applications	Parameters evaluated
Zhu Xi'an[55]	Arnoldmap and DWT.	image	SNR NC
Min Li[56]	Arnold map	image	----
D. Vaishnavi [57]	Arnold map	image	PSNR, NC
Abdallah Soualmi [58]	Arnold map	image	PSNR ,NC, SSIM
Chen Wei-bin[59]	Arnold + Henon map	image	----
Wangsheng Fang[60]	Arnold +logistic map	image	histogram
Onur Jane [61]	Arnold map ,DWT, SVD, and LU Decomposition	image	SR, PSNR
Mehdi Khalili[62]	DCT-Arnold.	image	PSNR ,NC and WAR
Fang Ma[63]	Arnold map+ DCT	image	NC ratio (RPSN)
Mohammad Keyvanpour[64]	Arnold map	image	-----
Chittaranjan Pradhan[65]	Arnold and DCT	image	PSNR, NC
Esam A. Hagras[66]	Arnold and DWT, DCT	image	PSNR, NCC
Jianhua Song[67]	Arnold and DCT	image	PSNR, NC
Xiaohu Ma[68]	Arnold and SVD	image	PSNR
Ruisong Ye[69]	Arnold map	image	Compression quality
Changjiang Zhang[70]	Arnold and Logistic map	image	PSNR
Qian-chuan Zhong[71]	Arnold and DCT	image	MSE

3. Conclusion

In this reviewer paper, first, the basics of some types of chaotic sequence which is used in the data encryptions systems are constructed. You can see that different researchers generate the chaos sequence and used it with other algorithms to produce a robust, efficient, and secured encrypted system. Some researchers encrypt text, other encrypt images, audio, and video, with attention to the conditions of its use, chaotic map gave great results in information security.

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