Cryptography Technique using Chaotic Map

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Abstract: This paper presents are view of Image cryptography techniques based on chaotic maps. The chaotic cryptography is gaining more attention than others because of its lower mathematical complexity & better Security. It also avoids the data spreading hence reduces the transmission cost & delay. The digital image cryptography which is based on chaotic system utilizes the discrete on-linear system dynamics generally called chaotic maps. Depending upon the type of system many types of chaotic maps are available. By combining the large number of cryptographic techniques could be designed in this paper we are presenting are views of some of those techniques.

Keywords: **chaotic map's, discrete on-linear system dynamics, symmetric cryptography.**

I. INTRODUCTION

The cryptography term is used with the encryption of visual Information. It is needed to protect the exposure of confidential or personal information especially in a system where the information is transferred through the open or insecure channel. The modern field of cryptography can be divided into several areas of study. But it can be broadly divided into two types
1) Symmetric-key cryptography
2) Asymmetric-key cryptography.

Generally the symmetric key cryptography is preferred for large data such as image and video because of its properties. The chaotic cryptography also falls in this category. Since in this paper we are only focusing on chaotic cryptography in rest of paper the considerations &designation will be specific to this method only. The chaotic cryptography techniques is generally made by combination of two operations called permutation (generally called Shuffling) &diffusion the both operations are repeatedly tautened till the sufficient encryption level is achieved. The quality of encryption is tested by its capability to defend different attacks like e known plain text attack, cipher text only attack, statistical attack, deferential attack, and brute-force attack, etc. The defending capability from each attack depends upon certain properties of the selected map and its configuration parameters. In this paper we are reviewing different techniques and configurations proposed recently.

II. DIFFUSION TECHNIQUES

Diffusion means spreading out the influence of a single plaintext digit over many cipher text digits, sothatthestatisticalstructureoftheplaintextbecomesunclear.Yaobin Mao and Guanrong Chen [1] [2], an XOR plus modulo (mod) operation is inserted to each pixel in between every two adjacent rounds of the map used. In their proposal the one dimensional logistic map is used for generating the diffusion template. The W7 stream cipher is a synchronous symmetric encryption designed for efficient hardware implementation at very high data rates. W7algorithmsupportskeylengths of128-bit and consists of a control and a function unit.
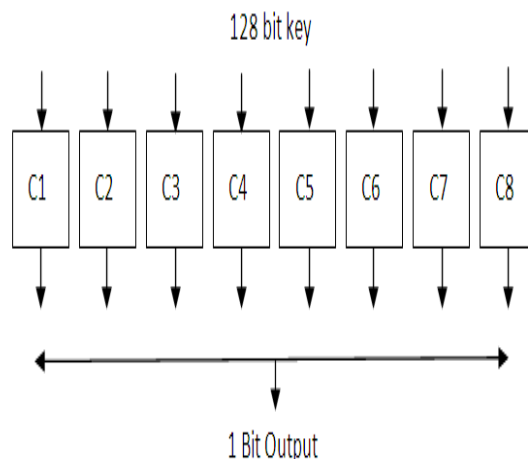
Fig1:W7 key stream generator [2]

The final diffusion is performed by

Shuffled_image$\oplus$Keystream= Cipher image

III. CONFUSION TECHNIQUES

Confusion, on the other hand, means using transformations that complicate the dependence of the statistics of the cipher text on the statistics of the plain text. Yao bin M a o a n d C h e n [1] u s e d 2D to 3D conversion technique for providing the depth in confusion, in their proposal they firstly converted the 2 D image into3D such as

Where W and H are the width and height in pixels of original

$$W \times H = W_1 \times H_1 \times D_1$$

Image and W_1, $H_1$and D_1 are the new dimensions of 3D space. After this the3D transformed image is shuffled bythe3D bakers map the equation (3) represents the 3D bakers map equations. In paper [2] the Hanon map based shuffling gap approach is used. The Henonmap is a proto typical two dimensional invertible iterated map represented by the state equations with a chaotic attract or and is a simplified model of the Poincare map for the Lorenz equation proposed by Henon in 1976[81].The two-dimensional Henon mapisde fined as follows:

$$x_{n+1} = 1 + y_n - \alpha x_n^2$$
$$y_{n+1} = \beta x_n$$

Now the used Cat map is first presented by V.I. Arnold in the research of ergodic theory. Let the coordinates of positions of pixels in an image are P={(x,y) |x,y=1,2,3,...,N}, a 2D Catmap with two control parameters is as follows:

$$x' = (x + ay)mod(N)$$
$$y' = (bx + (ab + 1)y)mod(N)$$

Where, a, b are control parameters which are positive integers and (x', y') is the new position of the original pixel position (x,y) of NxN plain-image when Catmap is applied once   to   the   original. An approach based on pixel bits permutation is proposed in [4] where each pixel is taken as a block of eight bits and then these bits are shuffled they called it the bit level permutation though for shuffling they also really on Cat Map. To implement bit-level permutation, each bit-plane of an image is shuffled separately by using Arnold Catmap with different control parameters, and then we can get the new G(x,y) is given by

$$G'(x,y) = b'(7)b'(6)b'(5)\dots b'(0)$$

Where b′(n) (n∈[0-7]) are   the bits moved from   other positions on the bit-plane. Thus an effective diffusion Mechanism is introduced. Rui song Ye, Wei Zhou [5] proposed the Tent Map based permutation technique. The 2D tent map $T_{a,b}:[0,1]^2 \to [0,1]^2$is given by:

$$T_{a,b}(x) \begin{cases} \begin{pmatrix} 1/a & 0 \\ 0 & 1/b \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix}, (x,y) \in [0,a] \times [0,b], \\ \begin{pmatrix} \frac{1}{a} & 0 \\ 0 & \frac{1}{1-b} \end{pmatrix} \begin{pmatrix} x \\ 1-y \end{pmatrix}, (x,y) \in [0,a] \times [b,1], \\ \begin{pmatrix} \frac{1}{1-a} & 0 \\ 0 & \frac{1}{b} \end{pmatrix} \begin{pmatrix} 1-x \\ y \end{pmatrix}, (x,y) \in [a,1] \times [0,b], \\ \begin{pmatrix} \frac{1}{1-a} & 0 \\ 0 & \frac{1}{1-b} \end{pmatrix} \begin{pmatrix} 1-x \\ 1-y \end{pmatrix}, (x,y) \in [a,1] \times [b,1], \end{cases}$$

Where (01) ab,∈(0,1) ,the 2D tent map is chaoticon [01].

IV. KEY-SPACE ANALYSIS

Image encryption algorithm should be sensitive to the cipher key, and the key space should be large enough to make brute-force attacks in feasible. Yaobin Mao and Guanrong Chen [1] method having a key length of 128bits & it's very sensitive to key as the result shows that a single bit change in key causes 99.59% difference between decoded image. The method [2] has a 128-bitkey, the key space size is 2^{128}. Furthermore, if we consider the two see point shuffler as part of the key, the key space size will be even larger. This means if the precision is 10^{-14}, then the key space can be 2^{128}x $10^{14} = 2^{221} = 3.6$x10^{66}. Apparently, the key space is large enough to resist all kinds of brute-force attacks. The Algorithm described in [3] used eight initial conditions of chaotic map in the algorithm and the initial conditions for x_0, y_0, z_0, μ_1, μ_2, γ_1, γ_2 and λ can be used as secret keys of encryption and decryption. In this case, the precision is 10^{-14}, the key space size is $(10^{14})^8$ i.e. 10^{112}, which is extensively large enough to resist the exhaustive attack. The algorithm proposed in [4] is a153-bitsencryptionscheme, while the key space of the most well-known secure encryption algorithm AES is 128-bits. Soitcan be seen that the proposed chaotic image encryption scheme is good a resisting brute- force attack. The result shows that the single bit change in key causes99.63% difference between decoded images. In [5] the key space is up to $(2^{52})^7 = 2^{364}$. Such a large key space can efficiently prevent opponent's brute-force attack.

V. CONCLUSION

After studying lot so work on chaos based cryptography it can be concluded that the architecture of all proposed work is almost same and the difference remains in the types of chaotic maps used, the way they are configured and how many variables can be created to control the characteristics of the map which reflects the robustness of the system on the other hand to speed up the process some simplification sin the mathematical process can be adapted.

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