Image Hiding Technology Based on Low Dimensional Compound Chaos Algorithm

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ABSTRACT

This paper proposes a low-dimensional compound chaotic algorithm to realize plaintext encryption and hide the encrypted text into the image. Because the texture DCT transform characteristics of the image are fully utilized, the embedded ciphertext has good masking and anti-attack ability. Experiments show that the proposed algorithm improves the security of hidden information and reduces the encrypting and decrypting time on the basis of maintaining the visual quality of the image.\(^1\)

INTRODUCTION

With the popularization of Internet, security has attracted more and more attention. How to transfer a file safely to the destination is very important. Document [1] pointed out that because the image contains more information than the traditional text, it has become an important carrier of information utilization, and image hiding has become a research hotspot. The experimental results of the image encryption algorithm of Lorenz system coupled with inline time-delay chaotic map designed in document [2] show that the algorithm has high security. Literature [3] proposes an enhanced hyperchaotic encryption algorithm, which has more complex plaintext and key relationships and discards scrambling operations. Literature [4] proposes that one-dimensional chaotic map encrypts plaintext with simple implementation, fast encryption speed, but low security. In order to obtain fast and secure encryption, sinusoidal mapping, Tent mapping, Logistic mapping are combined to construct.

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The new composite one-dimensional chaotic system can have the same security as hyperchaotic system, and the encryption efficiency will be significantly improved. By encrypting plaintext and embedding the secret sequence into the image, the security of information is enhanced and good results are achieved.

**PLAIN TEXT SCRAMBLING ALGORITHM FOR LOW DIMENSIONAL COMPOUND CHAOTIC SYSTEM**

**Definition 1:** Compound chaotic mapping model.

\[
x_{k+1} = \begin{cases} 
\alpha \times L(x_k) & x_k \leq 1/3 \\
\beta \times T(x_k) & 1/3 < x_k < 2/3 \\
\gamma \times S(x_k) & x_k \geq 2/3 
\end{cases}
\]

Among them, L(xk) is a Logistic mapping model, T(xk) is a Tent mapping, S(xk) is a sinusoidal mapping, \(\alpha, \beta, \gamma\) is a scaling factor of the composite chaotic mapping model. By adjusting the scaling factor, different chaotic sequences can be obtained. \(x_k \in (0, 1)\) is the initial value of the composite chaotic system, which is generated by random functions.

**Define the 2:** Logistic mapping model.

\[
L_n(x_{k+1}) = \mu L_n(x_k) \cdot [1 - L_n(x_k)]
\]

Among them, \(L_n(x_{k+1})\) is the value of Logistic mapping at any initial value \(x_0\) after \(n\) iterations; \(n=0,1,2,\ldots\). When \(\mu \in (3.594536, 4)\), the model enters into chaotic state, and the generated sequence \(\{L_n(x_k); k = 0,1,2,\ldots\}\) is non-periodic, non-convergent, sensitive to initial conditions, and has good security.

**Define 3:** Sine map.

\[
S(x_{k+1}) = \lambda \sin(\pi x_k)/4
\]

Among them, \(x_k \in [-1, 1]\) is the model variable, and the control parameter \(\lambda \in (0, 4] \). When \(\lambda = 3.965431\), the model enters chaos.

**Define 4:** Tent mapping.
\[ T(x_{k+1}) = \begin{cases} \delta \times x_k & x_k < 1/2 \\ \delta \times (1 - x_k) & x_k \geq 1/2 \end{cases} \] (4)

Among them, \( x_k \in (0, 1) \) is the system variable and \( \delta \in [0, 2] \) is the control parameter.

**EMBEDDING ENCRYPTED INFORMATION INTO IMAGES**

The input image is divided into 8*8 image blocks, and each image block is transformed by Discrete Cosine Transform (DCT). Because the texture of each block is different, the sensitivity of human eyes to each block is different. For the quantized DCT coefficient matrix, the DC coefficient is located in the upper left corner, and the AC coefficient is the remaining 63 coefficients. The more the high frequency coefficient is not zero, the more detailed the block is, the more complex its texture is, and the more sensitive the human eye is to the block. If the AC coefficient changes greatly, it will have a greater impact on the image. On the contrary, if the texture is not complex and the human eye is insensitive to it, the AC coefficients can be greatly modified to embed secret information.

**INFORMATION HIDING AND EXTRACTION ALGORITHM**

This algorithm directly embeds scrambled data on the quantized AC coefficients. Different methods are used to modify AC coefficients to embedding secret information for different blocks with different sensitivity to human eyes. A DCT coefficient of 8*8 block quantization is \( F(I,J) \) (I,j=0,1,...,7) The number of non-zero AC coefficients is \( n \). If the value of \( n \) is small, the texture of the block is simpler and least sensitive to human eyes. The larger the value of \( n \), the more complex the texture of the block is and the more sensitive it is to human eyes. Let \( T_1 \) and \( T_2 \) be the classification thresholds, where \( T_1 < T_2 \), image blocks are classified according to the value of \( n \). If \( n < T_1 \), image blocks are classified as W1. If \( T_1 < n < T_2 \), image blocks are classified as W2. If \( n > T_2 \), image blocks are classified as W3. Different embedding algorithms are applied to different classes to improve the hiding quality.

![Figure 1. Hidden effect diagram of Couple image.](image)
EXPERIMENTAL CONCLUSION AND ANALYSIS

Couple image after hiding encrypted file. A large number of experiments using this algorithm have achieved good results, taking the color image as an example for plaintext hiding. The Couple image hides the 65521bit information and its PSNR value is 38.3052dB. It can be seen from the graph that the hidden algorithm has better image quality after hiding the information. As shown in Figure 1. Among them, (a) is the original Couple image, (b) is the image after the secret information is scrambled, (c) is the Couple image after the encrypted file is hidden.

CONCLUSIONS

This paper studies the method of image hiding information. In order to make the information more secure, we first scramble the plaintext we want to hide by low-dimensional compound chaotic algorithm, and then divide each sub-block into different types according to its texture characteristics by using the DCT transform characteristics of the image. Different embedding methods are used to embed data. A large number of experimental data show that the proposed algorithm avoids the block effect, and can balance the relationship between the hiding capacity and the image visual quality, and improve the hiding capacity and information security of the carrier image on the basis of maintaining the image visual quality.

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REFERENCE