Intelligent Image Watermarking Using New Anti-Arnold Transform

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ABSTRACT

In this paper the new anti-Arnold transform pre-processing is used for decreasing time consumption in extracting the watermarks instead of using conventional Arnold transform and by exploiting watermarking algorithm which is used for having an optimized embedding. In this case the weighted mean in blending two images is used for being optimized by using genetic algorithm.

KEYWORDS

Watermarking, Anti-Arnold transform, Genetic algorithm.

1. INTRODUCTION

Associated with the widespread circulation of images are issue of copyright infringement, authentication and privacy. One possible solution is to embed some watermarks into the images [i]. Watermarking is divided into two main categories; Spatial domain and Transform domain. Transform domain itself is divided into two main categories; Discrete cosine transform (DCT) [ii] and Discrete Wavelet transform (DWT). Watermarks embedded in the frequency domain are more robust than watermarks embedded in the spatial domain [iii].

Each of the domains has its advantage and disadvantage in image watermarking. In DCT domain if the watermark is embedded into the middle frequency coefficients, the watermarking has a good imperceptibility after watermarking. In contrast the DCT transformation removes the unchanging quality of the system. DWT transformation has high consumption in both computational and time and also transformation affect the edges of the images after transformation.

Many approaches have been proposed so far to cater such issues of protection, copyrights and illegal duplication of digital images, out of which watermarking is most popular [iv].

This paper organized as follows; In part two the Arnold transform is introduced, in the third part the main embedding algorithm is represented and in the fourth part the experimental results are shown and at the end the conclusion of using this algorithm is presented.

2. ARNOLD TRANSFORM

Arnold transform [v] is used to scramble the watermark image here. Arnold transformation is posed in the research of Arnold and the Ergodic theory, which is also called face transformation [vi]. For N*N image, Arnold transform is defined as (1).

$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} 1 & 1 \\ 1 & 2 \end{pmatrix} . \begin{pmatrix} x \\ y \end{pmatrix} \bmod(N) \quad (1)$$

Where x, y are the coordinates of the watermark image and x', y' are the coordinates after scrambling and N is the size of the watermark image. As it is claimed in [6] the time of restoring watermark image after scrambling by using Arnold transform is rising by increasing the image size. So after image scrambling by Arnold transform, the method of [2,vii] is used for restoring the watermark image which has been used the inverse matrix to obtain the primary coordinates. In [5] the inverse matrix of (1) is used to re-scramble the watermark after extraction. It is claimed that the time consumption is less than previous algorithms.

3. Embedding Algorithm

The main algorithm for embedding the watermark image into the cover image is represented in [viii]. The embedding algorithm is optimized here by using the genetic algorithm [ix-xv]. The embedding algorithm is as (2).

$$S = \alpha.C + (1-\alpha)W \quad (2)$$

Where C is the cover image, W is the watermark image, S is the watermarked image and α is the embedding strength or blending coefficient. The bound of α is between [0, 1]. The more α approach to 0, the more blended image approach to secret image W. On the contrary, the more α approach to 1, the more blended image approach to cover image C [3].

The innovation of this paper using the Genetic algorithm to find the most appropriate α to resist against some attacks and withal preserves the imperceptibility into the logical value. The trade-off between imperceptibility and robustness is considered as the fitness function of the genetic algorithm.

The structure of the optimizing the embedding algorithm is as follows. First some initialize value of α is produced randomly and then convert to the binary representation. Then the embedding is performed with the initial value and the fitness value is measured. The cross-over is manipulated by the rate of 0.72 and the best value of α is obtained by iteration of embedding algorithm.

The embedding algorithm and GA optimization are illustrated in Figure 1 and Figure 2 respectively.

Actually we cannot separate the GA block and embedding block, because GA is global algorithm and embedding algorithm should be used inside the GA. Just for transparency we separate these two blocks.

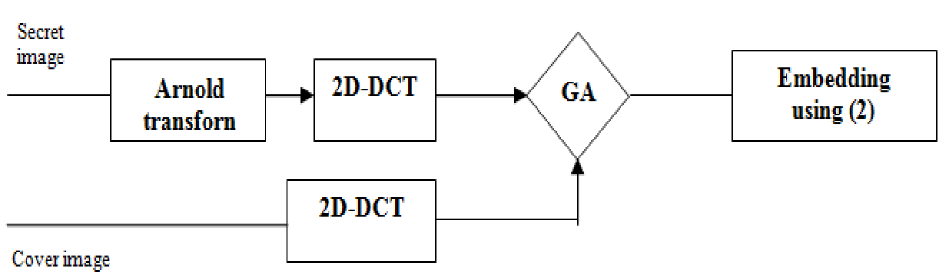


Figure 1. Embedding algorithm

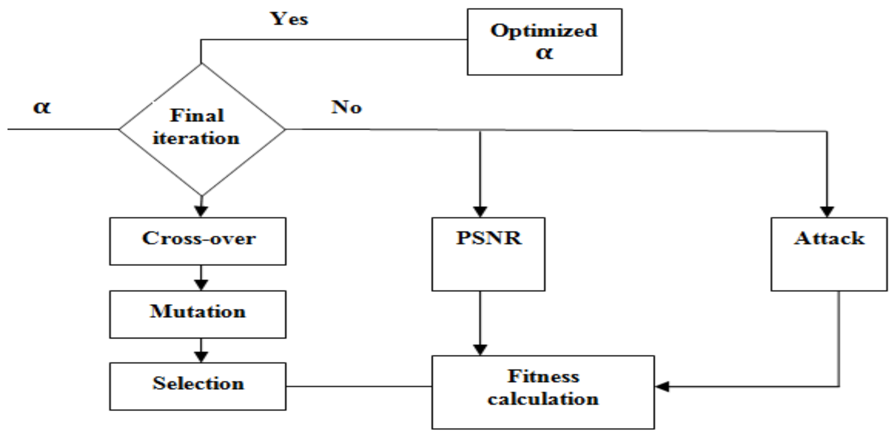


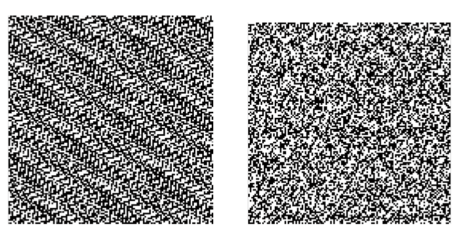
Figure 2. GA optimizing

4. Experimental Results

For analyzing our optimization we used the cameraman picture as cover image with size of 256*256 and the flower image as watermark image with size of 32*32. Both cover and watermark images are illustrated in Figure 3.

At first the Arnold transform is performed on to the watermark image (flower image), Then DCT transform is performed on to the cover image (cameraman) and scrambled image of watermark by using 8*8 blocking. The scrambled image after 35 iterations of Arnold transform is illustrated in Figure 4.

Figure 3. Cover and watermark image.



a b

Figure 4. (a) scrambled watermark by using Arnold transform (Iteration=35). (b) Transformed (a) by DCT.

The GA parameters are as follows: Crossover rate=0.8, Mutation rate=0.001, Initial population=20 and the fitness function is as (3).

$$F = PSNR + \lambda(1 - BER) \tag{3}$$

Because PSNR is at range of 30-40 and BER in the range of 0-1, their value should near each other and normally some coefficients like λ is used.

The construction of chromosome in each iteration, α is a 16 binary bit. The representation of the binary chromosome for the weighted mean with value of 0.72 is illustrated in Figure 5. The watermarked image is shown in Figure 6.

The result of implementing this algorithm is shown in Table 1 where Gaussian attack is considered as the optimization problem. The adaptive algorithm selected the best answer for value of α for blending image to resist against this particular attack. The attack can be different or even can be considered as a multiple attacks.

0	0	1	1	1	1	1	0	1	0	0	1	1	0	0	1

Figure 5. Chromosome representation for α.

Figure 6. Watermark extraction after Gaussian attack.

Table1. PSNR & (1-BER) after Gaussian Attack

	PSNR	**1-BER after Gaussian noise**	**α**
Cameraman	38.41	0.77	0.72
Lena	42.12	0.83	0.84
Baboon	41.87	0.81	0.91

5. Conclusion

In merging two images there is trade-off between robustness and imperceptibility. The weighted mean should be selected properly to have a rational value of robustness and imperceptibility. In this paper we optimized the weighted mean in the embedding algorithm by using the genetic algorithm. We decreased the consumption time of restoring the watermark by using new Arnold transforms in restoration which was introduced in 2010.

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