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A PSO BASED PREDICTION AND REVERSIBLE HISTOGRAM SHIFTING STEGANOGRAPHIC SCHEME

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***Abstract*—In this paper, we propose a steganographic scheme based on Particle Swarm Optimization (PSO) for prediction image and followed by Histogram shifting to embed secret data and obtain a stego image. The algorithm of PSO emulates from behavior of animals societies has been used by many applications of several problems. In this proposal, the optimal reference pixels are chosen and the prediction image is generated using PSO algorithm. Eventually, using the two selected groups of maxima points and minima points, the histogram of the error in prediction is shifted to embed the secret data reversibly. Since the same reference pixels can be exploited in the extraction procedure, the embedded secret bits can be extracted from the stego image correctly, and the cover image can be restored losslessly. The proposed scheme provides a better embedding rate and good visual quality when compared with recently used methods.**

Keywords*— *prediction image, steganography, Particle Swarm Optimization(PSO), histogram shifting,reversible data hiding.

I. INTRODUCTION

The expansion of Digital Communication over internet has caused various issues in terms of data security. Steganography is the act of encoding a data within an image such that the original image quality is not affected much and also the hidden data remains in it. The secret or host data can be text, image, audio or video. There are two key things stressed on the process of steganography. One is producing an acceptable quality of stego image which has very low distortion. The other is the tolerance of stego image to various attacks made during communication.

In Image steganography, there are various techniques available to embed data into an image. It is majorly divided into two types: Spatial domain techniques and Transform domain techniques. In spatial domain, the easiest form to embed data is using Least Significant Bit (LSB) technique but it is prone to the attacks made on the stego image. In transform domain, the Discrete Cosine Transform (DCT), the Discrete Fourier Transform (DFT) and the Discrete Wavelet Transform (DWT) are basic techniques. These techniques are computer over host image and the secret data is embedded by changing the coefficient values of the corresponding. The Transform domain technique is always able to withstand the attacks on it because the pixels are distributed throughout the spatial domain. Some of the spatial domain techniques have supported the issue of withstanding the distortion. Maity and Kundu [1] have framed concept on robustness which is blind watermarking of digital images. The concept said by them is well suited and could prevent various attacks through image processing but less amount of secret data. Lin et al. [2] proposed a concept on distortion tolerance in spatial domain technique. The concept assured that the stego image was able to withstand the attacks like noise and image compression, but the quality of stego image is low when the secret data is of large amount, since the pixels that are used for encapsulating data are chosen in random.

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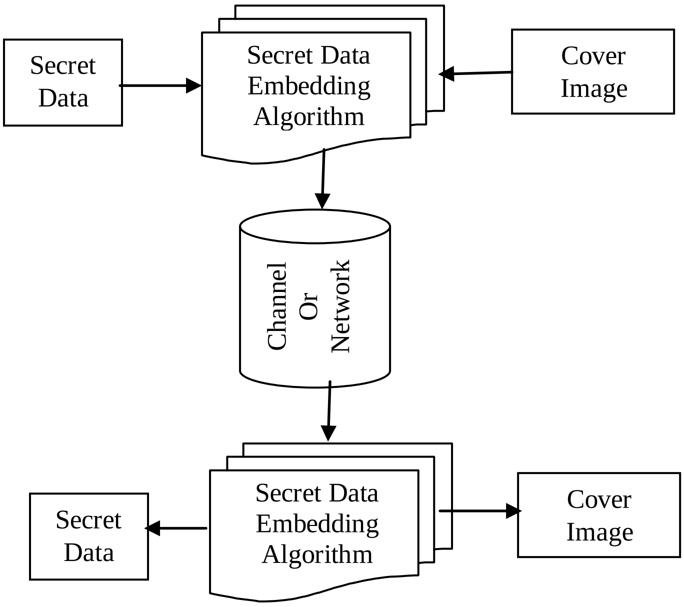

Fig. 1. STEGANOGRAPHY

Reversible Steganography in data has been used in the past years in order to achieve better secured embedding of share data with lossless conversion of cover image into stego image. . Ni et al. [3] proposed a technique based upon histogram shifting for secret data hiding reversibly. The maxima point of the histogram of the image was opted and the values of the pixels in the range from its right to the least or zero point were increased by single value to create one vacant bin in histogram for embedding. The count of secret bits which could be hidden always depends on the pixel value of the maxima point in the histogram. The information regarding the maxima point and the zero point required in the process of extracting the hidden data and recapture the cover image. The Fig. 1 represents the general flowchart of Steganography.

II. RELATED WORK

Many Researches have worked in this spatial domain to persist the quality of the image without tampering it and also providing the image with distortion tolerance. So the enhancement made on this image steganography technique is to use transform domain technique with spatial domain technique. The proposal of the following author(s) is such that they produce the method to form predication image and then perform embedding operation after that. In 2013, Chuan Qin et al proposed a concept which uses a PDE based inpainting algorithm to generate the prediction image that has similar structural and geometrical pattern as of the cover image and then histogram shifting mechanism is used to embed the bits of the secret data [4]. During the prediction image generation the reference pixels are chosen in random and it is not optimized, so we propose Particle Swarm Optimization (PSO) method could be optimized to generate the whole prediction image. In 2014, Mohamed Ismail proposed a system for constructing adaptive and hybrid lifting scheme with PSO algorithm that is used to calculate the prediction function P in the image lifting scheme and Artificial bee colony algorithm that is used to calculate the0 different update coefficient by local search, eventually choosing optimally the best update coefficient to get best quality of compressed image [5].

III. PROPOSED SCHEME

In our proposed scheme, the cover image is divided into blocks and reference pixels in each block is chosen using PSO algorithm and it is masked twice or thrice to generate the prediction image and then the histogram between the original image and this image is calculated and then histogram shifting technique is applied to it. The extraction with recovery of the images is almost the same as to that of the reverse process of the embedding technique.

A. Particle Swarm Optimization (PSO)

Particle Swarm Optimization (PSO) [32, 33] is a stochastic optimization technique which is based on population, bio-inspired algorithm which is bird flocking or fish schooling. Each particle in the population simulates a potential solution. The particles are transferred through a n-dimensional search space, where the particle position of each is adjusted based on its individual experience and of its neighbours. All the individual have fitness values that are computed by the objective function to be optimized by the use of PSO algorithm and have velocities which straight to the movement of the individual particles. Let $x_i(t)$ denote the particle position i in the search space at time step t. The particle position is modified to $x_i(t + 1)$ by adding velocity $v_i(t + 1)$ to the current position, i.e.

$$x_i(t + 1) = x_i(t) + v_i(t + 1) \qquad (1)$$

Each particle can be shown by its current speed and position, the most optimist position of each individual and the most optimist position of the surrounding. In the particle PSO, the speed and position of each particle change according the following equality [9]:

$$v_{id}^{k+1} = v_{id}^{k} + c_1 r_1^k (pbest_{id}^k - x_{id}^k) + c_2 r_2^k (gbest_d^k - x_{id}^k) \qquad (2)$$

$$x_{id}^{k+1} = x_{id}^{k} + v_{id}^{k+1} \qquad (3)$$

In this equality, v_{id}^k and x_{id}^k stand for separately the speed of the particle “i” at its “k” times and the d-dimension quantity of its position; $pbest_{id}^k$ represents the d-dimension quantity of the individual “i” at its most optimist position at its “k” times.

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```
Particle Swarm algorithm
procedure PSO
    repeat
        for i = 1 to number of individuals do
            if G(x_i) > G(p_i) then                          ▷ G() evaluates goodness
                for d = 1 to dimensions do
                    p_id = x_id                              ▷ p_id is the best state found so far
                end for
            end if

            g = i                                            ▷ arbitrary
            for j = indexes of neighbors do
                if G(p_j) > G(p_g) then
                    g = j      ▷ g is the index of the best performer in the neighborhood
                end if
            end for

            for d = 1 to number of dimensions do
                v_id(t) = f(x_id(t-1), v_id(t-1), p_id, p_gd)    ▷ update velocity
                v_id ∈ (-V_max, +V_max)
                x_id(t) = f(v_id(t), x_id(t-1))                  ▷ update position
            end for
        end for
    until stopping criteria
end procedure
```

Fig. 2 PSO Algorithm

$gbest_d^k$ is the d-dimension quantity of the swarm at its most optimist position. In order to avoid particle being far away from the searching space, the speed of the particle created at its each direction is confined between - V_{max}, and V_{max}. If the number of V_{max} is too big, the solution is far from the best, if the number of V_{max} is too small, the solution will be the local optimism; c1 and c2 represent the speeding figure, regulating the length when flying to the most particle of the whole swarm and to the most optimist individual particle. If the figure is too small, the particle is probably far away from the target field, if the figure is too big, the particle will maybe fly to the target field suddenly or fly beyond the target field. The proper figures for c1 and c2 can control the speed of the particle's flying and the solution will not be the particle optimism. Usually, c1 is equal to c2 and they are equal to 2; r1 and r2 represent random fiction, and 0-1 is a random number. In local PSO, instead of persuading the optimist particle of the swarm, each particle will pursuit the optimist particle in its surrounding to regulate its speed and position. Formally, the formula for the speed and the position of the particle is completely identical to the one in the whole PSO.

Particle Swarm has two primary operators [10]: Velocity update and Position update. During each generation each particle is accelerated toward the particles previous best position and the global best position. At each iteration a new velocity value for each particle is calculated based on its current velocity, the distance from its previous best position, and the distance from the global best position. The new velocity value is then used to calculate the next position of the particle in the search space. This process is then iterated a set number of times, or until a minimum error is achieved.

B. Reversible Data Hiding using Histogram Shifting

Though several improved HS-RDH methods have been proposed to increase the hidden data capacity in which the methods shift the histogram of processed image, e.g., each image tiles [4] or differences between pixels or prediction error [5], [6], and so on, this paper focuses generalized HSRDH [7], [8]. A generalized HS-RDH method firstly derives tonal distribution $\mathbf{h} = fh(p)g$ of an original image in which $h(p)$ represents the number of pixels with pixel value p where $p \in \{0;1;:::;2K-1\}$ for K-bits quantized pixels, and the method finds pixel value p_{max} which pixels with p_{max} are the most significant in the original image. This method also finds the longest successive zero histogram bins which are from po_{min} to po_{max}, i.e.,

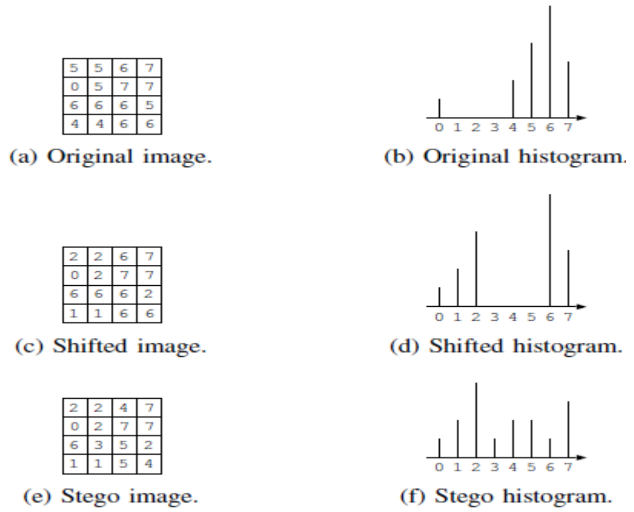

Fig. 3 Example of histogram modification

$$p_{max} = \arg\max h(\mathrm{p}) \tag{4}$$

$$\mathrm{h}_{max} = h(\mathrm{p}_{max}) = \max \mathrm{h}(\mathrm{p}) \tag{5}$$

Where it is assumed here that,

$$\mathrm{po}_{min} \leq po_{max \leq} p_{max} \tag{6}$$

To extract hidden data and to recover the original image, the method memorizes p_{max}, $p0_{max}$, and $p0_{min}$.

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This method easily knows *q* by Eq. (3), and it, then, extracts a hidden *q*-ary symbol from a pixel with pixel values between (*p*max-*q*+1) and *p*max. After extracting all symbols from pixels with pixel values between (*p*max-*q*+1) and *p*max, the pixel value in all pixels which carried hidden symbols in themselves is returned to *p*max. Finally, add (*q* + 1) to the pixel value of pixels with pixel values between *p*0min and (*p*max-*q*) to recover the original image.

C. System Architecture

It explains the total working paradigm of the whole project that undergoes the following steps as given in the sytem architecture fig. 4

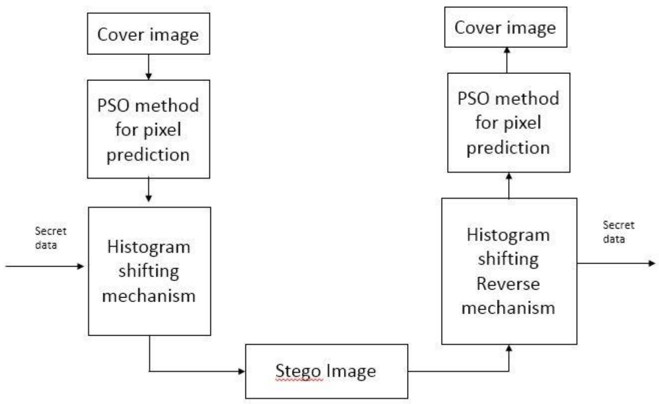

Fig. 4 System Architecture

D. Working

The working principle of this proposed concept is explained through following process:

- The Cover Image is chosen and it is converted into gray scale and is splitted into blocks
- The Secret data is chosen and it is qualified as array of bits and the data is aligned to be embed into it
- Each block is chosen with PSO optimization to gather the required scale
- Then the following thing is processed for two or three masking
- The masked image is compared with the original cover image and the difference is calculated to produce its histogram
- The prediction image generated with the latest histogram is processed further with histogram shifting
- The peak values and zero values are calculated and the respective shifting as per the histogram shifting technique the further process are carried out
- Then the secret bits are added in the relative positions of the histogram shifted pixels.
- Now, the prediction image is added with modified image to obtain the Stego image

Similarly the reverse process is carried out to extract the secret data and the extraction is carried out with the required parameters of reference pixels.

IV. CONCLUSION

The Proposed concept determines the reference pixels collectively with the usage of Particle Swarm Optimization followed by the secret data embedding using histogram shifting. The masking done before the generation of prediction image is twice or thrice using PSO gives a better embedding rate and the low loss in visible quality of stego image and original cover image. The enhancements could be done in order to work with color image rather than gray scale. This could be done with the help of analyzing the changing RGB functions.

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