Application of Genetic Algorithm to Optimize Robustness and Fidelity of Watermarked Images (A conceptual approach)

[1]Mr. Sachin Goyal
Department of I.T
Lecturer , UIT, RGPV, Bhopal
Sachingoyal@rgtu.net

[2]Dr Roopam Gupta
Department of I.T
Reader & Head, UIT, RGPV, Bhopal
Roopamgupta@rgtu.net

[3]Mr. Ashish Bansal
Department of I.T
Reader & Head , SVITS, Indore
Ashssi@rediffmail.com

Abstract

Digital Watermarking provides techniques to hide watermarks into digital content to protect it from illegal copy or reproduction. The prevalent techniques of digital watermarking in spatial domain cause the watermarked image to loose its image quality termed as Robustness and fidelity. Several techniques have been devised to optimize the Robustness and fidelity with given information content. Recently, genetic algorithms have become quite popular in artificial intelligence area due to their evolutionary nature and their special significance for optimization in several areas. This paper is an attempt to propose the conceptual background of technique based on genetic algorithm which may help to optimize the fidelity and robustness aspect of watermarking.

Genetic algorithm may help to search appropriate locations in cover images to insert watermark so that fidelity or robustness may be optimized. Based on a specific requirement, a suitable fitness function may be selected.

KEYWORDS: Digital watermarking, Genetic Algorithm.

I. INTRODUCTION

Digital watermarking should provide the qualities like imperceptibility, robustness, security of cover image. This paper is an attempt to provide a conceptual understanding of the application of genetic algorithm to optimize the fidelity and Robustness of watermarked images using genetic algorithms. A large number of techniques have been developed in spatial domain and frequency domain like manipulating the bit plane of Least Significant Bit (LSB)[1], linear addition of watermark to cover image, using mid band coefficients of DCT transformed blocks to hide watermark[2], maximizing strength of watermark using Discrete Wavelet Transform(DWT) techniques[3], Using radial basis function(RBF)neural network to achieve maximum strength watermark[4], Embedding watermark in the DC components of transformed blocks[5] etc. Cox et al. [6] pointed that, in order for a watermark to be robust to attack, it must be placed in perceptually significant areas of the image. Kundur and Hatzinakos [7] embedded the watermark in the wavelet domain where the strength of watermark was decided by the contrast sensitivity of the original image. Delaigle et el. [8] generated binary m-sequences and then modulated on a random carrier. A method for casting digital watermarks on images and analyzing its effectiveness was given by I.Pitas[9] and immunity to subsampling was examined. Cox and Kilan [10] presented a secure algorithm for watermarking images using spread-spectrum techniques. An innovative watermarking based on Genetic Algorithm in the transform domain [11] was proposed. It was robust against watermarking attacks. It was robust because it used Genetic algorithm to train the frequency set for embedding the watermark. Dengeun Lee, Takeyung Kim, Seongwon and Joonki Paik [12] present a novel watermark extraction algorithm based on DWT and Genetic algorithm. Zhicheng , Hao Li , Jufeng Dai and Sashuang Wang[13] proposed image watermarking based genetic algorithm. In order to improve the robustness and imperceptibleness of the image spread spectrum watermark algorithm, a new approach for optimization in 8x8 domain using genetic algorithm. Chien-Chang chen and Chien-Shian Lin [14] propose Genetic algorithm based image authentication approach to improve the image quality of a protected image.

Ali Al-Haj [15] described an imperceptible and a robust combined DWT-DCT digital image watermarking algorithm. The algorithm extracted watermarks given digital image using a combination of discrete wavelet transform and the discrete cosine transform. Franco and Juan carlos[16] provided a DWT based digital watermarking fidelity and robustness evaluation.

However, these techniques suffer from the problems of unsatisfactory values of fidelity and robustness to various attacks as discussed in these papers. Specially, spatial domain techniques are known for poor values of fidelity although they are simpler to implement. This paper proposes a technique which employs genetic algorithm which uses normalized correlation of cover image and watermarked image as the basis of fitness function which needs to be optimized and works by searching appropriate embedding locations of watermarks within the cover image which are treated as populations of the genetic algorithm.

Section II discusses the concept of genetic algorithm and its applicability in optimizing applications. Section III discusses the conceptual working of optimization of Robustness and

ISSN : 0975-3397

Fidelity using genetic algorithms. Conclusion is given in section IV followed by references.

genetic algorithm and its application in optimization

Genetic algorithms[17,18] are search algorithms based on mechanics of natural selection and natural genetics. They combine survival of fittest among string structures with a structured yet randomized information exchange to form search algorithms with some of the innovative flair of human search. In every search, a new set of artificial creatures (strings) is created using bits and pieces of fittest of the old creatures. Conventional search techniques are not very suitable for optimizing non-linear functions with multiple variables. However, genetic algorithms this can be conveniently done.

In the genetic algorithms, the parameters are represented by en encoded binary string called the "chromosome" and the elements in the binary strings or the "genes" are adjusted to maximize or minimize the fitness values. The fitness function has to be carefully selected specific to a particular application and the kind of optimization required. Thus, the entire process of genetic algorithm starts with a set of proposed solutions randomly generated and try to produce further possible solutions to achieve the desired optimization.

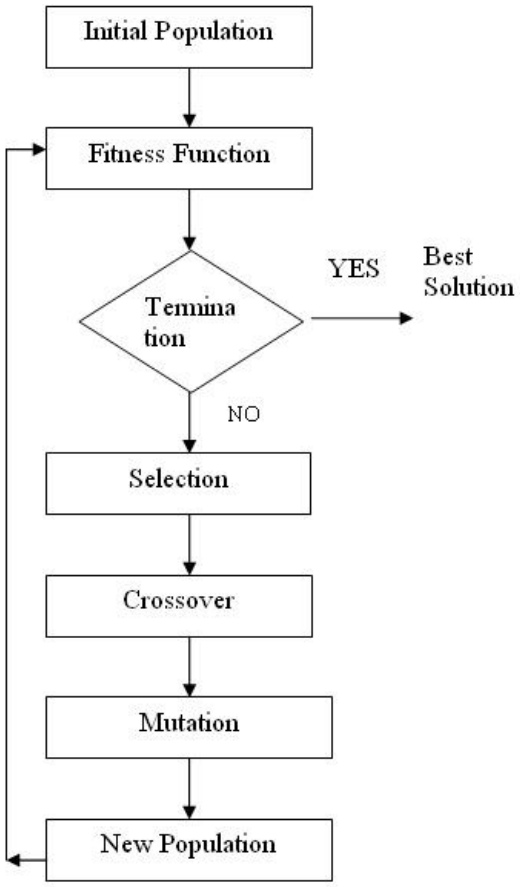

Figure 1. Flow Chart of Genetic Algorithm

This is the reason of the wide application of genetic algorithms in optimization areas. The figure 1 shown describes a simple genetic algorithm in its simplified form.

The core components of the GA[14,18] are as under.

1. Fitness Value
2. Selection
3. Crossover
4. Mutation

Fitness Function: A Measurement of how well the chromosome fit the search space.

Selection : Selection is based on the survival-of-the-fittest mechanism. Chromosome are selected based on the fitness value.

Cross Over: The Chromosome with the higher fitness values generate more offspring.

Mutation: After Crossover , the strings are subjected to mutation . mutation of a bit involves flipping it changing 0 to 1 and vice versa with a small probability.

II. CONCEPTUAL WORKING OF OPTIMIZATION OF ROBUSTNESS AND FIDELITY USING GENETIC ALGORITHM

The entire process of Robustness and fidelity optimization using genetic algorithm can be explained using the following points.

1. First of all a cover image and a watermark image is chosen.
2. Now, an initial set of random locations is chosen to insert watermark bits inside the cover image. This set makes the initial population.
3. The Selection of fitness function is based on the to optimize Robustness and fidelity. So Fitness function is as follow.

Fitness Value = PSNR + α NC ..(1)

Fitness Value = NC + α PSNR ..(2)

In case (1), with the increase in the value of α, the fitness value increases more with the increase in the value of NC rather than PSNR. Since, the value of NC has been taken to represent robustness, so ultimately the fitness value increases with the increase in the value of robustness. So, optimization of robustness takes place for a given value of fidelity.

In case (2), with the increase in the value of α, the fitness value increases more with the increase in the value of PSNR rather than NC. Since, the value of PSNR been taken to represent fidelity of the watermarked image , the fitness increases with the increase in the value of PSNR. So, optimization of fidelity takes place for a given value of robustness.

(4) Now, one by one, the fitness values of individual populations (random embedding positions) are calculated with the following procedure .

ISSN : 0975-3397

(a) Insert the watermark bits in the locations within the cover image as described by the selected population.

(b) Find the correlation between the cover image and the watermarked image so obtained. This correlation is taken as the fitness value.

(5) Now, the best fitness value and the corresponding best fit individual is selected. Also, the second most fit individual with the corresponding fitness value is selected.

(6) Now, the crossover of the two individuals are done.

(7) Now, the mutation process is done.

(8) The entire process stops when a particular population is reproduced with a fitness value more than or equal to an acceptable value decided at the beginning of the entire search procedure.

III. Conclusions

In this paper, attempts have been made to demonstrate the utility of genetic algorithm in the area of improving the fidelity and robustness of digital watermarking. The role of fitness function proposed is to ensure the optimization of fidelity or robustness.

As the genetic algorithms are very promising in field of optimization applications so they may be employed in digital watermarking area also to optimize its desirable characteristics. Several variations in genetic algorithm may be tried and tested for performance in fidelity and robustness optimization area which forms the further scope of research.

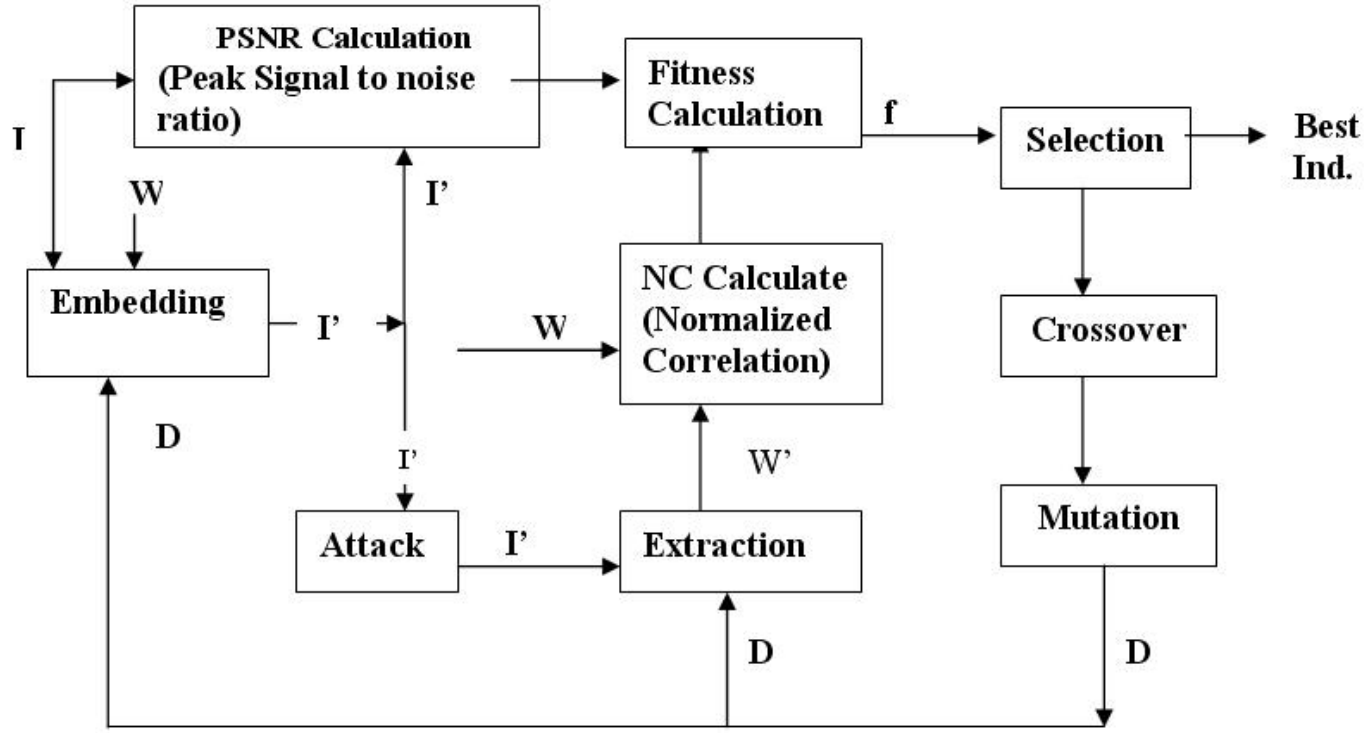

Figure 2. Block diagram for optimization of robustness and fidelity using Genetic Algorithm

Where

I : Cover Image

D : Key(Destination location to insert watermark)

I' : WaterMarked Image

W' : WaterMark Extracted after Attack

W : WaterMark

I'' : Attacked WaterMarked Image

f : Fitness Function

IV. REFERENCE

[1] R.G.Van Schyndel,A.Z.Tirkel and CF.Osborene, "A Digital Watermark" in Proc. IEEE International Conf. Image processing,1994,vol.2 pp 86-92.

[2] Ahmidi N. Safabaksh R. "A Novel DCT Based Approach for Secure Color Image Watermarking " in Proc. ITCC 2004 International Conference Information Technology:Coding and computing,2004,vol 2,pp 709-713.

[3] K.J.Davis and K.Najarian " Maximizing Strength of Digital Watermarks Using Neural Networks", in Proc. International Joint Conf. Neural Network ,2001,vol 4, pp. 2893-2898.

[4] Zhang Zhi Ming,Li Rong-Yan,Wang Lei,"Adaptive Watermark Scheme with RBF Neural Networks, in Proc. 2003 International Conf. Neural Networks and Signal Processing,2003,vol 2. pp.1517-1520.

ISSN : 0975-3397

[5] Fengsen Deng and Bingxi Wang,"A Novel Technique for Robust Image Watermarking in the DCT Domain" in Proc. Of the 2003 International Conf. Neural Networks and Signal Processing,2003,vol.2,pp.1525-1528.

[6] J.Cox,J.Kilian , "A Secure Robust Watermark for Multimedia" in Proc. First International Workshop, vol 1174 of Lecture notes in computer science ,pp. 185-206.

[7] D.Kundur and D. Hatzinakos, " A Robust Digital Image Watermarking Method using Wavelet – Based Fusion",in Proc,IEEE Int. Conf. on Image Processing , Oct. 1997, vol. I, pp. 544-547.

[8] J.Delaigle,C.De Vleeschouwer, and B. Macq, "Psychovisual Approach to Digital Picture Watermarking", Journal of Electronic Imaging,vol.7,No.3,pp.628-640,July 1998.

[9] I.Pitas , "A Method for Signature Casting on Digital Images",in Proc,IEEE Int. Conf. on Image Processing ,Sept 1996,vol.III,pp.215-218.

[10] I.Cox,J Kilan, " Secure Spread Spectrum Watermarking for Images,Audio and Video" , in Proc. IEEE International Conference on Image Processing ,1996,vol 3,pp. 243-246.

[11] C-S Shieh, H-C Huang and F-H Wang, J-S Pan " Genetic watermarking based on transform domain technique". The journal of the pattern recognition society 37(2004) pp 555-565.

[12] Dongeun Lee, Tackyung Kim, Seongwon Lee, and Joonki paik. " Genetic Algorithm based Watermarking in Discrete Wavelet Transform Domain". LNCS 4113, pp 709-716, 2006.

[13] Zhicheng Wei, Hao Li, Jufeng Dai, Sashuang Wang " Image Watermarking Based on Genetic Algorithm" IEEE Transaction, 2006.

[14] Chien-Chang Chen and Cheng-Shian Lin " A Genetic algorithm based nearly optimal image authentication approach". International Journal of Innovative computing, Information and Control, Volume 3, No. 3, pp 631-640, June 2007.

[15] Ali Al-Aaj " Combined DWT-DCT Digital watermarking". Journal of computer Science 3(9): pp 740-746, 2007.

[16] Franco A.Del Colle and Juan Carlos Gomez " DWT based digital watermarking Fidelity and Robustness Evalution" JC&T Vol.8 No. 1 April 2008

[17] Goldberg, D.E , "Genetic Algorithm in Search , Optimization & machine Learning", Addison-Weseley,1989.

[18] M.Srinivas and Lalit M.Patnaik, " Genetic Algorithm : A Survey" IEEE,1994.

ISSN : 0975-3397