Digital Image Watermarking Based on Genetic Algorithm Approach

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***Abstract* —** *Digital watermarking is the process of embedding information into a digital signal. The main issues to be considered during the watermark are robustness and fidelity. Robustness implies the strength of the watermark against various image processing attacks. The fidelity is used to determine the quality of the image after embedding the watermark. The techniques of digital watermarking are based on spatial domain and frequency domain. In this paper a watermarking scheme is implemented based on DWT using Genetic Algorithm. Discovering the locations to embed watermark into cover image can be viewed as an optimization problem. Genetic Algorithm is used to find optimal locations to achieve fidelity. The proposed technique uses Rank and Tournament based selection as a selection operator to find the optimal locations for embedding watermark into the cover image. Attacks are also possible on the watermarked image. Quantitative measures such as PSNR and NC are used to evaluate the quality of each watermarked image.*

Keywords: *Water Marking, Genetic Algorithm, Classification, Mutation, Embedding Process, Optimaization.*

I. INTRODUCTION

Digital watermarking is the process of hiding or embedding an imperceptible signal (data) into the given signal (data). The imperceptible signal called watermark and the given signal is called cover work. This cover work could be an image, audio or a video file. This embedded data can be later extracted from the multimedia for security purposes. This technology works as an appropriate tool for identifying origin, founder, owner, or legal consumer of a document or a image. Watermarking can be used to identify a document or image that is illicitly distributed or altered. It is expected that digital watermarking will have wide span of practical applications such as copyright authentication, video on demand systems, image databases etc.

II. WATERMARKING CLASSIFICATION

A. ***Visible watermarks:*** Visible watermarks are an expansion of the idea of logos. Such watermarks are applicable to images only. These logos are inserted into the image but they are transparent. Such watermarks cannot be eliminated by cropping the center part of the image. Further, such watermarks are safeguarded against statistical analysis. The disadvantage of visible watermarks is reducing the quality of image and detection by perceptual means only. Thus, it is not possible to find them by dedicated programs or devices. Such watermarks have applications in maps, graphics and software user interface[1][2].

B. ***Invisible watermark:*** Invisible watermark is hidden in the content. It can be detected by an authorized agency only. Such watermarks are used for content or author authentication for detecting unauthorized copier.

C. ***Fragile watermark****:* This watermark is also known as tamper-proof watermarks. Such watermark is demolished by data manipulation or it is a watermark that is designed to destroy when any copying is done. Absence of the watermark specifies that a copy has been made.

D. ***Private watermark:*** These watermarks are also known as secure watermarks. To read or to get such a watermark, it is important to have the secret key.

E. ***Perceptual watermarks:*** A perceptual watermark has taken the advantage of human sensory system to provide invisible and yet robust watermark. Such watermarks are also called as transparent watermarks that provide extremely high quality contents.

III. DESIGN AND IMPLEMENTATION

In the proposed method Genetic Algorithm is used to achieve the required watermark. The main theme of watermarking is to search for the appropriate locations for embedding the watermark

into the cover image. Suitable locations are obtained by using Genetic Algorithm[3][4].

Discrete Wavelet Transform (DWT) are special functions which are analogous to sines and cosines in Fourier analysis that are used as basic functions for representing signals. In **2-D images, applying DWT relates to processing the image by 2-D filters in every dimension.** The sub-band (LL) represents the coarse-scale DWT coefficients while the sub-bands (LH), (HL) and (HH) signify the fine scale of DWT coefficients. To attain the next coarser scale of wavelet coefficients, the sub-band (LL) is further processed until some final scale "*N"* is attained. When "*N"* is reached we would have 3N+1 sub-bands consisting of the multi-resolution sub-bands (LL_N) and (LH_X),(HL_X) and (HH_X) where "X" ranges from 1 until "N". Due to its brilliant spatio-frequency localization properties, DWT is very suitable to identify the areas in the host image where a watermark can be embedded effectively. In particular, this property permits the exploitation of the masking effect of the human visual system. If a DWT coefficient is modified, only the region corresponding to that coefficient will be modified. In general most of the image energy is concentrated at the lower frequency sub-bands (LL_X) and consequently, embedding watermarks in these sub bands may corrupt the image significantly. Embedding in the low frequency sub-bands, however, could increase robustness significantly. On the other hand, the high frequency sub-bands (HH_X) that include the edges and textures of the image and the human eye is not generally responsive to the changes in such sub-bands. This would allow the watermark to be embedded without being perceived by the human eye. The compromise adopted by many DWT-based watermarking algorithm is to embed the watermark in the center frequency sub-bands (LH_X) and (HL_X), where the acceptable performance of imperceptibility and robustness could be achieved[5].

Fig. 1: Original Image

A. GENETIC ALGORITHM

1. BEGIN
2. Generate initial population.
3. Compute fitness of each individual.
4. WHILE not finished DO LOOP.
5. BEGIN
6. Select individual from old generations for mating.
7. Create offspring by applying recombination and mutation to the selected individual.
8. Compute fitness of the new individuals.
9. Kill old individuals to make room for new chromosomes and insert offspring into new generation.
10. If population has converged Then finishes: =True.
11. END
12. END

B. EMBEDDING PROCESS

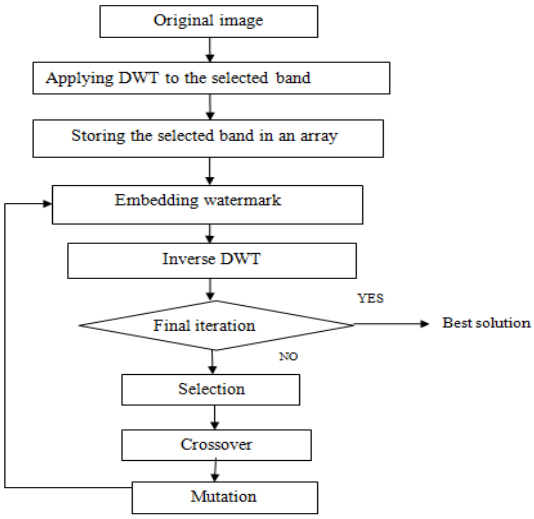

Fig. 2: Flowchart for watermarking with Genetic Algorithm.

Above Flow Chart shown in Figure 2 describes the process of watermarking with Genetic Algorithm.

C. EXTRACTION PROCESS

Input a watermarked image and let it be denoted as W.

1. Convert the watermarked image it into one dimensional vector form i.e. reshapes.

2. Initialize the memory size of watermarked image and compare it with original image that is denoted as O.
3. If the value of watermarked image is less than original image then Watermark bit 0 is detected, otherwise Watermark bit 1 is detected.

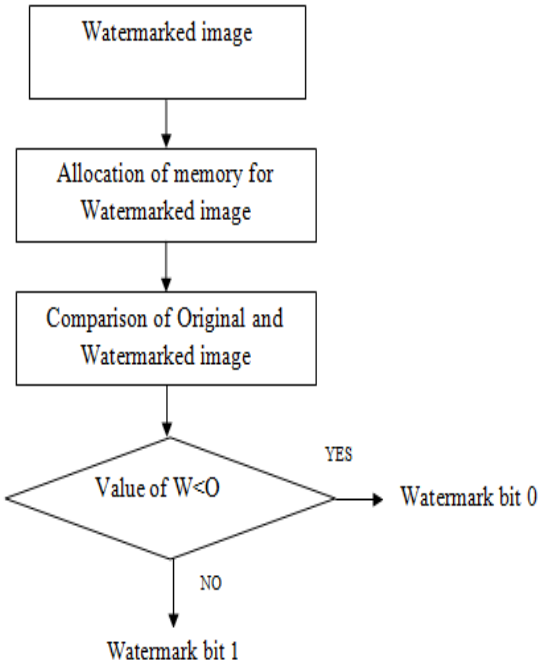

Fig. 3: Extraction Process.

Figure 3 Shows the steps for the extraction process.

IV. EXPERIMENTAL RESULTS

Table 1: PSNR (dB) and NC values

Selection criteria / images	Rank selection PSNR (dB)	Tournament selection PSNR (dB)	NC[Rank & Tournament selection]
Lena	81.24	80.79	1.0
Baboon	74.29	74.21	1.0
Peppers	81.53	81.07	1.0
Man	76.64	76.18	1.0
Boat	79.48	79.02	1.0

Above Table 1 shows PSNR (dB) and NC values for 30 iterations for population size as ten.

Table 1 and Table 2 indicates that the PSNR (dB) value is high for 16 bits of watermark as 98.45dB and low for 256 bits of watermark as 77.30dB, since the replaced pixels will be less that means more strength and increase in PSNR (dB) values. It can be observed that PSNR (dB) values are decreasing when the embedding strength increases. For 256 bits of watermark PSNR(dB) is 77.30dB, for embedding strength 0.1 and for 0.5 embedding strength PSNR (dB)[7][8] is 68.48dB because if the strength is increased then the replacement of the bit instead of image pixel will be done with more strength which in turn reduces the pixel value and its strength decreases which affects the PSNR (dB)[6][7].

Proposed method is implemented using Rank and Tournament based selection. Simulations are performed on different images like Lena, Baboon, Peppers, Man, and Boat. PSNR (dB) and NC values are calculated for two selections[9][10].

Table 2: PSNR (dB) and NC values for iterations 20 for population size as ten.

Table 2 describes the PSNR (dB) and NC values for iterations 20 for population size as ten. Proposed method is implemented using Rank and Tournament based selection. PSNR (dB) values are calculated for two selections for five standard images Lena, Baboon, Peppers, Man, and Boat. From Table it can be analyzed that Rank selection has high PSNR (dB) values than tournament selection. Since the obtained PSNR (dB) values show that peppers image has high fidelity as 81.53dB[8]. As there is little variations in the obtained PSNR (dB) values for Rank and Tournament based selection, Normalized Correlation value (NC) are constant and is same for all the sample images as 1.

Selection criteria / images	Rank selection PSNR (dB)	Tournament selection PSNR (dB)	NC[Rank and Tournament selection]
Lena	82.49	82.04	1.0
Baboon	75.54	75.28	1.0
Peppers	82.78	82.32	1.0
Man	77.89	77.11	1.0
Boat	80.73	80.12	1.0

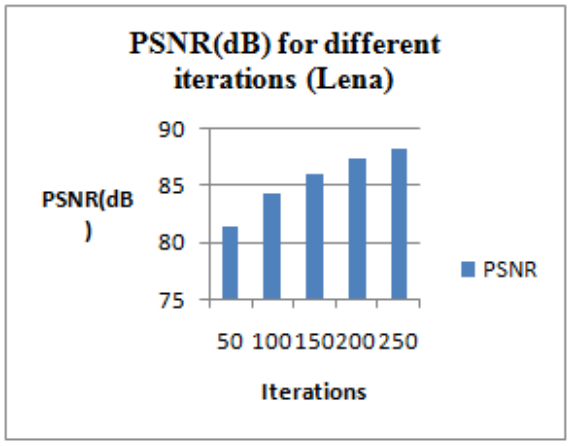

Fig. 4: PSNR (dB) values for different iterations.

Above shown in Figure Fig. 4 the PSNR (dB) values for different iterations for population as ten.

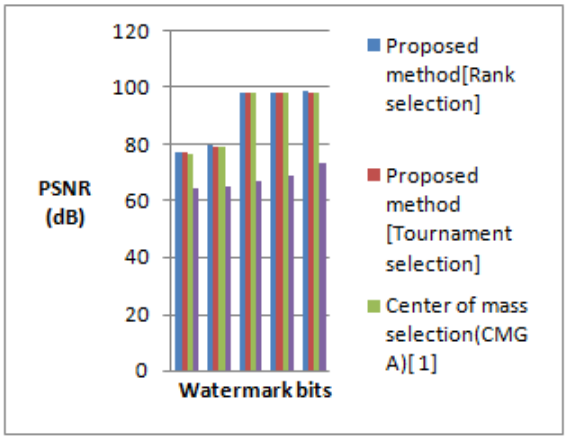

Fig. 5: Comparsion of PSNR(dB) values with the proposed method with other algorithm.

The Figure5 shows comparsion of PSNR(dB) values for 16,32,56,128,256 bits of watermarks for proposed method with other algorithms. It can be observed that proposed method has high PSNR(dB) values than the other algorithms.

V. CONCLUSION

In this work, the digital image watermarking using Genetic Algorithm is presented. Watermark is embedded into the suitable locations of a cover image. DWT is applied to the original image and watermark is embedded and robustness is evaluated. In this work to select new positions rank based selection and tournament based selection is used. The role of fitness function which is proposed is used to ensure the fidelity through optimization. It has been observed experimentally that the performance of the scheme is satisfactory for different images. For sample images like Baboon, Lena, Pepper, Man, Boat the quality of watermarked image is found to be good in terms of PSNR. For 256 bits of watermark the proposed method has shown a PSNR(dB) values of 77.30dB when compared to Center of Mass selection Genetic Algorithm(CMGA) i.e. 76.86dB and Roulette wheel Genetic Algorithm(RWGA) has depicted as 64.76dB. The proposed Genetic Algorithm based method is superior in terms of fidelity.

Finally a comparative analysis has been done on the algorithms based on Rank selection and Tournament selection. From the experiment a conclusion has been drawn that the embedding watermark using proposed method based on Rank selection has offered higher PSNR values, hence the higher fidelity is attained.

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