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Digital Watermarking Using Hybridization of Optimization Techniques:A Review

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Abstract— The vast data exchange on the Internet and the extensive use of digital media,has raised an alarm in multimedia security. Digital watermarking provides techniques to hide watermarks into digital content to achieve copyright protection and prevent its illegal copy or reproduction.This paper provides a survey of various optimization techniques for watermarking databases.

The Genetic Algorithm (GA) is a class of optimization algorithm that mimics the process of natural evolution. Genetic algorithm helps in searching appropriate locations in cover images to insert watermark.Also its hybridization with other nature inspired algorithms can further improve the process of watermarking.

Keywords— Watermarking, optimization, Genetic algorithm, Bacterial Foraging Algorithm,particle swarm optimization,Ant Colony Optimisation, DWT,DCT

I. INTRODUCTION

Before the invention of steganography and cryptography, it was challenging to transfer secure information and thus, to achieve secure communication environment. Hackers are the people who tend to change the original application by modifying it or use the same application to make profits without giving credit to the owner. Hence, protection techniques are required to be efficient, robust and unique to restrict malicious users. This lead to the development of the new technology called "Watermarking". Digital Watermarking describes methods and technologies that hide information, for example a number or text, in digital media, such as images, video or audio

Based on the method used for watermark embedding and extraction, invisible watermarking techniques are of three types– Spatial Domain, Frequency Domain and Mixed Domain. Invisible Watermarking is an optimization problem. There is a wide tradeoff between the two requirements- invisibility and robustness. Moreover various techniques show different level of robustness to different types of attacks.

II. PROPERTIES OF DIGITAL WATERMARKING

There are three main Properties of digital watermarking technique

A. Transparency or Fidelity: The digital watermark should not affect the quality of the original image after it is watermarked. Watermarking should not introduce visible distortions because if such distortions are introduced it reduces the commercial value of the image.

B. Robustness: Watermarks could be removed intentionally or unintentionally by simple image processing operations like contrast or brightness enhancement, gamma correction etc. Hence watermarks should be robust against variety of such attacks.

C. Capacity or Data Payload: This property describes how much data should be embedded as a watermark to successfully detect during extraction. Watermark should be able to carry enough information to represent the uniqueness of the image. Different application has different payload requirements

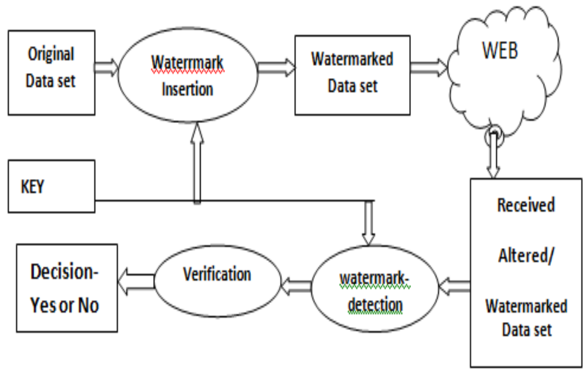

Fig1: Digital watermarking scheme

III. IMAGE WATERMARKING EMBEDDING DOMAIN

Based on domain used for watermark embedding process, the watermarking techniques can be classified into the following types:

1.) Spatial watermarking

Spatial watermarking can also be applied using colour partition such that the watermark appears in only one of the colour bands. However, the watermark appears when the colours are separated for printing. Spatial domain process involves addition of fixed amplitude pseudo-noise into the image. These approaches modify the least significant bits of original contents. The watermark can be hidden into the data to assume that the LSB data are visually irrelevant.

2.) Transformation based watermarking There are many techniques proposed based on transformation based watermarking. Watermarking can be applied in the transform domain; including such transforms are discrete Fourier, discrete cosine, and wavelet. In this first the host or main data is transformed and then modifications are applied to transformed coefficients. Watermark is embedded in DFT, DCT and DWT domain coefficients.

IV. DCT DOMAIN WATERMARKING

DCT based watermarking techniques are more robust as compared to spatial domain watermarking techniques. This algorithm is robust against simple image processing operations like low pass filtering, contrast and brightness adjustment, etc. However, they are difficult to implement and are computationally more costly. And also they are weak against geometric attacks like scaling, rotation and cropping etc. DCT watermarking can be classified into Block based DCT watermarking and Global DCT watermarking One of the first algorithms presented by Cox et al. (1997) used global DCT to embed a robust watermark in the tion of the image has many advantage because most compression algorithms remove the perceptually insignificant portion of the image. It represents the LSB in spatial domain however it represents the high frequency components in the frequency domain

V. DWT DOMAIN WATERMARKING

In the last few years wavelet transform has been widely used in signal processing in watermarking ,general and image compression schemes . In some applications wavelet based watermarking schemes better than DCT based approaches.

A. Characteristics of DWT

1) The wavelet transform decomposes the image into three spatial directions, i.e. vertical, horizontal and diagonal. Hence wavelets reflect the anisotropic properties of HVS more precisely.
2) Wavelet Transform is mathematically efficient and can be implemented by using filter convolution simply.
3) Magnitude of DWT coefficients is high in the lowest bands (LL) at each level of decomposition and is least for other bands (HH, LH, HL) .
4) The high magnitude of the wavelet coefficient the more significant.
5) Detecting watermark at lower resolutions level is effective because at every resolution level there are few frequency bands present.
6) High resolution sub bands helps to easily positioned edge and patterns of textures in an image.

B Advantages of DWT over DCT

1) Wavelet transform in HVS more closely than the DCT.
2) Wavelet transformed image is a multi-resolution description of image. Hence an image is shown at different resolution levels and can be continuously processed from low resolution to high resolution.
3) Visual artifacts introduced by wavelet transformed images are less marked compared to DCT because wavelet transform doesn’t decompose the image into blocks for processing. At high compression ratios blocking artifacts are noticeable in DCT; but in wavelet coded images it is much clearer.
4) DWT has spatial locality property, which means if signal or any watermark is embedded it will affect the image locally . Hence a wavelet transform provides both frequency and spatial in formation for an image.

Surekha et al.[1] have proposed a new optimization method for digital images in the Discrete Wavelet Transform (DWT) domain. The tradeoff between the transparency and robustness is considered as an optimization problem and is solved by applying Genetic Algorithm.

[5,6]The genetic algorithm is a model of machine learning which derives its behavior from a metaphor of the processes of evolution in nature. this is done by the creation within a machine of a population of individuals represented by chromosomes, in essence a set of character strings that are analogous to the base-4 chromosomes that we see in our own dna. the individuals in the population then go through a process of evolution.

when the genetic algorithm is implemented it is usually done in a manner that involves the following cycle: 1)Evaluate the fitness of all of the individuals in the population.

2)Create a new population by performing operations such as crossover, fitness-proportionate reproduction and mutation on the individuals whose fitness has just been measured. 3)Discard the old population and iterate using the new population. one iteration of this loop is referred to as a generation. There is no theoretical reason for this as an implementation model. indeed, we do not see this punctuated behavior in populations in nature as a whole, but it is a convenient implementation model.

The first generation (generation 0) of this process operates on a population of randomly generated individuals. From there on, the genetic operations, in concert with the fitness measure, operate to improve the population.

VI. OUTLINE OF THE BASIC GENETIC ALGORITHM

1. [Start] generate random population of n chromosomes (suitable solutions for the problem)
2. [Fitness] Evaluate the fitness f(x) of each chromosome x in the population
3. [New population] Create a new population by repeating following steps until the new population is complete
    1. [Selection] Select two parent chromosomes from a population according to their fitness (the better fitness, the bigger chance to be selected)
    2. [Crossover] With a crossover probability cross over the parents to form a new offspring (children). If no crossover was performed, offspring is an exact copy of parents.
    3. [Mutation] With a mutation probability mutate new offspring at each locus (position in chromosome).
    4. [Accepting] Place new offspring in a new population
4. [Replace] Use new generated population for a further run of algorithm
5. [Test] If the end condition is satisfied, stop, and return the best solution in current population
6. [Loop] Go to step 2

Particle swarm optimization [2,3,4](PSO) is a new promising evolutionary algorithm for the optimization and search problem. One problem of PSO is its tendency to trap into local optima due to its mechanism in information sharing.

PSO shares many similarities with evolutionary computation techniques such as Genetic Algorithms (GA). The system is initialized with a population of random solutions and searches for optima by updating generations. However, unlike GA, PSO has no evolution operators such as crossover and mutation. In PSO, the potential solutions, called particles, fly through the problem space by following the current optimum particles. the PSO algorithm works by having a population (called a swarm) of candidate solutions (called particles). These particles are moved around in the search-space according to a few simple formulae. The movements of the particles are guided by their own best known position in the search-space as well as the entire swarm's best known position. When improved positions are being discovered these will then come to guide the movements of the swarm. The process is repeated and by doing so it is hoped, but not guaranteed, that a satisfactory solution will eventually be discovered.

Mona M. Suliman[2] et al have incorporated PSO with GA in hybrid technique called GPSO. This paper proposes the use of GPSO in designing an adaptive medical watermarking algorithm.

The[10] ant colony algorithm is an algorithm for finding optimal paths that is based on the behavior of ants searching for food.At first, the ants wander randomly. When an ant finds a source of food, it walks back to the colony leaving "markers" (pheromones) that show the path has food. When other ants come across the markers, they are likely to follow the path with a certain probability. If they do, they then populate the path with their own markers as they bring the food back. As more ants find the path, it gets stronger until there are a couple streams of ants traveling to various food sources near the colony.Because the ants drop pheromones every time they bring food, shorter paths are more likely to be stronger, hence optimizing the "solution." In the meantime, some ants are still randomly scouting for closer food sources.

One of the optimization techniques is [9]Bacterial Foraging Optimization technique. It is an optimization method of searching based on evolutionary process. BFO algorithm is a novel evolutionary computation algorithm, it is proposed based on the foraging behavior of the Escherichia coli (E. coli) bacteria live in human intestine. Natural selection tends to eliminate animals with poor foraging strategies such as locating, handling and ingesting food and favor the propagation of genes of those to achieve successful foraging [3]. The foraging behavior of E.Coli bacteria is adopted for the evolutionary computation algorithm, and it is named as Bacterial Foraging Optimization (BFO). BFO is an optimization technique based on the population search and efficient for global search method.

S. M. Ramesh[5] et al. have presented an efficient image watermarking technique to defend the copyright protection of digital signatures. The major steps include the watermark embedding and watermark extraction. This work is implemented to watermark the original input medical image. The grayscale digital signature image as a watermark and it is embedded in the HL and LH sub-bands of the wavelet transformed image.

VII. CONCLUSION

In this paper, survey on various nature inspired algorithms was done. By employing a GA with a proper fitness function into the watermarking system, both the watermark imperceptibility and watermark robustness requirements are considered.The The hybridization of GA with any of the other algorithms can surely improve the process of watermarking

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