# Implementation of Watermarking Using DCT, DWT and Optimization Techniques

**Gagan Badole[1], Dr. Sanjay Chouhan[2]**
[2]Head, Dept of ECE
[1, 2] Jawaharlal Institute of Technology, Borawan

***Abstract-*** *Digital watermarking may be a technique which is employed to cover the ownership information within the digital media. Watermarking techniques are developed to guard the copyright of multimedia objects like text, audio, video, etc. This work mainly focuses the necessity of aerial and medical image watermarking. In the field of surveillance, planning and inspection, now image processing plays an important role and as a result watermarking is essential to provide the image security. In this work, different transform are used like discrete cosine transform, discrete wavelet transform. Optimization techniques like bacterial foraging optimization (BFO) and particle swarm optimization are going to be applied and analyzed their performance for the aim of watermarking the aerial image. PSNR (Peak signal to noise ratio) value, NCC (normalized cross correlation) and IF (image fidelity) will be calculated to show the comparative performance of the applied algorithms. The value of PSNR and NCC must be high permanently embedding of message.*

***Keywords***- Watermarking, Discrete Wavelet Transform, Bacterial Foraging Optimization, Peak Signal to Noise Ratio.

## I. INTRODUCTION

In this time, internet offers great convenience in transmitting The birth of paper watermarks took place in Fabrioano, Italy 700 years ago. It was at first used to indicate the paper brand and production mill. Then the use of water marks increased in Italy and in a little span over Europe quickly. Primarily to get identified the brand of the paper watermarks were used and its production mill, but afterwards, for the format of the paper it served the purpose, strength and quality, and authenticity of the paper. Paper marks were used as safety measures against as anti-counterfeiting on currency and documents related to currencies by 18 century and still are used as security features in currency today [1] in shown in Figure 1.1.

**Figure 1.1: Watermark in Mark and Dollar Bank Notes**

The term water marks got its name at the end of the 18th century as it resembles the effects of water on paper. Emil Hembrooke filed a patent in 1954 which was for identifying music works was the first example of technology similar to digital water marking, Komatsu and Tominaga used the term "digital watermarking" in 1988 first.

The Watermarking System can be compared to a communication system. Like the Communication System the watermarking system consists of three parts. The analogy of communication system and watermarking system is shown in table 1.1 and figure 1.2.

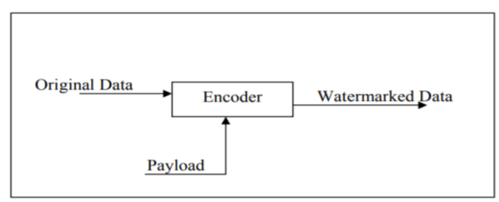



**Figure 1.2: Watermark Encoder (Embedder)**

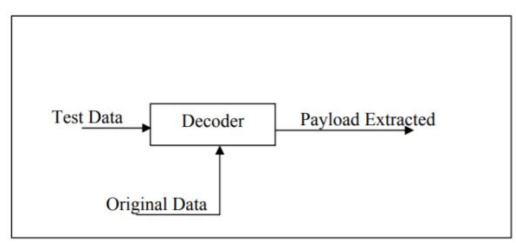



**Figure 1.3: Simple Decoding Process**

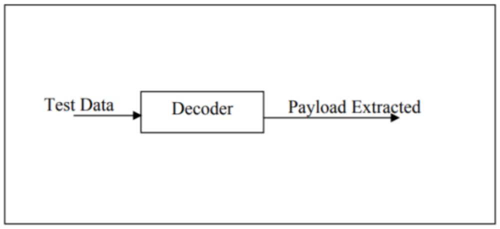



**Figure 1.4: Blind Decoding Process**

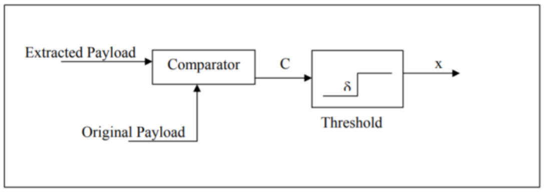



**Figure 1.5: Comparing Process**

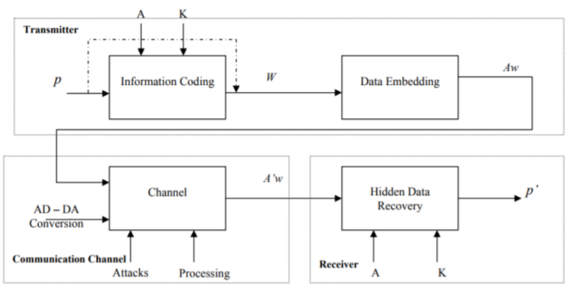



**Figure 1.6: Overall Picture of Data Hiding System**

Digital watermarking is extensively used for the copyright protection of digital data. In this thesis, our focus is on the image data. As watermarking has got considerable attention in the past decades; its security and robustness need to be taken care of. Thus, the main objective of this thesis is concerned with the enhancement of security and robustness in the image watermarking through application of various techniques and to study the efficiency of the applied techniques.

## II. LITERATURE REVIEW

The unlimited growth in internet and multimedia leads to large usage of images resulting in huge storage and distribution of multimedia contents. With increasing use of digital transmission techniques the potential risks for multimedia content is high which lead to necessity of protection for authenticity and confidentiality. Some researchers proposed a secure algorithm to protect the watermark image over a public network in digital watermarking and is embedded in transform domain like DCT or DWT. The unique key same as size of watermark is generated from the cover image. Also to secure the watermark, one needs to find the best frequency place.

The year 1993 can be considered the beginning of the digital image watermarking era. After that many techniques of watermarking have been proposed. Macq et al., introduce watermarking technique which is adapted to the human visual system using masking and modulation. Koch et al. proposed an efficient watermarking in the DCT domain for the first time. This method has shown good robustness to JPEG compression down to a quality factor of 50%

RakhiDuboliaet. Al. [1] used discrete cosine transform (DCT) and Discrete wavelet transform (DWT) for embedding and extraction of watermark. They have showed that DWT gives better Image quality then DCT. Md. Saiful Islam used a DCT DWT SVD based blind watermarking technique for embedding watermark in his research paper.

Charu Jain [2] implemented the BFO algorithm for watermarking the digital input image and BFO used to find the high frequency areas of the image where the watermark would be inserted.

PunamBediet. Al. illustrated a robust multimodal biometric image watermarking system adopting Particle Swarm Optimization (PSO) in order to watermark an individual's face image with his fingerprint image and demographic data [3].

Anurag Mishra presented an optimized watermarking scheme based on the discrete wavelet transform (DWT) and singular value decomposition (SVD) with good visual quality of the signed and attacked images having good PSNR [4].

Koch et al. [5], [6], [7] proposed an efficient watermarking in the DCT domain for the first time This method has shown good robustness to JPEG compression down to a quality factor of 50%.

Tao and Dickinson et al [8] introduced an adaptive DCT Domain watermarking technique based on a regional perceptual classifier with assigned sensitivity indexes.

From the literature review discussed above, we found the following facts:

1. The watermark should be encrypted before the embedding process.
2. Dual chaotic maps may be used for the security enhancement.

The encrypted watermark bits should be embedded in the middle frequency coefficients to achieve better robustness.

## III. WATERMARKING USING DWT AND BFO

In mathematical analysis and practical analysis, a discrete wavelet transform (DWT) is a transform wavelet at all for which the wavelets are individually experimented. Such as with several wavelet transforms, a basic benefit it has above Fourier transforms is dynamic exploration: it seizures both information of frequency and location. The discrete wavelet transform has an enormous number of applications in mathematics, science, computer science and engineering. Especially, it is conducted for signal processing, to illustrate a separate signal in an additional excessive form, frequently as before data compression. Applied applications can also be established in signal processing of speeding up for gait exploration, in digital communications as well as various others. It is exposed that DWT is productively executed as correspondent filter bank in ultra-wideband (UWB) wireless communications, biomedical signal processing and so on [5].

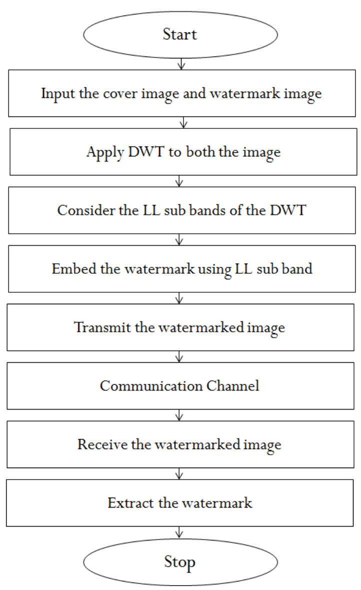



**Figure 1.7: Flow Chart of Watermarking in DWT Domain**

Algorithm of Bacteria Foraging Optimization is a novel to the family of nature-inspired optimization algorithms. Optimization algorithms comparable Genetic Algorithms (GAs), Evolutionary Strategies (ES), Evolutionary Programming (EP) which inducement their creativeness from growth and normal genetics, have been controlling the dominion of optimization algorithms. In recent times natural swarm stimulated algorithms are similar to Particle Swarm Optimization (PSO), Ant Colony Optimization (ACO) have established their manner into this dominion and showed their efficiency. Application of assembly searching approach of the function of E.coli bacteria swarm in multi-optimal optimization is the vital idea of the novel algorithm. Bacteria exploration for nutrients in a method to exploit energy achieved per unit time. Separate bacterium also connects with others by transfer signals.

A bacterium precedes searching decisions later considering two earlier factors. The process, where a bacterium transfers by charming minor steps while penetrating for nutrients, is termed chemotaxis and basic idea of BFOA is simulating chemotactic movement of effective bacteria in the difficult exploration space. Subsequently its initiation, BFOA has strained the thoughtfulness of researchers from various fields of knowledge particularly owing to its biological inspiration and smooth construction. Researchers are annoying to crossbreed BFOA with dissimilar further algorithms with the purpose of discover its global and local search properties independently. It has been previously practical to numerous real world complications and showed its usefulness over several variations of PSO and GA. Throughout searching of the real bacteria, movement is succeeded by an established of tensile flagella. Flagella aid an E.coli bacterium to spill or swim, which are two elementary processes achieved by a bacterium at the period of searching [16].

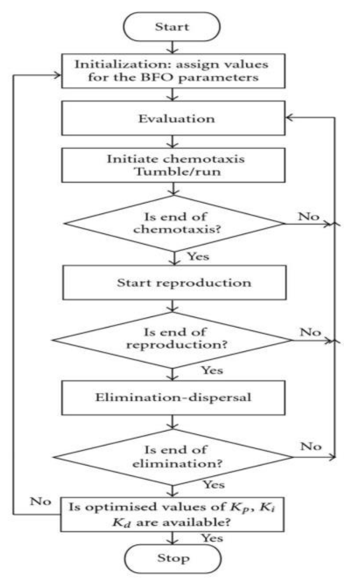



**Figure 1.8: Flow chart of Bacteria Foraging Optimization**

## IV. RESULTS & SIMULATION

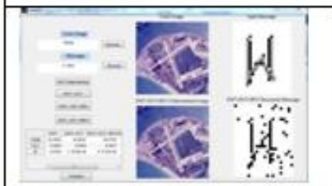
The main objective of the dissertation is to create robust watermarked image and this can be done with the help of Bacteria Foraging Optimization Algorithm. In this thesis we are taking two types of images for experiment purpose i.e. Aerial image.

**CASE 1:** We have taken cover image as aerial image of San Diego taken form the database of SIPI - University of

Southern California. For watermark image we have taken a **low frequency image**. Implementation is shown as below.


DWT based watermarking


DWT+DCT based watermarking


DWT+DCT+BFO based watermarking


DWT+DCT+PBFO based watermarking

**CASE 2**: We have taken cover image as aerial image of Oakland taken form the database of SIPI - University of Southern California. For watermark image we have taken a **medium frequency image**. Implementation is shown as below.


DWT based watermarking


DWT+DCT based watermarking


DWT+DCT+BFO based watermarking


DWT+DCT+PBFO based watermarking

**CASE 3:** We have taken cover image as aerial image of San Fracisco taken form the database of SIPI - University of Southern California. For watermark image we have taken a **high frequency image**. Implementation is shown as below.


DWT based watermarking


DWT+DCT based watermarking


DWT+DCT+BFO based watermarking


DWT+DCT+PBFO based watermarking

**Table 1: Output parameter for images**

| | | | | |
|---|---|---|---|---|
| **Output parameter for low frequency key image** | | | | |
| | DWT | DWT+DCT | DWT+DCT+BFO | DWT+DCT+PBFO |
| PSNR | 22.402 | 44.6591 | 48.3703 | 53.8087 |
| NCC | 0.002 | 0.0039 | 0.0037 | 0.0033 |
| IF | -0.0535 | -1.11E-04 | -4.71E-05 | -1.35E-05 |
| **Output parameter for medium frequency key image** | | | | |
| PSNR | 27.464 | 44.9124 | 48.8248 | 54.9071 |
| NCC | 0.0038 | 0.0049 | 0.0049 | 0.0049 |
| IF | -0.0106 | -7.85E-05 | -3.19E-05 | -7.86E-06 |
| **Output parameter for high frequency key image** | | | | |
| PSNR | 25.1423 | 44.8867 | 48.8044 | 54.5339 |
| NCC | 0.002 | 0.0039 | 0.0039 | 0.0039 |
| IF | -0.0329 | -1.56E-04 | -6.33E-05 | -1.69E-05 |

## V. CONCLUSION

The usefulness of the complete system is established through simulation results similar to

- PSNR excellence calculation objectives are realized.
- Watermarked image have very noble pictorial feature.
- No supplementary data is obtained for feature estimation.

In this simulation, a still image watermarking system with high toughness in the frequency dominion is engaged. The offered system tests only image instead of video otherwise audio. This algorithm can be recycled for data cover up in various applications for instance copyright security and authentication. In this work, overall coding-type structure which offers valuable and suitable tools in the exploration and design of watermarking method is used. Above all determines the usefulness of watermarking methodology in realizing design objectives for example implementation efficiency, robustness, security, capacity and so on.

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