# Artificial Intelligence Techniques for DWT Based Image Watermarking

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***Abstract* - In this paper DWT and SVM based image digital watermarking has been presented. In proposed work firstly Fuzzy logic will be used for training based on membership functions and DWT. The DWT will be used for decomposition into HL, LL, LH, LL components. Then watermark embedding has been performed using SVM then extraction of hidden message will be done. The parameter evaluation has been measured using PSNR, MSE, BER and time consumption. The results of our scheme show realization and robust experiments and it has been observed that this method has preferable performance in MTLAB environment.**

**Keywords:** Digital watermarking, DWT, SVD, SVM, Fuzzy Logic, PSNR, BER, MSE.

## 1. INTRODUCTION

Watermarking is not another system. It is a descendent of a procedure known as Steganography, which has been in presence for no less than a couple of hundred years. Steganography is a procedure for covered correspondence [1]. As opposed to cryptography where the substance of a conveyed message is secret, in steganography the very presence of the message is a secret and just gatherings included in the correspondence know its vicinity [2]. Steganography is a strategy where a secret message is covered up inside another inconsequential message and afterward conveyed to the next gathering. A percentage of the methods of Steganography like utilization of imperceptible ink, word separating examples in a printed record, coding messages in music structures, and so on have been utilized by military knowledge since the seasons of old Greek human advancement [3].

Watermarking can be considered as an exceptional method of Steganography where one message is implanted in another and the two messages are identified with one another somehow [4]. The watermarking systems avert imitation and unapproved replication of physical articles. Advanced watermarking is like watermarking physical articles aside from that the watermarking procedure is utilized for computerized substance rather than physical items.

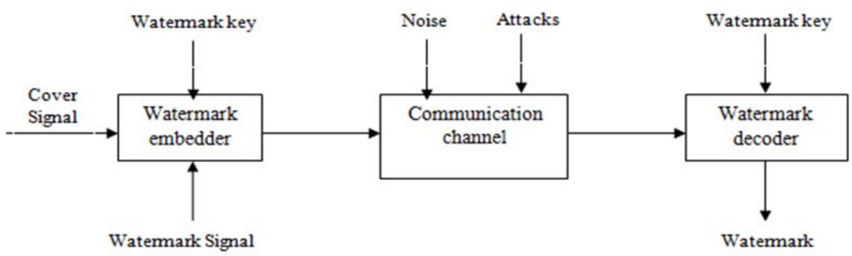


Fig.1 Digital Watermarking System

In advanced watermarking a low-vitality sign is intangibly installed in another sign. The low-vitality sign is known as the watermark and it delineates some metadata, similar to security or rights data about the primary sign. The primary signal in which the watermark is installed is alluded to as the cover signal since it covers the watermark [5]. The cover signal is generally a still image, audio clip, video sequence or a text document in digital format.

In previous work many techniques has come into existence like Fast Fourier Transform (FFT), Discrete Cosine Transform (DCT), Discrete Wavelet Transform (DWT), Curve let Transform (CT), counter let Transform (CLT) etc.So proposed work will hybrid two methods like neural network and DWT will be used to watermark an image [6].

### 1.1 Fuzzy Logic

Fuzzy logic is a form of many-valued logic; it deals with reasoning that is inexact rather than exact. Compared to traditional binary sets fuzzy logic variables may have a truth value that ranges in degree between 0 and 1.In fuzzy logic, exact reasoning is viewed as a limiting case of approximate reasoning [15].FIS performs the mapping between given input and output without the use of mathematical modeling concepts the rule base consists of IF-THEN rules that can be specified by a human proficient. Fuzzy Inference System technique is used to classify blocks which are more suitable to embed watermark based on fuzzy membership value.Fuzzy logic is based on natural language[16].

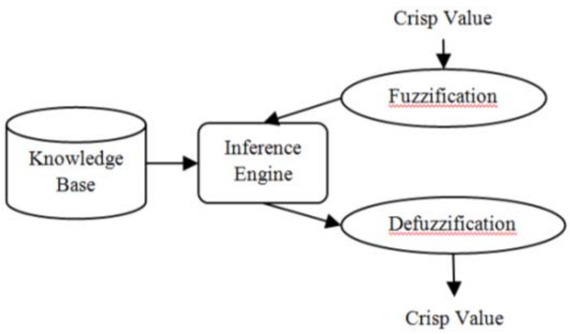


Fig 2: Fuzzy Inference System

FIS as in fig 2 consists of four function blocks. They are

**1. Fuzzifier:** It transfers the crisp input to fuzzy sets.

**2. Knowledge Base:** It mainly consists of database and rule base. The data base defines the membership functions of the linguistic variables. The rule base consists of a set of IF-THEN rules that can be given by a human expert or also can be extracted from the linguistic description of the data.

**3. Inference Engine:** It is a general control mechanism that exploits the fuzzy rules and the fuzzy sets defined in the Knowledge Base in order to reach certain conclusion.

**4. De-Fuzzifier**: It transfers the fuzzy sets into crisp outputs.

### 1.2 DWT (Discrete wavelet transformation)

Dwt is digital wavelet Transformation and Two-dimensional discrete wavelet transform (2-D DWT) decomposes an input image into four sub-bands LL, LH, HL, and HH at level 1 in the DWT domain, where LH, HL, and HH represent the finest scale wavelet coefficients and LL stands for the coarse-level coefficients. The LL subband can further be decomposed to obtain another level of decomposition. The decomposition process continues on the LL subband until the desired number of levels determined by the application is reached. Since human eyes are much more sensitive to the low-frequency part (the LL subband), the watermark can be embedded in the other three subbands to maintain better image quality. as shown in Figure .2

| | |
|---|---|
| LL | HL |
| LH | HH |

Fig.3 Sub Bands of DWT

DWT decompose an image using following equation:

$$^{\Phi}2\ (x,y)\ =\ ^{\Phi}1\ (x)\ ^{\Phi}1(y) \quad (1)$$

### 1.3 SVD (Singular Value Decomposition)

SVD method is used when the extraction of the feature image value takes place. SVD is used for variety of image processing applications such as image watermarking, image steganography, image compression, noise reduction. Singular values of an image give good stability which helps to keep the image stable after adding small value [4]. SVD is important linear algebraic technique that used to solve many mathematical problems. which says that a

rectangular matrix SVD of an image A with size MxN is represented as

$$A = U\Sigma V^T, \quad (2)$$

where U and V are orthogonal matrices such that, $UU^T = I$ and $VV^T = I$ , Σ is summation of diagonal entries $\lambda_1, \lambda_2$.....gives the singular vectors of A.

These diagonal entries are called as singular values of A and the decomposition is called as 'singular value decomposition'. Thus we have

$$A = \lambda_1 U_1 V_1^T + \lambda_2 U_2 V_2^T + \cdots \ldots \ldots + \lambda_r U_r V_1^T \quad (3)$$

Where, r is rank A. The columns of U and V are called left and right singular vectors of B. [12].

### 1.4 Support Vector Machine (SVM)

Support vector machines (SVM) is a binary classification algorithm developed by Vapnik. SVM is margin-based classifier with good generalization capabilities. It is the method of creating functions from a set of labelled training data. The function can be either a classification function or a general regression function. Support vectors are the points that form the decision boundary between classes. The main features of SVM are shown below, due to which its applications are quite important:

- Robust to large number of variables.
- Can be applied to & it can learn complex and simple learning models.
- It avoid overfitting.

Support vector machines (SVMs) have the hyperplane that classifies the various variables as shown below:

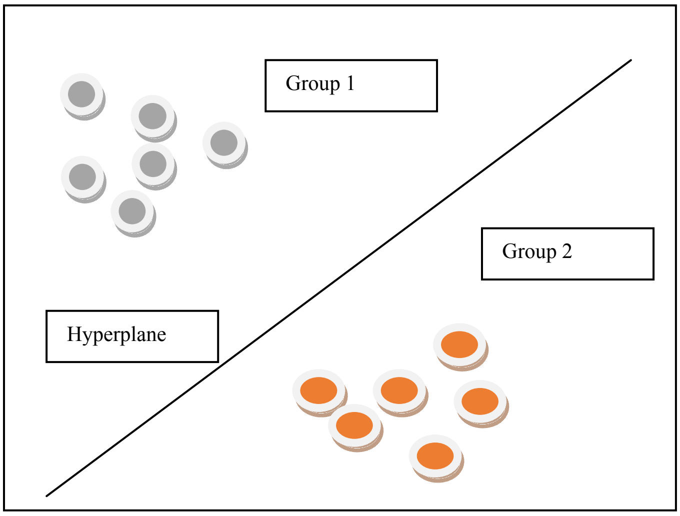


Fig 3: Support Vector Machine

Equation of hyperplane can be written as below:

$$w \cdot x + b = 0 \quad (4)$$

(Recall that w is in fact the vector orthogonal to the hyperplane.) Given such a hyperplane (e, n) that separates the data, this gives the function $f(c) = sign(e \cdot c + n)$ Which correctly classifies the training data (and hopefully other "testing" data it hasn't seen yet) [9]. However, a given hyperplane represented by (e, n) is equally expressed by all pairs $\{\lambda e, \lambda n\}$ $for\ \lambda\ \in T +$.So we define the canonical hyperplane to be that which separates the data from the hyperplane by a "distance" of at least 1. That is, we consider those that satisfy:

$ci \cdot e + n \geq +1\ when\ ui = +1$

$ci \cdot e + n \leq -1\ when\ ui = -1$

$or\ more\ compactly$:

$$ui\ (ci \cdot e + n) \geq 1\ \forall i \quad (5)$$

## 2. PROPOSED WORK

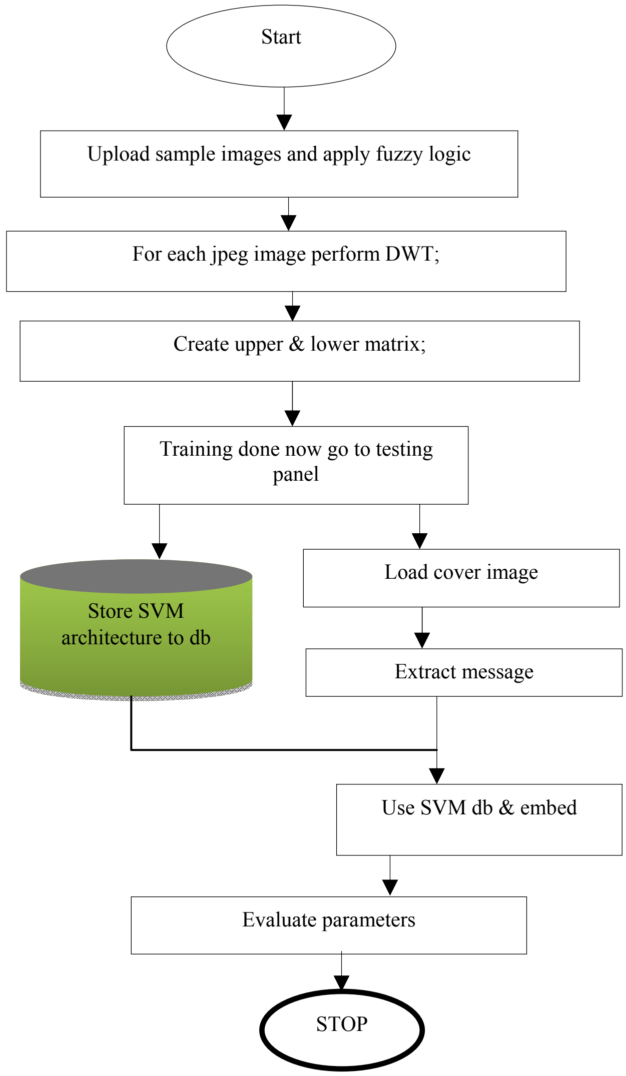


Fig 4: Flow chart for Embedding Watermark

**For Embedding Process**

1. Pre-processing:- Selection of the cover image to hide the data using function imread.
2. Image Selection: - HL Images are selected randomly from image by applying the algorithm which detects the variation in scene of image.
3. Conversion: - Convert normal image to rgb image. In cover frame using DWT. Hide the authentication key.
4. Training using Fuzzy logic
5. Save embedded image.
6. End embedding.

**Extraction Process**

1. Load embedded image.
2. Read embedded image.
3. Obtain DWT of embedded image
4. Extract hidden message sample from embedded image using SVM.
5. End extraction.
6. Parameter evaluation.

## 3. RESULT ANALYSIS

The results are taken in mat lab programming. The PSNR, BER, Time and MSE values are calculated using equation (5) and (6).The Peak Signal-to-Noise Ratio (PSNR) is defined as [12,13]:

$$PSNR = 10.log_{10}\left(\frac{MAX_I^2}{MSE}\right), \qquad (6)$$

The mean-squared error (MSE) between two images I1(m,n) and I2(m,n) is

$$MSE = \frac{1}{mn}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i,j) - K(i,j)]^2,$$

(7)

Where M and N are the number of rows and columns in the input images respectively.

In addition to this time and BER has also been calculated**.**The robustness is measured by BER defined by

$$\text{BER} = \frac{\text{Berror}}{\text{Btotal}} \times 100\%, \qquad (8)$$

Where Berror and Btotal denote the number of error bits and the number of total bits, respectively. In addition to this time has also been calculated**.**

TABLE 1 : RESULT METRICS

| Image | Previous PSNR | Proposed PSNR |
|---|---|---|
|  | 55.5 | 70.56 |
|  | 53.5 | 69.19 |
|  | 53.8 | 66.16 |
|  | 54.7 | 63.91 |

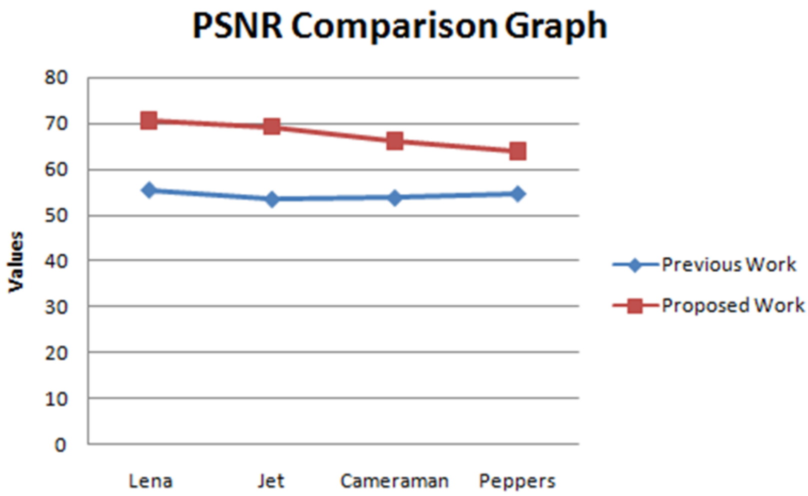


Fig 5: Comparison of PSNR matrices values w.r.t to different images

## 4. CONCLUSION AND FUTURE SCOPE

In this paper, we presented the robust digital image watermarking algorithms using fuzzy logic with machine learning algorithms as well as optimization algorithms. The novelty of the algorithms is that the watermark is embedded into high and middle frequency components of the host image using SVM based on DWT components like HH, HL, LH and LL. The advantage of the SVM algorithm is that it provides better PSNR, MSE for watermarking giving less error rate values.

The future work is the consideration of improving robustness against rotation. Future scope is also lies in the utilization of another families of wavelets like IWT, CWT or FFT to get better results.

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