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AN OPTIMIZED DWT BASED APPROACH IN VIDEO WATERMARKING WITH MULTIPLE WATERMARKS USING OPPOSITIONAL KRILL HERD ALGORITHM

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ABSTRACT

In video watermarking applications, there is a need to extract the watermark without using the original data because of the huge storage of the cover data. In this paper, we have intended to present an efficient multiple video watermarking using optimized three levels DWT. Basically, the system consists of three modules such as (i) selecting optimal wavelet coefficients using Oppositional Krill Herd Algorithm (OKHA) (ii) Watermark embedding process and (iii) Watermark extraction process. A hybrid combination of the Krill Herd with Oppositional-Based Learning (OBL) has been used to select the optimal wavelet co-efficient OBL is used to improvise the performance of Krill Herd algorithm, while optimizing the co-efficient of standard DWT model. It is then followed by encryption of watermark based on Arnold transform. After, that we encrypt the watermark based on the Arnold transform and different types of media (gray image and colour image) are used for the watermark. Finally, the original video is obtained with the help of extraction process. The robustness of this technique is tested by various attacks such as: noising, compression, and image-processing attacks

KEYWORDS: Video Watermarking, DWT, Oppositional Krill Herd Algorithm, Opposition-based learning, multiple watermarking.

I. INTRODUCTION

Digital watermarking is a data hiding method that is utilized for copyright fortification of digital media. Dissimilar steganography, where the message is associated with the cover information [1, 2] copyrights data information signify the owner rights known as ‘‘watermark’’ are entrenched into the digital media in a method of image, audio, or video without distressing the perceptual quality. Imperceptibility and sturdiness in contradiction of attacks are the basic problems in digital watermarking systems [3]. The watermark is entrenched and abstracted as per prerequisite to signify the ownership and/or the individuality of multimedia [4]. In video watermarking, the watermark can be entrenched in the spatial domain [5] or in the transmute domain such as Discrete Cosine Transform (DCT) [6], Discrete Fourier Transform (DFT) [7], and DWT [8]. The frequency domain watermarking systems are comparatively predominant than the spatial domain watermarking systems, in lossy compression, noise addition, rescaling, pixel removal, rotation and cropping.

A digital watermark is an indiscernible signal further to digital information, known as cover work that can be perceived later for buyer/seller documentation, ownership proof, and so forth [9]. It shows the role of a digital signature, as long as the image with an intellect of ownership or legitimacy. A watermark is proficient of displaying frequent momentous features. These encompasses that the watermark is hard to observe, tolerates common distortions, resists malicious attacks, conveys numerous bits of data, is capable of being contemporaneous with other watermarks, and difficult to insert or detect [10]. In order for a watermark to be valuable it must be robust to a diversity of conceivable attacks through pirates. These comprise robustness against compression namely JPEG, scaling and aspect ratio changes, cropping, rotation, row and column removal, addition of noise, cryptographic, filtering and statistical attacks, and also enclosure of other watermarks [11].

In this association, a flood of numerous methods and modifications are efficiently engaged on the image to obscure the associated data limited in the image. The transform domain embedding is well-defined as the domain of assimilating approaches for that a host of algorithms have been envisioned [12]. Additionally, the important image watermarking methods include the Discrete Cosine Transform (DCT) [13], Discrete Wavelet Trans-form (DWT), Z-transform [14], bit-plane compression techniques [15, 16], and the LSB based method [17]. Furthermore, the wavelet-based watermarking system to entrench multiple watermarks in medical images is enlightened. The watermarking methods for protected data hiding in wavelet trampled fingerprint images are elucidated in [18, 19]. Visual Cryptography is additional field that is utilized for content protection. Visual cryptography has been implemented to numerous applications, including but not limited to data hiding, overall access edifices [20], visual confirmation and empathy [21].

In this paper, video approaches for multiple watermarks using oppositional krill Herd algorithm is developed. Here (i) optimal three-level discrete wavelet transform (DWT) based watermark embedding/extracting, (ii) Arnold transform based watermark encryption/decryption method and (iii) different types of watermarks (gray/color) are used. The rest of this paper is organized as follows. Section II describes the details of the literature survey and section III describing the proposed video watermarking scheme and the experimental results being presented in Section IV and Section V summarizing the work.

II. RELATED WORKS

A host of inquiries are accessible in literature associated with the topic of video watermarking, some of that are reviewed at this time. Mohamed M. Ibrahim*et al.* [22] has enlightened the Video Multiple Watermarking Technique Based on Image Interlacing using DWT. This method was on the basis of image interlacing. In this method, three-level discrete wavelet transform (DWT) was utilized as a watermark embedding/extracting domain, Arnold transform was utilized as a watermark encryption/decryption technique, and dissimilar kinds of media (gray image, color image, and video) were utilized as watermarks. The sturdiness of this method was tested by implementing dissimilar kinds of attacks namely: geometric, format-compression, noising, and image-processing attacks.

Chitrasen and TanujaKashyap [23] persuasively scheduled the digital video watermarking engaging DWT for the drive of Data Security. In their innovative method, the random segmentation and modernization of engrained confidential information was performed without any preceding notion concerning the innovative host video. In the sequence of the inserting process, the confidential information was engrained in discrete video frames engaging the DWT's frequency domains. A DWT video watermark technique was luminously brought in for the drive of maintenance information. In addition to this, they efficiently projected a Haar wavelet based digital watermark method to defend the information. In the Haar wavelet, Dyadic equation was engaged to graft the copy right information in video bit streams.

In [24], Marwen Hasnaoui and Mihai Mitrea luminously transported to light the conceptual outline enabling the binary Quantization Index Modulation (QIM) implanting approaches that had to be protracted in the direction of multiple-symbol QIM. The uncomplicated detection method was augmented in relation to the minimization of the average error probability under the semblance of white, additive Gaussian conduct for the assaults. In this way, for the quantified parameters like the lucidity and robustness, the information payload was enriched by a factor of log2m. M-QIM was legitimate based on inquiries against the edifice of the MEDIEVALS French national project and of the SPY ITEA2 European project, related to the MPEG-4 AVC robust and semi-fragile watermarking implementations.

Agilandeeswari and Ganesan [25] have elucidated an effectual rescindable adaptive video watermarking system for multiple watermarks on the basis of Bi-directional Associative Memory (BAM) Neural Networks and Fuzzy Inference System specifically, Multi-BAM-FUZ scheme. The chief aim of this paper was to design a robust video watermarking scheme that simplifies secure video broadcast over a communication channel by preserving a trade-off amongst imperceptibility, robustness and then the watermark capacity or payload. The BAM neural network provisions, creation of weight matrix (formed out of multiple images) and this matrix was entrenched into the DWT uncorrelated mid frequency coefficients of entirely the constituents (Y, Cb, Cr) of all frames of the video with fluctuating entrenching strength 'α'. This adaptive embedding strength was engendered with the help of the Fuzzy Inference System that receipts HVS features namely luminance, texture and edge of each frame as an input in the DWT transform.

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Natarajan Mohananthini and Govindarajan Yamuna [26] presented a multiple medical image watermarking scheme based on discrete wavelet transform (DWT) and singular value decomposition (SVD) to increase the security of medical images and to preserve the privacy of patients.

The robust watermarking outline with a blind abstraction procedure for HEVC encoded video was provided by Tanima Dutta and Hari [27]. A readable watermark was implanted invisibly in 4×4 intra prophesied blocks of the HEVC encoded video. Their watermarking outline implements security by reconnoitring the spatio-temporal features of the compressed video and a haphazard key for selection of inserting regions. They also analyze the strengths of dissimilar compressed domain features of HEVC encoded video for applying the entrenching algorithm. Experimental solutions was validate that their work confine the upsurge in video bit rate and dilapidation of perceptual quality.

N.Mohananthini and G.Yamuna [28] proposed a multiple watermarking scheme based on DWT using genetic algorithms to improve the performance of imperceptibility and robustness.

The QIM blind video watermarking system on the basis of Wavelet transform and principal constituent analysis was elucidated by Nisreen et al. [29].The refuge of the system was reputable with the help of one secret key in the recovery of the watermark. Discrete Wavelet Transform (DWT) was implemented on each video frame disintegrating it into a number of sub-bands. Maximum entropy blocks were nominated and distorted by Principal Component Analysis (PCA). Quantization Index Modulation (QIM) was utilized to quantize the maximum coefficient of the PCA blocks of each sub-band. Then, the watermark was implanted into the nominated appropriate quantize values. Their system was tested by a number of video systems.

III. PROPOSED VIDEO WATERMARKING METHODOLOGY

The basic idea of proposed methodology is multiple video watermarking using oppositional krill herd algorithm (OKHA). The proposed system consists of three modules such as (i) optimal wavelet coefficient selection, (ii) Embedding process and (iii) Extraction process. Here, at first the input video is divided in to sub videos, among the sub videos we select two identical copies of the original video. Depending on the sub videos the embedding and extraction process are carried out. After that, we apply the three-level discrete wavelet transform (DWT) to the selected video sub frames. In this approach, to increase the efficiency of the system the watermark images also encrypted. The encrypted watermark image is embedded into the original sub video frame. The same process is repeated for the extraction process also. The overall process of the proposed multiple video marking system shows in figure 1.

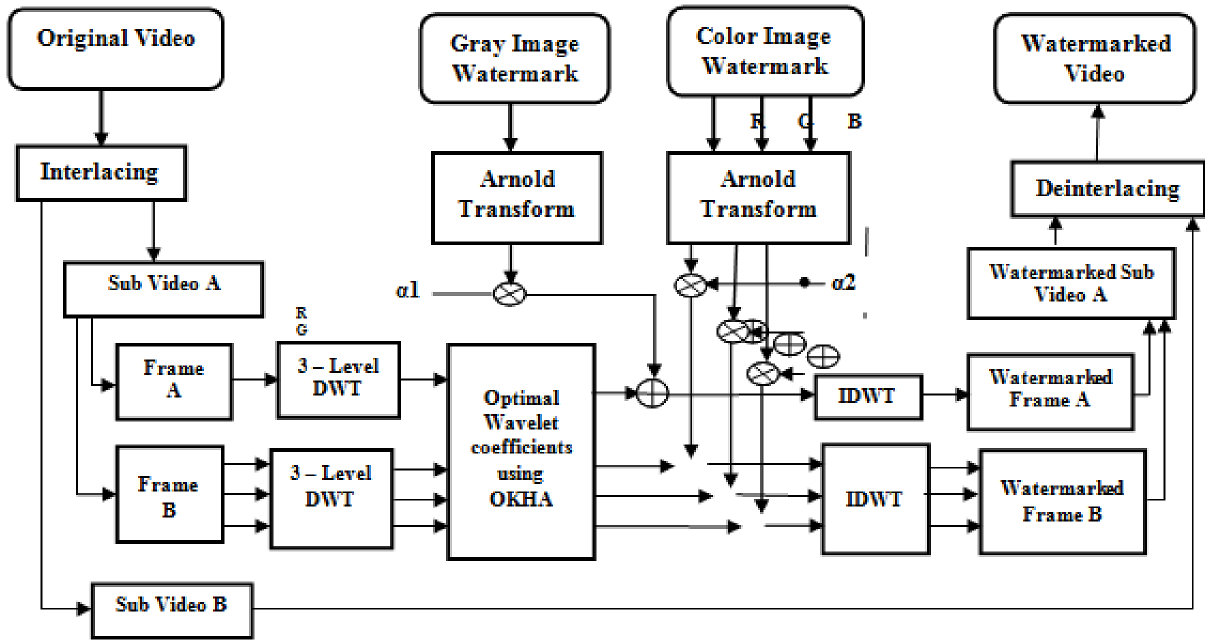

Figure 1: Overall Diagram of Proposed Multiple Watermarking Scheme

IV. SELECTING OPTIMAL WAVELET COEFFICIENTS USING OKHA

The objective of this section is to select the optimal coefficient using oppositional Krill Herd Algorithm. The KHA algorithm is a meta-heuristic swarm intelligence optimization algorithm used to increase the PSNR and NC values. Oppositional-Based Learning (OBL) is integrated with KHA for improving the convergence speed and simulation results of conventional KH algorithm. A detailed proposal of optimal wavelet coefficient selection using OKHA is explained below.

Step 1: Solution Encoding

The solution encoding is the important process in the optimization algorithm. In this work, we optimize the wavelet coefficient of DWT. At first, we randomly assigned optimal values. These optimal values are used to split the frame into sub bands. The frequency bands are selected depending on the range of the coefficient values. The coefficient values vary with respect to lower bound (L_i) and upper bound (U_i) values. Initially set the each coefficient with a real random value. To increase the image quality, the coefficient values are optimally selected using OKHA.

$$Y_i = [\, y_i^1, ..., y_i^d \,] \qquad i = 1,2,..., N \tag{1}$$

where, $y_i^d \in [L_i^d, U_i^d], d = 1,2,..., D$, is the position of i^{th} krill in the d^{th} dimension, D is the complete dimension encoding with $(Nh + Ng) \times T$ independent variable in the search space and L_i^d, U_i^d are the lower and upper limits of i^{th} krill in the d^{th} dimension.

Step 2: Opposite Solution of KHA

Rendering to opposition based learning (OBL) familiarized by Tizhoosh in 2005 [30], the current krill and its opposite krill are measured instantaneously to attain a better calculation for present krill result. It is given that an opposite krill solution has a better chance to be closer to the global optimal solution than random krill solution. The opposite krill's positions (OY_i) are totally demarcated by constituents of Y_i .

$$OY_i = [\, oy_i^1, ..., oy_i^d \,] \tag{2}$$

where, $oy_i^d = L_i^d + U_i^d - y_i^d$ with $oy_i^d \in [L_i^d, U_i^d]$ is the position of i^{th} opposite agent OY_i in the d^{th} dimension of opposite population.

Step 3: Fitness Calculation

An objective function needs to be designed to evaluate the fitness of a solution and to quantify the performance of each individual. In this research, the objective function is defined as follows:

$$Fitness\ function = \underset{H}{Max}(P) \tag{3}$$

$$P = PSNR = 10\log_{10}\frac{255^2}{MSE} \tag{4}$$

$$MSE = \frac{1}{M \times N}\sum_{i=0}^{M}\sum_{j=0}^{N}\left[E(i,j) \oplus E'(i,j)\right]^2 \tag{5}$$

where $E(i,j)$ and $E'(i,j)$ are the corresponding pixel values in the original and watermarked frames and the size of each frame is $M \times N$. It represents the coefficient range based on the equation (3), the ultimate goal is maximization of the Objective function P ,which highly depends on filter coefficients. In the above optimization problem, H represent the coefficient range.

Step 3: Calculation of Krill Movement

After the fitness calculation, the krill's are moving to another place on the basis of the density performance. Conferring to theoretical arguments, the krill individuals try to preserve a high density and move because of their mutual effects [31]. The direction of motion induced β_i , is estimated from the local swarm density (local effect), a target swarm density (target effect) [33]. For a krill individual, this movement can be well-defined as:

$$M_i^{new} = M^{Max}\beta_i + \omega_n M_i^{old} \tag{6}$$

$$\beta_i = \beta_i^{local} + \beta_i^{target} \tag{7}$$

Where, $M^{\max}$ is the maximum induced speed, ω_n is the inertia weight of the motion induced in the range [0,1], M_i^{old} is the last motion induced, β_i^{local} is the local effect provided by the neighbours and β_i^{Target} is the target direction effect provided by the best krill individual. In this study, the effect of the neighbors in a krill movement individual is determined as follows:

$$\beta_i^{local} = \sum_{j=1}^{NN}\hat{K}_{ij}\,\hat{X}_{ij} \tag{8}$$

$$\hat{X}_{ij} = \frac{X_j - X_i}{\left\|X_j - X_i\right\| + \varepsilon} \tag{9}$$

$$\hat{K}_{ij} = \frac{K_i - K_j}{K^{worst} - K^{best}} \tag{10}$$

where, K^{best} and K^{Worst} are the best and the worst fitness values of the krill individuals so far; K_i signifies the fitness or the objective performance value of the i^{th} krill individual; K_j is the fitness of j^{th} $(j = 1,2.,,,NN)$neighbour; X signifies the related positions; and NN is the number of the neighbours. For avoiding the singularities, a small positive number ε is added to the denominator. The sensing distance for each krill individual can be determined with the help of the dissimilar heuristic approaches. At this time, it is dogged for utilizing the subsequent formula for each iteration.

$$D_{s,i} = \frac{1}{5N}\sum_{j=1}^{N}\left\|X_i - X_j\right\| \tag{13}$$

where, $D_{s,i}$ is the sensing distance for the i^{th} krill individual and N is the number of the krill individuals. The factor 5 in the denominator is empirically obtained. By means of equation (13), if the distance of two krill individuals is less than the defined sensing distance, they are neighbours. The known target vector of each krill individual is the lowermost fitness of an individual krill. The consequence of the individual krill with the best fitness on the i^{th} individual krill is considered using Equation (3). This level is communicated as

$$\alpha_i^{target} = C^{best}\,\hat{K}_{i,best}\,\hat{X}_{i,best} \tag{14}$$

where, C^{best} is the effective coefficient of the krill individual with the best fitness to the i^{th} krill individual. This coefficient is defined since α_i^{target} leads the solution to the global optima and it should be more operative than other krill individuals such as neighbours. Herein, the value of C^{best} is defined as

$$C^{best} = 2\left(rand + \frac{1}{I_{\max}} \right) \tag{15}$$

Where rand is a random values between 0 and 1 and it is for enhancing exploration, I is the actual iteration number and $I_{\max}$ is the maximum number of iterations.

Step 4 Calculation of Foraging Motion

The foraging motion is expressed in the name of two chief effective parameters. The primary one is the food location and the second one is the preceding experience about the food location. This motion can be articulated for the i^{th} krill individual as follows:

$$F_i = V_f\ \beta_I + W_f\ F_i^{old} \tag{16}$$

$$\beta_i = \beta_i^{food} + \beta_i^{best} \tag{17}$$

V_f is the foraging speed, W_f is the inertia weight of the foraging motion in the range [0,1], is the last foraging motion, β_i^{food} is the best fitness of the i^{th} krill so far. The centre of food for each iteration is formulated as

$$X^{food} = \frac{\sum_{i=1}^{N} \frac{1}{K_i} X_i}{\sum_{i=1}^{N} \frac{1}{K_i}} \tag{18}$$

Therefore, the food attraction for the i^{th} krill individual can be determined

$$\beta_i^{food} = C^{food}\ \hat{K}_{i,\,food}\ \hat{X}_{i,\,food} \tag{19}$$

where C^{food} is the food coefficient. Because the effect of food in the krill herding decreases during the time, the food coefficient is determined as

$$C^{food} = 2\left(1 - \frac{I}{I_{\max}}\right) \tag{20}$$

The effect of the best fitness of the i^{th} krill individual is also handled using the following equation:

$$\beta_i^{Best} = \hat{K}_{i,ibest}\ \hat{X}_{i,ibest} \tag{21}$$

where, $K_{i\,best}$ is the best previously visited position of the i^{th} krill individual.

Step 5: Calculation of Physical Diffusion

The physical diffusion of the krill individuals is measured to be a haphazard procedure. This motion can be expressed in terms of the maximum diffusion speed and a haphazard directional vector and can be articulated as

$$D_i = D^{\max}\ \delta \tag{22}$$

where, $D^{\max}$ is the maximum diffusion speed, and δ the random directional vector and its arrays are random values between -1 and 1.

Step 6: Updation based on KH Algorithm

Using different effective parameters of the motion during the time, the position vector of a krill individual during the interval $t + \Delta t$ is given by the equation:

$$X_i(t + \Delta t) = X_i(t) + \Delta t \frac{dX_i}{dt} \tag{23}$$

Step 7: Termination Criteria

The algorithm discontinues its execution only if maximum number of iterations are achieved and the solution which holding the best fitness value is selected and specified as best coefficient of wavelet. Once the best fitness is attained by means of KHA algorithm, selected coefficient is allocated for DCT.

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Embedding Process

Embedding is an essential method of converting the image into another format for video watermarking. This encrypted watermark image is embedded into the original sub frame so as to withstand the malicious attacks on the original information. The step by step process of proposed embedding process is explained below,

Step 1: Consider the input video V^{in}, which consist of n number of sub videos $V^{in} = (V_1, V_2, ..., V_n)$. As first step, the original video is interlaced into n number of sub videos $(n = 1,2,..., N)$. The interlaced process is explained in next section.

Step 2: The two most resembling sub videos Sub_A and Sub_B are picked from video V^{in}. The resemblance is deduced on the basis of normalized correlation (NC) measure which is a two step process. The average NC value of all color sub bands and for all sub video frames is computed. Two sub videos that constitute the biggest average NC are considered to be the most alike sub videos and these two videos are agreed to the additional processing. The designated sub videos.

$$NC = \frac{1}{l \times m} \sum_{x=1}^{l} \sum_{y=1}^{m} \left(S_{x.y} \oplus S'_{x,y} \right) \tag{24}$$

where, $S_{x,y}$ and $S'_{x,y}$ are corresponding pixel values of two sub frames and $l \times m$ is the sub frame size.

Step 3: A three level discrete wavelet transform is applied to the selected sub video frames. Here, the optimal wavelet coefficients are selected using OKHA algorithm, a detailed explanation of this algorithm is lineated in the following section.

Step 4: After the selection of similar sub videos Sub_A and Sub_B, multiple watermarking scheme is performed. In this paper, two types of watermark images such as gray image and colour image are used in embedding process. Secret information is embedded into four parts of the original information between sender and receiver.

Part 1: Multiple watermarks is different types
Part 2: Watermarked frame numbers corresponding to each watermark.
Part 3: Number of iterations applied to encrypt watermark image.
Part 4: Scaling factor for all sub video frames

Step 4: To improve the efficiency of the system before the embedding process, Arnold transform is applied to encrypt the watermark image W^{in}. This number is the third part of the secret key between the sender and the receiver.

Step 5: The watermark image is embedded into sub video A frames based on the below equation (25).

$$I' = I + \alpha W \tag{25}$$

where, $I \rightarrow$ HL3 sub band of original sub video frame; $I' \rightarrow$ Watermarked image
$W \rightarrow$ Watermark signal; $\alpha \rightarrow$ scaling factor

This scaling factor is a constant value for all subvideo frames. This scaling factor is the fourth and last part of the secret key between the sender and the receiver.

Step 6: Finally, the watermarked video is generated by de-interlacing the watermarked subvideo and other sub videos. This watermarked video and the secret key (of four parts) are sent to the receiver and no copy of the original video is sent which is the ultimate goal of this paper.

Watermark Extraction Process

During the extraction process, an operation in reverse to the embedding process is performed, to extract the watermark image W^{in} from a subvideo and is compare with the original subvideo. In order to discover the original sub video, in the beginning; the extraction algorithm performs the same set of operations as the embedding algorithm. The watermarked video and four parts of secrete key are given as the input for the extraction process. The step by step extraction process is explained below;

Step 1: Consider the watermarked video I, which is interlaced by the same level and type as the original video.
Step 2: Watermarked subvideo A and the subvideo B is selected by using the first part of the secrete key.
Step 3: The watermark extraction process is based on the selected sub videos.

- The frame from both selected subvideos using the third part of the secret key is selected at first.
- These frames are then transformed into frequency domain using three-level DWT.

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CODEN: IJESS7

- Using the watermark extraction equation (26), the watermarks are extracted.

$$W' = \frac{(I'' - I^*)}{\alpha} \quad (26)$$

where I'' is the HL3 subband of the watermarked subvideo A frame, I^* is the corresponding HL3 subband of the subvideo B frame, W' is the extracted encrypted watermark, and α is the scaling factor from the fourth part of the secrete key.

- *Number of Iterations is deduced from the second part of the secret key and inverse Arnold Transform is applied that many iterations, to extract the encrypted watermark image.*
- *Original video V is obtained based on the above process.*

V. RESULTS AND DISCUSSION

The result of our proposed methodology is dissected in this section. The proposed watermarking scheme discussed in this paper has effectively embedded the watermark image into video frame and extracted it back from the embedded frame of the watermarked image. In our experiment, the standard video air horse is used.

Evaluation Metrics

The evaluation of the proposed technique is carried out using the following metrics as deducted by using below equations

Peak Signal to Noise Ratio (PSNR)

The PSNR is used to measure the quality of the watermarked image. The PSNR is the ratio between the input image $I^{in}(i, j)$ and the watermarked image $I^{W}(i, j)$. The PSNR is identified using the mean square error (MSE). The MSE gives the cumulative squared error between the corrupting noise and the maximum power of the signal. Higher the PSNR and lower the MSE, better the quality of the image.

$$PSNR = 10 \log_{10}\left(\frac{255^2}{MSE}\right)$$

$$MSE = \frac{1}{M * N}\sum_{x=1}^{M}\sum_{y=1}^{N}\left[I^{in}(i, j) - I^{W}(i, j)\right]^2$$

where, $I^{in}(i, j)$ → Input video frame $I^{W}(i, j)$ → Watermarked frame

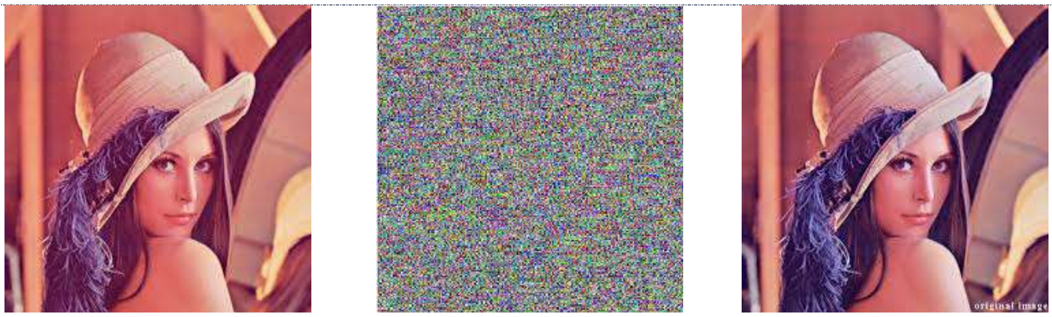
Arnold Transform

Arnold transform is one of the encryption algorithm [31] used to enhance the security and robustness of the watermarking system. The Arnold transform uses the following formula for changing the location of each pixel in the image/video frame of size $N \times N$.

$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} 1 & 1 \\ 1 & 2 \end{pmatrix}\begin{pmatrix} x \\ y \end{pmatrix}\begin{pmatrix} x \\ y \end{pmatrix}$$

where, (x, y) is the current location and x', y' is the new location. Figure 6 shows the encryption of "Lena" image using Arnold Transform. For a symmetric arnold transform, the number of iterations must be less than the arnold period to used it as an encryption key. This technique is the image interlacing for image watermarking,

and the same technique can be used in videos but in two steps: first, the video frames are divided into subframes using image interlacing and then these subframes are collected together to generate the subvideos.



(a) Original Image (b) Encrypted Image (c) Restored Image

Figure 2 Arnold Transform as Image / Video Frame Encryption Method

Interlacing Results

Image interlacing is an operation in which any image can be divided into sub-images was proposed by [32]. De-interlacing is the reverse operation of combining sub-images together to generate the original image. In this proposed method, a two level of interlacing is used. One-level interlacing has two types: interlacing by rows only to get even rows (ER) and odd rows (OR) sub images and interlacing by columns only to get even columns (EC) and odd columns (OC) sub-images. Two-level interlacing is a method of interlacing by rows first and then by columns (or in the opposite order) to get four sub-images: even rows even columns (EE), even rows odd columns (EO), odd rows even columns (OE), and odd rows odd columns (OO). The NC values are tabulated in table 1.

Table 1: Video Interlacing Operation

Interlacing Level	Sub-videos	Red	Green	Blue
One	ER-OR	**0.9532**	0.9412	0.9234
	EC-OC	**0.9662**	0.9542	0.9315
Two	EE-OE	**0.9627**	0.9231	0.9320
	EE-EO	0.9615	**0.9732**	0.9645
	EE-OO	**0.9483**	0.9265	0.9352
	OE-EO	0.9650	0.9417	**0.9712**
	OE-OO	0.9622	**0.9755**	0.9543
	EO-OO	**0.9654**	0.9437	0.9367

Table1 shows the NC values between the two resulted subvideos in each interlacing level. From these results, it is identified that all NC values are close to one, which means that the used interlacing algorithm gives subvideos that are similar to each other. A closer comparison helps to deduce the most similar pair to be EC and OC for one level interlacing and OE and OO for two-level interlacing and among color bands, red is found to be the one which has the best result.

Simulation Results

The main intention of proposed methodology is multiple video watermarking based on Oppositional Krill Herd Algorithm (OKHA). The proposed method is tested with “Airhorse.avi” as a host video with, “Evil Inside.jpg” as a grayscale image watermark of size 32 × 32 and “Lena.jpg” as a color image watermark of size 32 × 32 are shown in figure 3. Three-level discrete wavelet transform is applied to the frame got by dissecting original videos. Before apply the DWT, we calculate the optimal wavelet coefficient using Oppositional Krill Herd Algorithm. Then, we perform the multiple watermark schemes. Finally, we obtain the watermarked video.

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Original Video Frame (Gray)

Grayscale Image Watermark

Watermarked Video Frame (Gray)

Extracted Watermark

Original Video Frame (Color)

Grayscale Image Watermark

Watermarked Video Frame (Color)

Extracted Watermark

Figure 3 Original Video Frames and its Watermarked Video Frames

Table 2. Performance Comparison (Gray Image Watermark)

	Gray Scale Image Watermark					
	M.Ibrahim *et al.* [22]			**Proposed Method**		
Interlacing Level	**No**	**1-Level**	**2 –Level**	**No**	**1-Level**	**2 –Level**
Sub-Videos		EC-OC	OE-OO		EC-OC	OE-OO
Scaling Factor	0.5	1.5	1.5	0.5	1.5	1.5
PSNR	36.7755	35.2069	33.9840	39.707	37.1348	35.3802
NC						
No attacks	0.9824	0.9578	0.9725	0.9826	0.9580	0.9736
Gaussian Noise (10%)	0.6231	0.8794	0.8962	0.7650	0.8872	0.8971
Salt & Pepper Noise (10%)	0.8100	0.9382	0.9556	0.9432	0.9847	0.9881
Contrast Factor (10%)	-	-	-	0.7781	0.8493	0.8412
JPEG Quality (80%)	-	-	-	0.7232	0.8362	0.8372
JPEG Quality (60%)	-	-	-	0.7351	0.8541	0.8554
Cropping	0.7250	0.7252	0.7303	0.7481	0.8423	0.8413

Table 3. Performance Comparison (Color Image Watermark)

	Color Image Watermark					
	M.Ibrahim *et al.* [22]			**Proposed Method**		
Interlacing Level	**No**	**1-Level**	**2 –Level**	**No**	**1-Level**	**2 –Level**
Sub-Videos		EC-OC	OE-OO		EC-OC	OE-OO
Scaling Factor	0.5	1.5	1.5	0.5	1.5	1.5
PSNR	36.7755	35.2069	33.9840	39.7078	37.1348	35.3802
NC						
No attacks	0.9824	0.9578	0.9725	0.9826	0.9580	0.9736
Gaussian Noise (10%)	0.6231	0.8794	0.8962	0.7650	0.8872	0.8971
Salt & Pepper Noise (10%)	0.8100	0.9382	0.9556	0.9432	0.9847	0.9881
Contrast Factor (10%)	-	-	-	0.7781	0.8493	0.8412
JPEG Quality (80%)	-	-	-	0.7232	0.8362	0.8372
JPEG Quality (60%)	-	-	-	0.7351	0.8541	0.8554
Cropping	0.7250	0.7252	0.7303	0.7481	0.8423	0.8413

Table 2 shows the performance of the proposed method for multiple watermarks with attacks using air horse video. In this proposed approach, we use the multiple watermarks such as gray image and color image watermark. From table 2, it is inferred that the maximum PSNR of 39.70 is obtained for non-interlacing, followed by 37.13 for using one-level interlacing and 35.38 for two-level interlacing. First, the results of the with and without interlacing are close to each other which indicate that the goal of this paper is achieved. Second, the results of both first and second level interlacing are close to each other which indicate that there is no need for more levels of interlacing because there is no enhancement in results in two levels interlacing over one level interlacing.. Moreover, we obtain the maximum normalized correlation value. During the communications channel between the sender and the receiver, the watermarked video is attacked; these attacks are categorized into five categories. These categories are as follows: geometric attacks, noising attacks, de-noising (filtering) attacks, format compression attacks, and image-processing attacks. In order to ensure that our proposed solution is not affected against the robustness of the video multiple watermarking systems against attacks.

VI. CONCLUSION

In this paper, a multiple watermarking approach based on three-level discrete wavelet transform and interlacing technique is proposed. This method mainly reduces the non-blind watermarking system problems. In this approach three-level discrete wavelet transform (DWT) was used as watermark embedding/extracting process and Arnold transform as watermark encryption/decryption process. Proposed scheme has been tested against different standard videos, and is inferred to get more efficient results. The results of the proposed watermarking technique do not seem to be robust against attacks and results in higher manipulation of the watermark text after extraction. In future we will try to enhance the performance of the proposed hybrid algorithm using different strategy for embedding and extraction of watermark in order to impart better robustness to the scheme.

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