An Efficient Lossless Video Watermarking Extraction Process With Multiple Watermarks Using Artificial Jellyfish Algorithm

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Abstract

In recent years the applications of video water markings are need to extract the watermark without using the original data because of the enormous storage of the cover data. In order to get the better performance an efficient multiple video watermarking techniques using artificial jellyfish with H.265 video encoding is developed. The proposed approach deals with watermark extraction process. In the extraction process, initially, the videos are subdivided into sub videos. Then, each video is converted into frames. Then, DWT is applied for each frame. To enhance the DWT performance, the co- coefficients are optimally selected using an artificial jellyfish algorithm. After-that, the watermark encryption/decryption method is carried out, and a different type of media (gray image, color image) is used as watermarks. After the watermarking, the image is compressed using H.265 video encoding algorithm. The performance of the proposed method is analyzed in terms of different metrics and the proposed work is implemented in MATLAB. The performance of the proposed method is validated by performances metrics and compared with the DWT based watermarking approach.

Keywords: *Extraction process ,Watermarking, , DWT, Jellyfish algorithm,.*

I. Introduction

The watermarking method is fed to audio, video, and multimedia applications. The techniques may hinder the originality of the data due to the rapid increase in internet technologies. The distribution, duplication, and the access of multimedia data are simpler, which results in multiple issues like broadcasting and illegal usage [1,2]. Thus, the safety of multimedia content has become a major challenge. Watermarking methods are classified as strong watermarking, semi-fragile watermarking and fragile watermarking. The strong watermarking method which allows you to extract hidden watermarks from watermarked images, even after image processing (e.g., image compression and filtering) [3]. Thus, it can be exploited to verify copyright and intellectual property rights. The fragile watermarking technique can be easily destroyed by simple image processing; thus, it can accurately detect the tampered area [4].

There are currently two types of fragile watermarking techniques. The first type detects only the tampered area from the cover image [5]. The second can detect and find the tampered area as well as recover the area on the image. Self-embedding is a way of recovering the tampered area with the recovered bits, which are embedded in the pixels of the cover image, where the recovering bits are composed of the feature of the original image [6]. The performance of the self-embedding method based on watermarking technology is generally evaluated by the quality of the recovered image. In most self-embedding methods, the recovery bits of a specific block are always hidden in the other block of the image. A method like this can fail if the block containing the recovery bit has been tampered with. This is called the tampering coincidence problem [7].

The remaining part of the paper is organized as follows, section 2 provides the recent related works of watermarking scheme. The complete proposed watermarking scheme is presented in section 3. The section 4 provides the results and discussion section. Finally, the conclusion part is presented in section 5.

2. Literature Review

Fauzia Yasmeen *et al.,* [8] have developed a hybrid watermarking scheme to furnish the robustness and protection of digital data. This hybrid scheme was a form of discrete wavelet transform (DWT) and singular value decomposition (SVD). The embedding and extracting features are carried out through multi-level operations of DWT and SVD. Various attacks were added to the proposed method to justify the robustness of the watermark. In the end, the suggested approach was contrasted with existing methods to confirm the supremacy.

Yuan et al., [9] have presented adaptive multiple embedding factors (AMEF) algorithm for calculating the optimal embedding regions and the optimal embedding strengths. In the presented AMEF algorithm, proposed that the optimal embedding regions were determined by the contrast function of different blocks. Then determine the multiple embedding strengths to depend on the weighted ratio of the contrast values of blocks and the eigen values of different marks. Furthermore, in order to calculate the weight value in the AMEF algorithm, define a single objective function and utilize a hybrid particle swarm optimization and grey wolf optimizer (PSO-GWO) algorithm to optimize the objective function. In this work, by the use of the discrete wavelet transform (DWT),singular value decomposition (SVD) and AMEF, four encrypted color watermarks were inserted into the selected regions of the color (normal or medical) host image, simultaneously. Then watermarked host image was tested under various attacks and compared to other recent existing schemes.

Singh *et al.,* [10] have developed a self-embedded watermarking technique based on Absolute Moment Block Truncation Coding (AMBTC) for reconstructing tampered images by cropping attacks and forgery. AMBTC was suitable as a recovery bit (watermark) for the tampered image. This was because AMBTC has excellent compression performance and image quality. Moreover, to improve the quality of the marked image, the Optimal Pixel Adjustment Process(OPAP) method was used in the process of hiding AMBTC in the cover image. To find a damaged blocking a marked image, the authentication data along with the watermark must be hidden in the block. Here, employ a checksum for authentication. The watermark was embedded in the pixels of the cover image using 3LSB and 2LSB, and the checksum is hidden in the LSB.

Sarkar *et al.,* [11] have developed watermark synchronization process and the corresponding watermarking scheme. In this scheme, the watermark bits were represented by random patterns. The message was encoded to get a watermark unit, and the watermark unit was flipped to generate a symmetrical watermark. Then the symmetrical watermark was embedded into the spatial domain of the host image in an additive way. In watermark extraction, first get the theoretically mean-square error minimized estimation of the watermark. Then the auto-convolution function was applied to this estimation to detect the symmetry and get a watermark units map.

3. Proposed Watermark extracting process

In the proposed methodology, practicality and robustness is mainly related on embedding and extraction process. This is important step in the watermark process. To extract the watermarking steps, only the watermark video location and embedding procedure is needed. The complete process of the watermark embedding algorithm is presented follows,

Input: Compressed video output

Output: Extracted original video and image

- **Step 1:** This step computes the embedded watermark bit stream and extracts it
- **Step 2:** Extract each image and insert the secret image
- **Step 3:** 2DDWT is utilized to watermark changed to get the original image back.
- **Step 4:** Extracted watermark image pixels are located in a matrix with the image size to extract the watermark.

Finally, the original video and watermark pictures are extracted. With the help of proposed methodology, the inserting the watermark image into a unique video. In the extraction process, the modified blocks are changed into single block to develop the watermarked image. Once completed the watermarked images, the data size is increased to large size. The size of the video and data is affecting the memory space of storage devices and transmission lines. Hence, the full input video cannot be stored normally. So, the proposed method is designing a H.265 encoder for reducing the original data size and stored in the system. This encoder technique is reducing the bit size of frames and maintains the image quality with their small pixels. Then the jellyfish algorithm has been implemented as follows.

The jellyfish algorithm is mathematically formulated as three idealized rules,

- Jellyfish may follow the move inside the swarm and ocean current. This movement is organizing by switching process among the two movement.
- To search food, the jellyfish travels in the ocean. They are more depends on the locations which location have greater.
- The food quantity is computed based on related objective function and location.

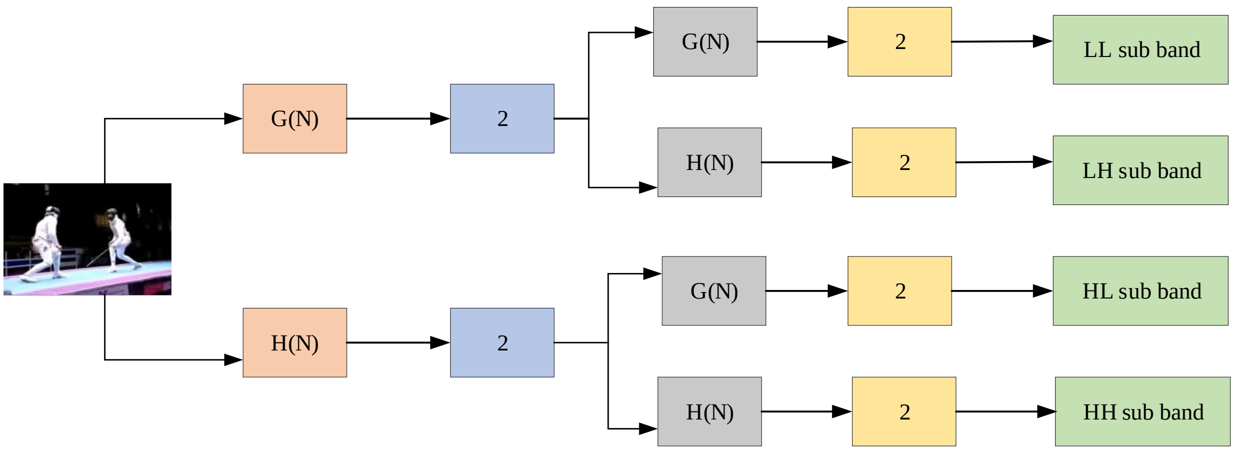
3.1. Two-Dimensional Discrete Wavelet transform

The 2D DWT is utilized to enhance the watermarking procedure. In the embedding process, the best coefficients are selected by using 2D DWT transform. The wavelet transform is an efficient mathematical calculation for converted frames of images and it's a best selection in different image classification and analysis problems. In the proposed methodology, DWT is utilized to changes the image in to different frame resolution or scales. Compared with the conventional transform methods, wavelet transform provides signal time-frequency localization of an image, which is most excellent properties for extracting frames from the images [12].Higher order wavelets are shifted and scaled versions of some fixed mother wavelets. The figure 1(a) shows the DWT structure and figure 1(b) shows the process of Level 3 2DWT. Initially, the square integral function is considered as continuous function. The continuous wavelet transform is described as real valued wavelet. Hence, the wavelet function is formulated as follows,

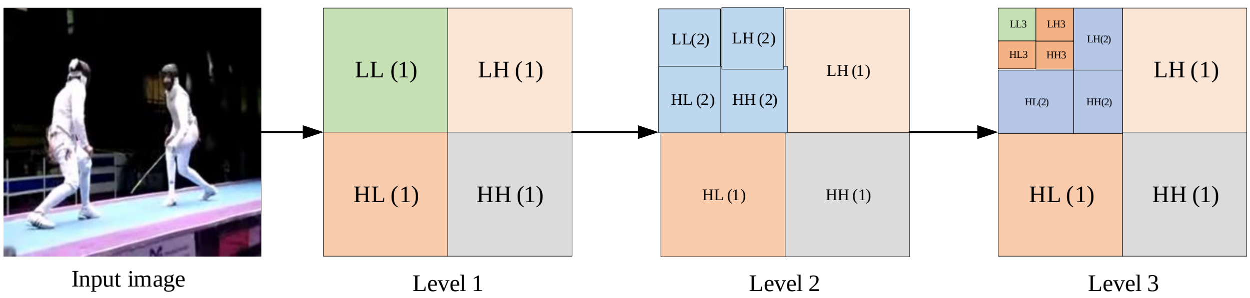
$$W^{\Psi(S,T)} = \int_{-\infty}^{+\infty} F(X)\, \Psi_{s,t}(X)\, dX \qquad (1)$$

Where,

$$\Psi_{s,t}(X) = \frac{1}{\sqrt{S}} \Psi\left(\frac{X-T}{S}\right); \qquad S \in \Re^{+},\ \ T \in \Re \qquad (2)$$



(a)



(b)

Figure 1: Analysis of (a) DWT structure and (b) process of Level 3 2DWT

The DWT function is formulated from the mother wavelet with the consideration of scaled and translation parameters of S and T respectively. The discrete variation of equation (1) can be achieved through restructure the S and T to maintain a discrete lattice with $T = 2^J K$ and $S = 2^J$ is formulated as follows,

$$DWT^{F(N)} = \begin{cases} A^{J,K}(N) = \sum_N F(N) G_J^*(N - 2^J K) \\ D^{J,K}(N) = \sum_N F(N) H_J^*(N - 2^J K) \end{cases} \quad (3)$$

Where, $G(N)$ is described as low pass filter coefficients, $H(N)$ is described as high pass filter coefficients, $A^{J,K}(N)$ is described as approximation component coefficients, $D^{J,K}(N)$ is described as detail component coefficients. The translation and wavelet scale factors are denoted by K and J respectively. The three level 2D DWT is executed with the combination of down samplers and digital filters [25]. In the 2DWT cases, the DWT is applied to each and every dimension separately such as columns and rows of the images with the consideration of 1DDWT to build up the 2D DWT. From the structure of 2DDWT, four sub bands are obtained at each level such as LL: low-low, LH: low-high, HL: high-low and HH: high-high). From the four sub bands, three sub band images are collected such as$HH\ (D_J^D)$, $LH\ (D_J^D)$ and $HL\ (D_J^D)$. These images are presented along diagonal, vertical and horizontal directions. $LL\ (A_J)$sub band is the approximation image that is utilized for computation of 2DDWT in the next level. With the help of 2DDWT, the video images are converted in to the frames [13]. The frame conversion, the 2DDWT coefficients should be selected optimally to enable efficient secure watermarking.

3.2. Ocean current

The ocean current consists huge volume of nutrients so, jellyfishes are lived and attracted to it. The ocean current direction is computed by averaging the whole vectors from each jellyfish in the ocean to jellyfish which presently in the optimal location [14]. The ocean current of jellyfish is formulated as follows,

$$\overrightarrow{O.C} = \frac{1}{Pop^N} \sum \left(X^* - E^c X^i \right) = X^* - E^c \frac{\sum X^i}{Pop^N} = X^* - E^c \mu \quad (4)$$

Set $df = E^c \mu$,

Hence, the ocean current is computed based on below equation,

$$\overrightarrow{O.C} = X^* - df \quad (5)$$

Where, df can be described as difference among the jellyfish current best location and jellyfish mean location, μ can be described as jellyfish mean location, E^c can be described as attraction factor, X^* can be described as best location of the jellyfish and Pop^N is described as number of jellyfish. With the consideration of normal spatial distribution of jellyfish in all dimensions, distance of the jellyfish around mean location which consists specified jellyfish likelihood [15]. The distance of the jellyfish is mathematically formulated as follows,

$$D = \pm \beta \sigma \quad (6)$$

Where, σ is described as standard deviation of the distribution in jellyfish.

$$df = \beta \times \sigma \times rand^f(0,1) \quad (7)$$

$$\sigma = rand^\alpha(0,1) \times \mu \quad (8)$$

The new optimal location of jellyfish is presented as,

$$X^i(T+1) = X^i(t) + rand(0,1) \times \overrightarrow{O.C} \qquad (9)$$

3.3. Jellyfish swarm

The jellyfish is divided in to two different motions such as passive and active motions. Based on the jellyfish motions, the local search or exploitation can be processed with below formulations,

$$\vec{s} = X^i(t+1) - X^i(t) \qquad (10)$$

From the equation (7), the calculation is presented as follows,

$$\vec{s} = rand(0,1) \times \vec{D} \qquad (11)$$

$$\vec{D} = \begin{cases} X^j(t) - X^i(t) \;\; if\; f(X^i \geq fX^j) \\ X^i(t) - X^j(t)\; if\;\; f\;(X^i < fX^j) \end{cases} \qquad (12)$$

Where, f is described as an objective function of location.

3.4. Initial Population

Initially, population of the jellyfish is created with randomly. The jellyfish may affect due to slow convergence and trapped at local optima. The slow convergence may be created the low population diversity. To overcome the slow convergence rate, the chaotic maps have been designed such as liebovitch map, tent map and logistic map. The logistic map is selected which is one of the simplest chaotic maps. This map presented more diverse initial populations than does random selection. Hence, the logistic map is presented as follows,

$$X^{i+1} = \eta X^i(1 - X^i), \;\; 0 \leq X^0 \leq 1 \qquad (13)$$

Where, X^0 can be described as initial population of jellyfish $X^0 \epsilon (0,1)$ and X^i is described as logistic chaotic value of location. The efficiency parameter is set as 4.0.

3.5. Boundary conditions

The jellyfish is mostly depending on the ocean characteristics and ocean located around the world. The boundary conditions of the jellyfish are formulated as follows,

$$\begin{cases} X^{i,d}_{ref} = (X^{i,d} - U^{u,d}) + L^b(d)\; if\; X^{i,d} > U^{b,d} \\ X^{i,d}_{ref} = (X^{i,d} - L^{b,d}) + U^b(d)\; if\; X^{i,d} < U^{b,d} \end{cases} \qquad (14)$$

Where, $L^{b,d}$ can be described as lower bound constraints in search space, $U^{u,d}$ is described as upper bound constraints in search space and $X^{i,d}$ can be described as jellyfish location.

4. Results and Discussion

The performance of the proposed method is analyzed in this section. In this paper, efficient watermarking techniques is developed to empower the security of the images in the process of watermark embedding and extraction process. The proposed method is implemented in the MAT laboratory version (7.12). This proposed technique is performed on the Windows machine with the Intel Core i5 processor at 1.6 GHz and 4 GB RAM. The proposed system has been tested on a set of data available on the Internet. The database is collected from the open source system which presented in the "512 × 512" size images.

Table 1: Comparative analysis of the proposed method with the attack such as AD, MD, NAE and SC

Input videos		**AD**		**MD**		**NAE**		**SC**	
		Proposed method	**DWT**	**Proposed method**	**DWT**	**Proposed method**	**DWT**	**Proposed method**	**DWT**
1	Noise	12.41385	14.28	24.33333	23.48	0.917684	0.96	0.099027	0
1	Filter	0.014691	0.35	34.66667	55.18	1.003611	1.27	0.008577	0
1	Cropping	6.062441	14.81	85	85.18	1.04415	1.51	0.047884	0
1	Blurring	0.000123	0.3	62	42.84	1.010213	1.54	0.027498	0
2	Noise	15.97341	14.98	22.33333	22.88	0.84836	0.91	0.198094	0
2	Filter	0.035324	0.35	39	41.84	1.003146	1.05	0.005764	0
2	Cropping	1.895741	13.45	85	85.87	1.028998	1.57	0.023352	0
2	Blurring	0.000189	0.24	46.66667	40.48	1.009626	1.24	0.023888	0
3	Noise	13.44231	11.91	20	22.84	0.922922	0.99	0.171853	0
3	Filter	0.04495	0.29	36	35.81	1.00218	1.28	0.00399	0
3	Cropping	8.839945	6.01	85	86.8	1.173221	1.21	0.112421	0
3	Blurring	0.000539	0.29	40	63.81	1.008322	1.27	0.019605	0
4	Noise	13.44231	13.15	20	27.05	0.922922	1.07	0.171853	0
4	Filter	0.04495	0.1	36	36.87	1.00218	1.84	0.00399	0
4	Cropping	8.839945	8.48	85	86.18	1.173221	1.29	0.112421	0
4	Blurring	0.000539	0.09	40	43.81	1.008322	1.57	0.019605	0
5	Noise	16.90476	15.48	24	24.91	0.840759	0.92	0.173634	0
5	Filter	0.045559	0.37	26.66667	55.48	1.002128	1.27	0.004273	0
5	Cropping	2.218448	11.18	64	85.91	1.025173	1.35	0.022641	0
5	Blurring	4.90E-05	0.28	37.33333	42.84	1.003105	1.23	0.010742	0

From the table 1, the performance of the proposed method and existing methods are analyzed in terms of AD, MD, NAE and SC respectively. The AD value of proposed and existing methods are 0 and 0 for initial videos. The MD value of proposed and existing methods are 0 and 0 for initial videos. The NAE value of proposed and existing methods are 0 and 0 for initial videos. The SC value of proposed and existing methods are 1 and 1 for initial videos. From the comparison analysis, we can concluded as the proposed method is achieved the best results than the DWT based watermarking technique.

5. Conclusion

In this paper, an efficient watermarking extraction technique have been designed with the help of jellyfish algorithm. Once the extraction process is enabled, the multiple blocks are changed into a single block. The original image and watermarked images are consumed high memory space in memory device. To overcome the drawbacks of the memory issues, the encoder process is utilized which reduces the consumption of memory spaces and maintain the image quality. The proposed method is implemented in MATLAB and performance were evaluated by performance metrics. The performance analysis and comparison analysis is evaluated in the paper. The proposed method is compared with the existing method such as DWT based watermarking process. Hence the proposed method has achieved an enhanced result than the existing technique.

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