International Journal of Engineering Research and Technology. ISSN 0974-3154, Volume 14, Number 7 (2021), pp. 652-663

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

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Abstract: In video watermarking applications, it is necessary to extract the watermark without using the original data due to the large storage of cover data. In literature, many watermarking methods are reviewed which may be degrades the performance to enhance the efficiency and image quality. Therefore, in this paper, many efficient video watermarking techniques have been developed using synthetic jellyfish with H.265 video encoding. The anticipated approach contains of two major methods namely; (i) watermark embedding process and (ii) watermark extraction process. In the embedding 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 process is carried out, and a dissimilar type of media (gray image, color image) is utilized as watermarks. After the watermarking, the image is compressed using H.265 video encoding algorithm. The same process is repeated for the extraction process. The performance of the proposed method is analyzed using various metrics and the proposed task is implemented in MATLAB. The performance of the proposed method is verified through performance measurements and compared with the DWT-based watermarking approach.

Keywords: watermarking, secure operation, DWT, jellyfish algorithm, extraction and embedding process.

I. INTRODUCTION

In recent years, the internet and multimedia technologies have bought the increasing popularity of digital videos such as mobile videos, online videos and network TVs. The video watermarking is an attractive domain for creating an authentication and copyright protection system [1]. Here, security is seen as a main problem including multimedia copyright infringement, corruption, and illegal fraud. Cryptographic algorithms are used to securely transfer data between the content provider and the customer. Multimedia applications have increased the demand for secure mechanisms for the legal distribution of digital data [2]. The transmission of multimedia data is easy owing to the high internet speed and the multimedia settings in the distributed environment. Therefore, the copyright on digital content must be protected. The watermark is modified to the original multimedia data in order to avoid the originality of the data and the owner can interpret the data [3].

The watermarking system is intended for audio, video, and multimedia applications. Methods can prevent the originality of data due to the rapid rise of Internet technologies. Distribution, copying, and access to multimedia data are easy that leads to many problems such as broadcasting and illegal use [4,5]. Therefore, the security 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) [6]. Thus, it can be exploited to verify copyright and intellectual property rights. The fragile watermarking technique can be easily erased by simple image processing; thus, the damaged area can be accurately identified [7].

There are currently two types of fragile watermarking techniques. The first type detects only the tampered area from the cover image [8]. 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 [9]. 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 [10].

Different watermarking approaches for coefficient domains offer enhanced robustness with concentrated payload and increased computational effort. Various water identification methods [11] based on Fourier transform [12] and frequency modification [13] are used to carry out general-purpose applications. Multipurpose watermarks are a cocktail or multiple watermarking approaches [14] that are copyrighted by embedding dissimilar watermarks and are susceptible to various attacks. Some robust watermarking techniques are based on vector quantization (VQ) [15], in that watermark data is inserted into coded codes under several constraints to indicate deviations beyond a certain limit. In general, embedding and retrieving watermarks should be less of a problem, as realtime watermarks are enviable [16]. Depending on the domain in which the watermark is embedded, watermarking techniques are classified into three types, named as compressed, spatial, and domain watermark conversion. In compressed domain watermark systems, the watermark is embedded in an encoded bitstream created by utilizing encoders. Now days, the optimization algorithms are utilized in the watermarking scheme to enable the optimal secure operation in the images.

The rest of the paper is organized subsequently; Section 2 presents the latest related tasks of the water-related project. The complete anticipated watermarking plan is provided in Section 3. Section 4 presents the results and discussion section. Finally, the conclusion is given in Section 5.

2. Literature Review

Many different methods are available to secure watermarking method which developed by researchers. Some of the methods are reviewed in this section.

Amir M. Usman Wagdarikar*et al.,* [17] provides a video watermark optimization algorithm based on areas of interest. Here the optimal areas for video watermarks are designatedby utilizing the anticipated Chronological Moth Search (Chronological-MS) methodthat is recognized by modifying the techniques concept of the moth search algorithm (MS). The rented practice process has a cost function that uses parameters such as energy, edge, pixel intensity, brightness, and coverage. Primary, the feature of the input video file was extracted and the extracted features were used to select the optimal parts using the proposed Chronological-MS. Thereafter, the wavelet transform was given to the original image to obtain the wavelet coefficients. Here, the data protection message is broken down into binary images by utilizing bit plane method. Therefore, the embedding process is carried out to hide the secret message using areas of interest recognizedby utilizing the anticipated timeline MS procedure and the extraction phase is restored.

Konstantinos Pexaras*et al.,* [18] had presentedto keep the entire part of the arithmetic functions at an optimal level, computational updates of the implemented algorithm have been provided so that the arithmetic units are as small as possible. Also, another investigation was carried out to reduce the measurement error. Three different types of hardware configuration have been proposed, two for image watermarks and one for video (pipeline), which reuse even small arithmetic units in various arithmetic operations, thereby further reducing implementation costs. The proposed designs are inexpensive in terms of area, performance, and performance compared to existing processes. Also, the errors of watermarked images/frames are very small compared to their floating-point counterparts and at the same time, they are more prone to various attacks.

Sayantam Sarkar *et al.,* [19] had presented the Optimized Haar wavelet transformation was developed using the optimal modules Kogge-Stone Adder / Subtractor, Optimal Controller, Buffer, Shifter, and D_FF blocks. The existing Kogge- Stone Adder architecture has been updated by utilizing the modified Carry Correction modulethat utilizes a parallel architecture to reduce computation lag. Similarly, the control module has been enhanced with the interdependent use of clock dividers and reset counters. In order to protect the accurateness of the processed data, appropriate intermediate bits are considered with the help of Q-code in fractional format.

Fauzia Yasmeen *et al.,* [20] have established a hybrid watermarking project to provide the strength and security of digital data. This hybrid scheme consists of unique discrete wavelet transform (DWT) and singular value decomposition (SVD). Embedding and extraction functions are performed through multi-level operations of DWT and SVD. The proposed method has been expanded to include several attacks to justify the strong character of the watermark. In summary, the proposed approach contradicted the existing methods of ensuring dominance.

Yuxin Shen et al., [21] had proposed adaptive multiple embedding factors (AMEF) procedure forcalculating optimal embedding areas and optimal embedding thicknesses. In the AMEF algorithm provided, it is proposed that the optimal embedding areas are determined by the different functions of dissimilar modules. Determine several embedment strengths depending on the weight ratio of the various values of the blocks and the equilibrium values of the various ratings. In addition, for calculating the weight value in the AMEF method, an objective function can be defined and the objective function can be improved using a hybrid particle swarm optimization and grey wolf optimizer (PSO-GWO) algorithm. In this thesis, four encrypted color watermarks are selected simultaneously for a colored (normal or medical) host image, with unique discrete wavelet transform (DWT), singular value decomposition (SVD) and AMEF inserted into areas. The watermarked host image was then tested under numerous attacks and compared with other existing programs.

Cheonshik Kim *et al.,* [22] have developed an independently integrated watermarking method based on absolute moment block truncation coding (AMBTC) for recovering buffered images by formatting and manipulating attacks. AMBTC appeared as a recovery bit (watermark) for a fake image. AMBTC has excellent compression characteristics and excellent image quality. In addition, to improve the quality of the tagged image, the OPAP (Optimal Pixel Adjustment Process) method was used to cover the AMBTC on the cover image. To find the corrupted image that is blocking the tagged image, the credentials as well as the watermark must be hidden in the block. The checksum is used here for verification. Using 3LSB and 2LSB, the watermark was embedded in the pixels of the cover image and the checksum was masked into LSB.

Zehua Ma *et al.,* [23] have developed synchronization process for watermarks and associated watermarking scheme. In this scheme, watermark bits are represented by random shapes. The message was encoded to get the watermark unit and the watermark unit was flipped to create a symmetrical watermark. The symmetric watermark is then embedded in the host image's spatial domain in an integrated manner. In watermark extraction, the theoretical mean square error first reduces the rating of the watermark. The automatic conversion function was used in this estimate to find the symmetry and get a map of the watermark units.

3. PROPOSED SECURE WATERMARKING SCHEME

Digital watermarking methodology is the process of changing the multimedia data by adding information into the host media to secure its copyright information. To designing a robust and efficient image watermarking system, the characteristics should be maintained such as security, capacity, robustness and imperceptibility. Different existing methods have been presented in the watermarking which may fails to provide efficient security, limited in size. Hence, in this paper efficient watermarking is developed to secure the image. In the proposed method, stego images are very similar to normal cover images, which reduce the attacker's attention. The proposed watermarking method is implemented with two main functions, namely the watermark embedding method and the watermark extraction method. Initially, the input videos are changes into number of frames. After that, frames are converted to sub bands with the help of 2D DWT transform. Among the proposed methods, the jellyfish algorithm is used to select the optimal position of the sub-band images. Once optimal position is selected, the secret image is embedded with the help of ECC encryption algorithm. The selected optimal position is embedded with each bit of encrypted image. After that, the reverse operation of the embedding process is preceded which provides the final watermarked bit and extracted. Finally, the combining the modified blocks in to a single block to develop the watermarked image. The watermarked image size is very large which create the memory problem in storage devices and transmission lines. To solve this memory issues the proposed video compression H.265 encoder is used to minimize the data quantity.

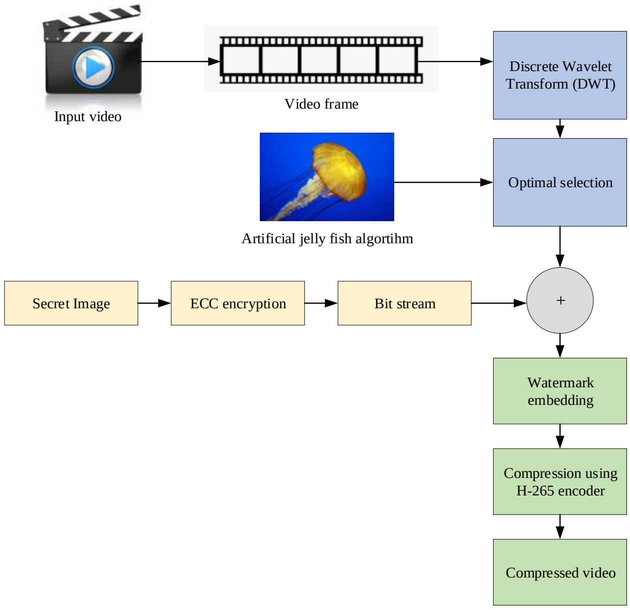


Figure 1: Block diagram of the proposed system

The proposed architecture is illustrated in figure 1. From the figure 1, the input video is converted into many frames. In the frame conversion, the input video is decomposing into different frames such as LL, HH, LH and HL with the assistance of DWT. The detail description of DWT is presented in below.

A. Two-Dimensional Discrete Wavelet transform

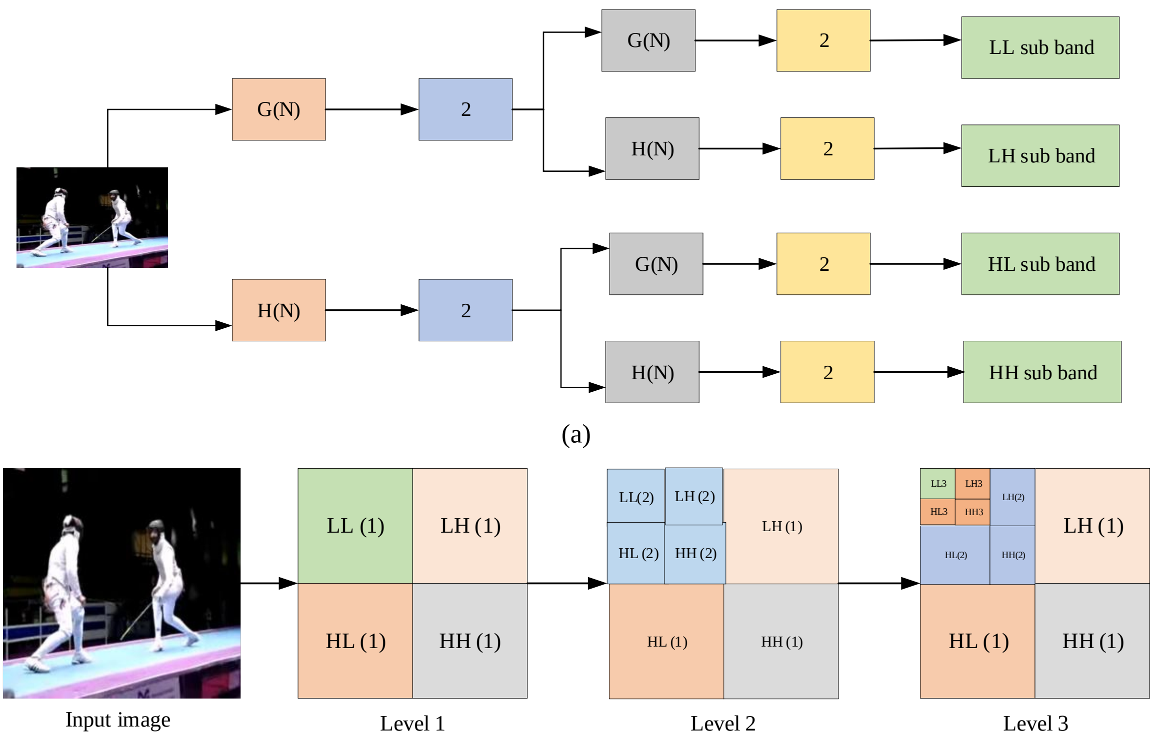
The 2D DWT is used to improve watermarking practice. The embedding process selects the best coefficients using the 2D DWT transform. Wavelet transform is an efficient mathematical computation for modified image frames and an excellent choice for various image classification and analysis issues. In the proposed methodology, DWT is utilized to changes the image in to different frame resolution or scales. Compared to conventional transformation methods, wavelet transform provides signal-time-frequency localization of an image, which is an excellent feature for extracting frames from images[24].Higher order wavelets are shifted and scaled versions of some fixed mother wavelets. Initially, the square integrable 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,

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

International Journal of Engineering Research and Technology. ISSN 0974-3154, Volume 14, Number 7 (2021), pp. 652-663



(b)

Figure 2: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 figure 2, 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 [26]. The frame conversion, the 2DDWT coefficients should be selected optimally to enable efficient secure watermarking.

B. Optimal position selection using jellyfish algorithm

In the proposed method, the Jellyfish algorithm is used to select the optimal coefficients in the 2D DWT transform. Optimal coefficients enable an efficient and safe watermarking process. Jellyfish live in bodies of water with different temperatures and depths around the globe. Jellyfish are shaped like pearls. Some jellyfish are less than an inch in diameter while others are much larger. In addition, there are different shapes, sizes, and colors. Compared to other creatures in the ocean, jellyfish have different nutritional properties; H. They filter and use tentacles to get food into their mouths. The remaining jellyfish grab the prey vigorously and shake it by stabbing it with their tentacles. Jellyfish usually use tents to pierce their prey and release a poison that paralyzes them. They didn’t hunt works, but rather against swimming creatures that cause death. Some jellyfish sticks are not dangerous, but they are painful [27]. Normal prick can cause tingling, numbness, itching, red spots, and pain. Some sticks also count jellyfish from the Indian Ocean coast, the Philippine coast, the Australian coast, and the central Pacific. When jellyfish bloom, it is very dangerous for the organism.

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.

The required mathematical model of jellyfish algorithm is presented in this section.

3.2.1. Ocean current

The ocean current is rich in nutrients, so jellyfish live and be attracted to it. The current direction of the ocean is calculated by averaging the absolute vectors of each of the jellyfish in the ocean that are the most optimally located jellyfish [28].The ocean current of jellyfish is formulated as follows,

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

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 jellyfishand 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 [29]. 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,

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

3.2.2. 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,

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

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

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

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

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

3.2.3. 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 that is one of the simplest chaotic maps [30]. This map presented more diverse initial populations than does random selection. Hence, the logistic map is presented as follows,

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

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.

3.2.4. 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,

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

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.

3.2.5. Fitness calculation

Once initial population is completed, the fitness function computed. Based on the fitness function, the optimal coefficient value of the DWT transform. The fitness function is evaluated with the consideration of the PSNR value. The PSNR should be maximized to enable efficient secure operation. Hence, the fitness function is formulated with maximization of PSNR. The fitness function is achieved by selecting optimal DWT coefficient value. The fitness function is mathematically formulated as follows,

$$\mathrm{FF} = \mathrm{MAX}\{\mathrm{PSNR}\} \quad (15)$$

$$PSNR = 10log_{10}\left(\frac{255^2}{MSE}\right) \quad (16)$$

$$MSE = \frac{1}{N*M}\sum_{X=1}^{N}\sum_{Y=1}^{M}\left[I_{image}(A,B) - I_{d-image}(A,B)\right]^2 \quad (17)$$

Where, $I_{d-image}(A,B)$ is described as denoised images and $I_{image}(A,B)$ is described as input image. Based on the fitness function, the 2DDWT coefficients are selected which utilized to enhance the optimal watermarking procedure.

C. Elliptical Curve Cryptography based encryption process

The ECC is used to encrypt the secret images for improve security level of the anticipated watermarking process. In this process, the secret image is considered as plain text. The ECC security has been improved to be more efficient cryptographic methods as contrasted to conventional cryptographic techniques. This method presented an equivalent level of security with less key size [31]. The ECC mathematical formulation is presented as follows,

$$E_P(A,B): Y^2 = X^3 + AX + B \ mod \ P (18)$$

Where, $A, B \in Z_P$ and $4A^3 + 27B^2 \ mod \ P \neq 0$ and P is the large prime number. The values of A and B elliptic curve parameter. The source code is encrypted with the consideration of public key of the destination due to usage of private key. The data is decrypted in the destination node. The public key generation is presented follows,

$$K_{pu} = K * P \ (19)$$

Where, P is described as point of the elliptic curve, K is described as random prime numbers in the limit of $[1, n-1]$ and the receiver private key. The receiver public key is denoted byK_{pu}. The private key is optimally selected by based on prime number. Once, the secret image is encrypted, it is processed to the watermark embedding method which presented in below section.

D. Watermark embedding algorithm

The watermark embedding procedure is utilized the embedding algorithm and watermark key to make a watermark video. The watermark embedding method is depends on the image information such as bandwidth, domain, frequency and location. In the watermarking process, initially secret image is encrypted with the help of ECC method. Once the encryption process is accomplished, the secret image is changed into a watermark bitstream and their combination is utilized for watermark in the selected position of blocks. After that, H.265 encoder is utilized to video compression which reduces the storage space of memory devices. The watermark embedding process is presented as follows,

Input: Original video $V^0[A, B\}$

***Output*:** Compressed video$V^c[A, B\}$

- Firstly, the input original video is converted into number of frames with the help of 2DDWT. This transform is divided into four sub bands such as LL, HH, LH, and HL which utilized to watermark embedding process.
- From the four sub bands, the low variance sub bands are selected and position related to bitstream also selected with the help of jellyfish algorithm.
- Watermark, and then select an image add a watermark bit stream which changed into bitstream. This bitstream component is utilized to embed a watermark in the selected position of the blocks.

From the reference value, the value of low variance sub bands are 1 the bit stream of secrete images are presented as,

$$V_s = -V_s \times \left(\frac{1}{\delta}\right) (20)$$

The selected value of low variance sub bands are 0, the secret image with their bit stream is formulated as follows,

$$V_s = V_s \times \delta \quad (21)$$

Where, δ can be described as random value (0,-1) and V_s can be described as secrete videos respectively. Finally, the compressed watermark is generated.

E. 3.5. 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 procedure 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. The complete process of the proposed encoder is presented as follows.

F. H.265 video encoder and compression

H.265 is an efficient video coding technique which utilized to reduce the memory space of storage devices. This H.265 also named as high efficiency video coding (HEVC) and it is a latest standard in video coding and advanced video coding method. The main aim of this method is to enhance the image quality and improves compression efficiencies to make huge data files. Additionally, this compression completely reduces the storage of watermarking image as well as original image. This compression techniques is reduce the burden of storage space and maintain the quality of the images in the compression process. In the compression, the bit rate also reduced which empower the process of the system [32]. This compression technique is processed with the similar process of H.264 but it have different advantages such as minimization of bandwidth usage, encoding every pixel from every frame. Hence, this approach completely encoding the whole image and it is more aggressive. Changes or sizes from 16 x 16 pixels to 64 x 64 expand the areas explored, and capabilities such as motion compensation, spatial prediction, and sample adaptation offset (SAO) image filtering have all been improved in part.

4. RESULTS AND DISCUSSION

This section analyzes the performance of the anticipated method.In this study, efficient watermarking techniques have been developed to progress the security of images during the watermark embedding and extraction process. The anticipatedtechnique is executed in the MAT laboratory version (7.12). Theanticipatedmethod is done on Windows system with Intel Core i5 processor at 1.6 GHz and 4 GB RAM. The projectedmodel has been tested on a set of data available on the Internet. The database is collected from the open source system provided in the "512 × 512" size images.

A. Dataset description

The projected methodology is validated with the help of the collected database. To validate and justify the proposed methodology, the performance and comparison of the projectedprocess is evaluated. The UCF dataset is collected from the reference [33].The collected database contains the five different video databases such as 'v_Fencing_g02_c05.avi', 'v_GolfSwing_g06_c01.avi', 'v_Billards_g04_c02.avi', 'v_SoccerJuggling_g01_c02 .avi', 'v_HorseRiding_g05_c01 .avi'. The sample collected database is illustrated in figure 3.

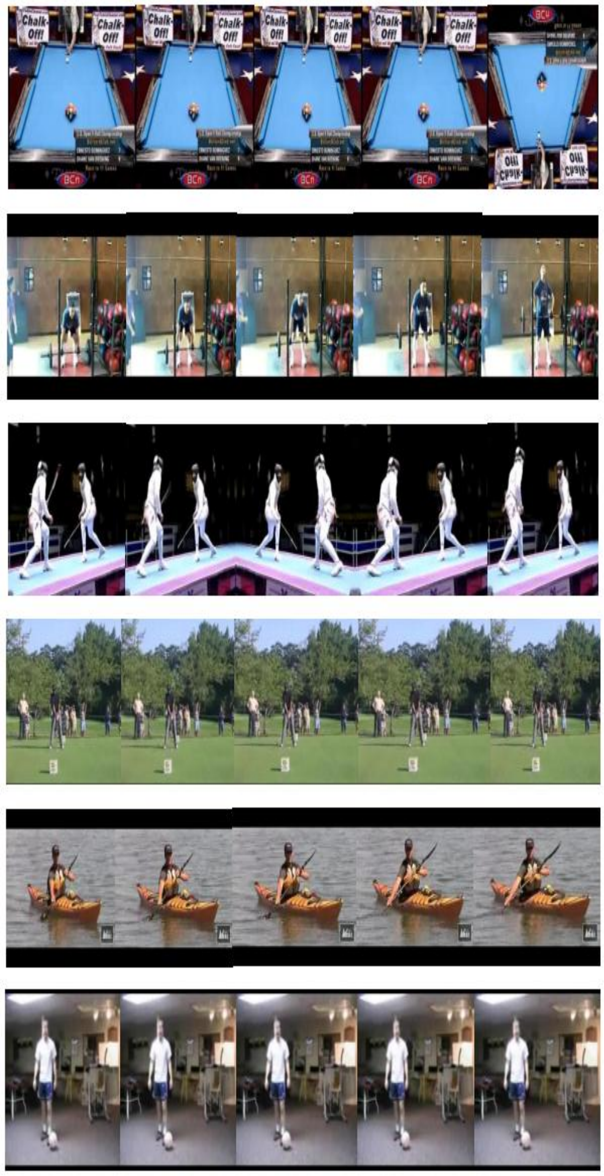


Figure 3: Sample dataset

B. Performance analysis

The proposed method is analyzed using common performance measurements such as Average difference, Compression, Minimum difference, Mean Square Error, Normalized Absolute Error, Normalized Correlation Coefficient, Peak Signal to Noise Ratio, Structural Content. The mathematical calculation of the proposed method is given as follows:

Average difference

It is defined as the average difference among watermarked images and original images. The formula of the average difference (AD) is presented follows,

$$AD = \frac{1}{MN}\sum_{I=0}^{M}\sum_{J=0}^{N}\{I_0[i,j] - I_D[i,j]\} \quad (22)$$

Where $I_0[i,j]$represents the original images and $I_D[i,j]$signifies the decomposed images.

International Journal of Engineering Research and Technology. ISSN 0974-3154, Volume 14, Number 7 (2021), pp. 652-663

Compression ratio

The compressed ratio is determined as the ratio of the size of the original image to the size of the compressed data stream. The compression ratio is given by,

$$Compression\ ratio = \frac{size\ of\ original\ data}{size\ of\ compressed\ data} \quad (23)$$

Minimum difference

Minimum difference is defined as the maximum error between the original and watermarked image. The minimum difference formula is expressed as,

$$Minimum\ difference = Max\ (original\ input\ image - warermarked\ image) \quad (24)$$

Mean square error

MSE provides the total square error between the corrupting noise and the maximum power of the signal. MSE is given below,

$$AD = \frac{1}{MN}\sum_{I=0}^{M}\sum_{J=0}^{N}\{I_0[i,j] - I_D[i,j]\}^2 \quad (25)$$

Normalized Absolute Error

Normalized absolute error (NAE) is given by,

$$NAE = \frac{\sum_{I=0}^{M}\sum_{J=0}^{N}|\{I_0[i,j]-I_D[i,j]\}|}{\sum_{I=0}^{M}\sum_{J=0}^{N}\{I_0[i,j]\}} \quad (26)$$

Normalized Correlation Co-efficient

The normalized correlation coefficient is given by,

$$NAE = \frac{\sum_{I=0}^{M}\sum_{J=0}^{N}|\{I_0[i,j]-I_D[i,j]\}|}{\sqrt{\sum_{I=0}^{M}\sum_{J=0}^{N}|\{I_0[i,j]^2-I_D[i,j]^2\}|}} \quad (27)$$

Peak Signal to Noise Ratio

The peak signal to noise ratio is determined as the ratio between the input image and the de-noised image. It is used to measure the quality of the output de-noised images. The PSNR value is given below,

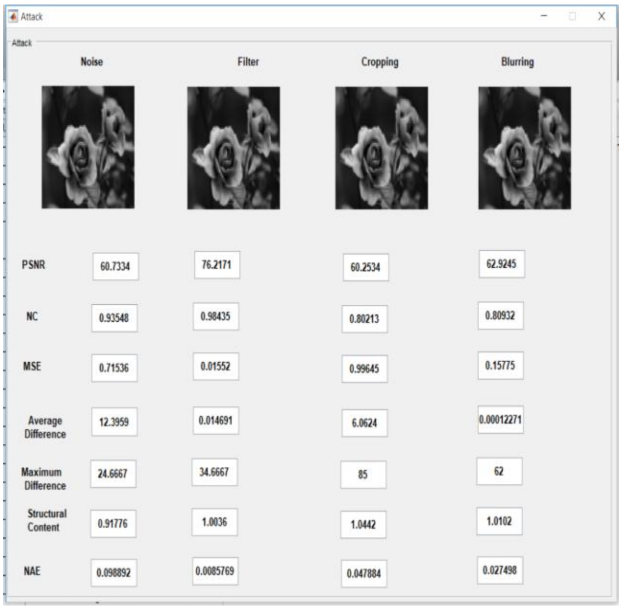
$$PSNR = 10log_{10}\left[\frac{255^2}{MSE}\right] \quad (28)$$

Structural Content

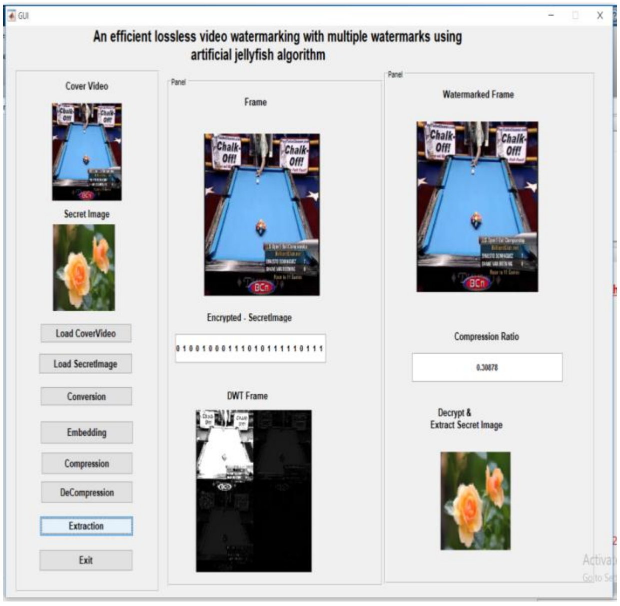
The Structural Content (SC) is also a correlation-based measure and measures the resemblance between two images.

$$SC = \frac{\sum_{I=0}^{M}\sum_{J=0}^{N}\{I_0[i,j]\}^2}{\sum_{I=0}^{M}\sum_{J=0}^{N}\{I_D[i,j]\}^2} \quad (29)$$

Based on the above performance measures, the performance of the plannedtechnique is validated in this section. The anticipated performance measures and compression standards are illustrated in figure 4.



(a)



(b)

Figure 4: Analysis of proposed method (a) Performance measures and (b) compression standard

Figure 5: Experimental results (a) Input image, (b) Watermarked image, and (c) extracted image

The proposed efficient watermarking scheme is achieved the PSNR is 60.7334. Similarly, the NC, MSE, AD, MD, SC and NAE are 0.934, 0.71536, 12.3959, 24.6667, 0.91776 and 0.098892 respectively. This measurements are computed in the noise removal images. In the figure 4(b), the compression images, extraction image and DWT features are illustrated. The output of the original image, watermark image and output image is presented in figure 5.

C. Comparison analysis

The comparative analysis is essential to validate the proposed methodology. The proposed method is comparable to current methods such as the DWT-based watermarking method. The proposed methodology is processed with two main operation such as watermark embedding process and watermark extraction process. Initially, the dataset is collected from the UCI database. After that, DWT is applied in the input video sequences into several frames. Then the jellyfish algorithm is utilized to find optimal position of the secret images. Based on the optimal position, the secrete images are embedded in the watermark embedding process, before that, the secret images are encrypted with the help of ECC. At last, the changing blocks are constructed with the one block which produced the watermarked image. The comparison analysis of performance metrics are presented in figure 6.

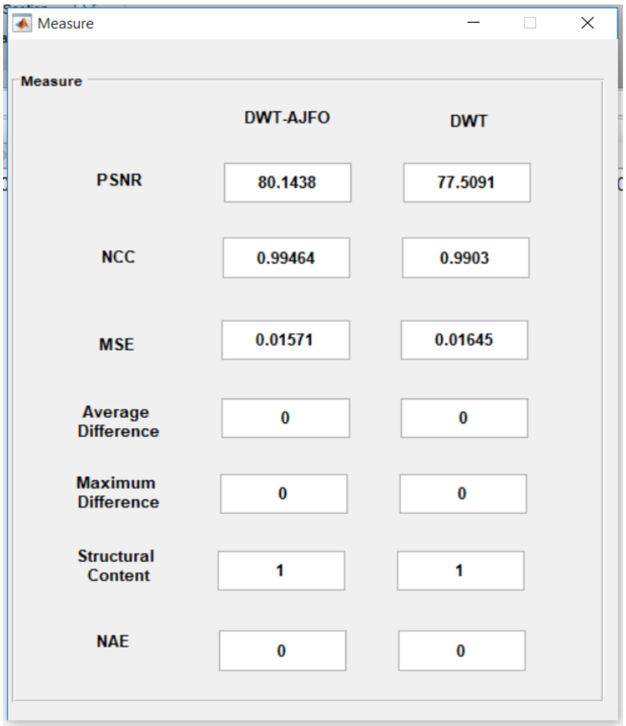


Figure 6: Comparison analysis of proposed method

TABLE 1: COMPARATIVE ANALYSIS OF THE PLANNEDPROCESS WITH THE ATTACK SUCH AS PSNR, MSE AND NCC

Input videos		PSNR		MSE		NCC	
		Proposed method	DWT	Proposed method	DWT	Proposed method	DWT
1	Noise	60.72949	52.01	0.717287	1.02	0.93382	0.72
1	Filter	76.21707	54.99	0.01552	2.48	0.985194	0.72
1	Cropping	60.25342	52.32	0.996448	2.84	0.805491	0.73
1	Blurring	62.92445	53.12	0.157749	1.97	0.807618	0.73
2	Noise	60.24877	51.78	0.999656	1.08	0.931325	0.74
2	Filter	75.49131	55.07	0.01512	2.84	0.984447	0.74
2	Cropping	61.9341	52.27	0.312312	1.87	0.809322	0.75
2	Blurring	64.36579	53.48	0.058509	1.16	0.806143	0.75

3	Noise	60.52121	52.08	0.828228	2.8	0.938976	0.75
3	Filter	75.74749	54.98	0.01526	2.57	0.986898	0.76
3	Cropping	59.28322	52.84	1.947326	2.78	0.807015	0.77
3	Blurring	64.42391	53.12	0.05622	1.78	0.805424	0.78
4	Noise	60.52121	52.17	0.828228	1.24	0.938976	0.77
4	Filter	75.74749	55.27	0.01526	2.78	0.986898	0.78
4	Cropping	59.28322	52.84	1.947326	2.87	0.807015	0.78
4	Blurring	64.42391	53.48	0.05622	0.99	0.805424	0.79
5	Noise	60.1598	51.87	1.062993	1.81	0.934369	0.79
5	Filter	75.34386	54.84	0.01504	2.82	0.983154	0.8
5	Cropping	61.83466	52.21	0.334493	1.68	0.801454	0.81
5	Blurring	65.90624	53.03	0.020419	1.38	0.801267	0.83

TABLE 2: 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

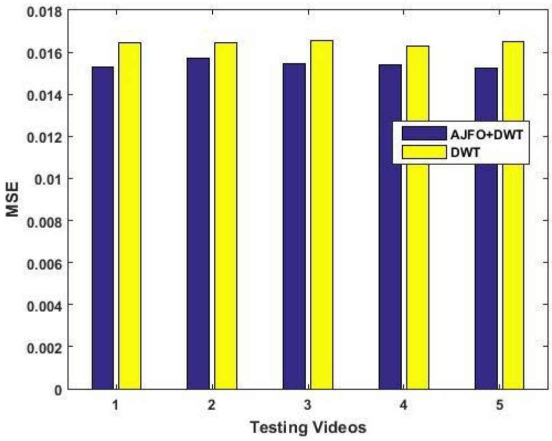


Figure 7: Comparison analysis of MSE

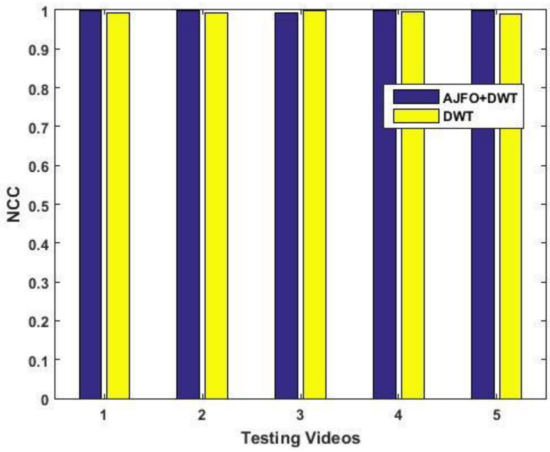


Figure 8: Comparison analysis of NCC

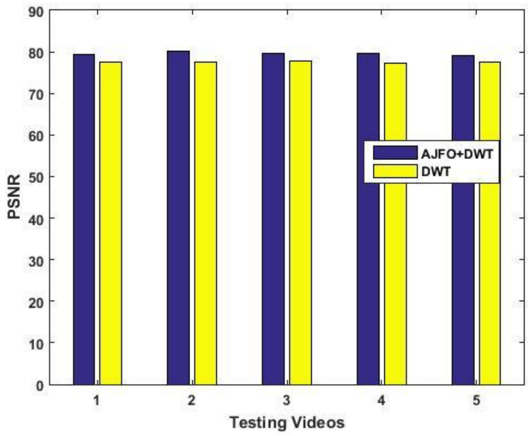


Figure 9: Comparison analysis of PSNR

Table 1 analyzes the performance of the proposed technique and the existing methods based on BSNR, MSE, and NCC, respectively. The BSNR of the projected and traditional methods for the first video is 80.1438044 and 77.50907737. The MSE values of the proposed and existing approaches for early video are 0.01571 and 0.01645. The NCC values of the projected and existing methods are 0.997173625 and 0.99218864 for initial videos. Table 2 analyzes the performance of the proposed method and the existing methods based on AD, MD, NAE, and SC, respectively. The AD value of the suggested and existing methods for the first videos is 0 and 0. The MD value of the suggested and traditionalapproaches for the first videos is 0 and 0. The NAE value of the suggested and existing methods is 0 and 0 for the first videos. The SC value of the proposed and existing methods for first videos is 1 and 1. The graphical representation of MSE, NCC, and PSNR is given in Figures 7, 8, and 9, correspondingly. From the comparative analysis, we can conclude that the planned method gives better results than the DWT-based watermarking technique.

5. CONCLUSION

This article uses a jellyfish algorithm to develop an efficient watermarking technique. Initially, the database has been collected to process the proposed method. The video sequences are changed into frames with the assistance of the DWT transform. After that, the optimal position of the frames is selected using the jellyfish method. The optimal position is selected and the secret image is inserted into the original image. The projected method works with the embedding and extraction process. Once the image embedded process is completed, the extraction is process enabled. Finally, 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 methodology is implemented in MATLAB and performance is assessed against performance metrics. Performance analysis and comparative analysis are evaluated in the thesis. The proposed method is comparable to the current method, for example, the DWT-based watermarking method. From the performance and comparative analysis, the research concludes that the proposed method has produced better results than traditional techniques.

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