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An Efficient Approach for Secure Video Watermarking Through Compression Standard: A Signcryption and H.264 Paradigm

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Abstract:

Watermarking is a component of inserting data into the multimedia, for example, image, audio or video. Video watermarking has become an important research issue due to increase in threats of video piracy, content authentication, and ownership integrity.The proposed method discusses digital image watermark embedding and extraction process. Initially, the Discrete Wavelet Transform (DWT) is applied to the input frame for partitioning the blocks. Then the optimal position is found for all the blocks using improved crow search algorithm (ICSO). Here, the updating process is developed by combining firefly with improved crow search optimization. Next the secret image is embedded in watermark embedding process. In order to improve the security, the secret images are encrypted using signcryption algorithm. Then each bit of encrypted image is embedded to the optimal position. At last, merging all the modified blocks into one block to construct the watermarked image. Video Compression technique has large demand in the field of video engineering due to storage and bandwidth requirements. The data quantity is very large for digital video and memory of storage devices and transmission line are not infinite. So it is practically not possible for us to store full digital video without processing. Thus, video compression standards techniques had been developed to reduce the data quantity. For that proposed video compression H.264 encoder is utilized here. This standard noticeably reduces the bit size of an I-frame and maintains a high quality of smaller box of pixels. The performance is evaluated in terms of peak signal-to-noise ratio, normalized coefficient value and compressed ratio. The proposed method is implemented in MATLAB platform.

Keywords: - *Discret e Wavelet Transform (DWT), Improved Crow Search Algorithm (ICSO), Fire Fly, H.264 encoder, peak signal-to-noise ratio, normalized coefficient value.*

1. Introduction

Watermarking is a procedure of embedding information (watermark) into digital multimedia (image, video, et al), with the goal that the watermark can be detected for a variety of purposes including duplicate assurance, copyright the board [1]. Watermarking technology has been generally applied in different multimedia filing and correspondence, including however not constraining to insurance of information and their verification [2]. The significant points of interest of this technology are security, readability, imperceptibility and robustness [3]. It is a procedure of embedding of a message signal as a proof of verification into a host signal to such an extent that it meets the required criteria of imperceptibility just as robustness against all the assaults during the recuperation of watermark [4, 5]. It is utilized as

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additional information related with original information and this metadata is helpful to give security [6].

Digital watermarking is one of the most enchanting procedures that serve the idea of embedding the intangible signal into host image, audio, information or video [7]. Different digital watermarking plans are proposed to give realness, copyright, unauthorized access and to anticipate the illegal redistribution of audio, video and information [8]. It is a sort of marker secretively implanted in the host medium, for example, digital image, audio, text, software or video [9]. Watermarking algorithms fall into two major categories: spatial domain watermarking and transformation domain watermarking [10]. Spatial watermarking is by logically adjusting the pixel values of image to install watermark and transformation watermarking usually change the transformation domain coefficient to implant the watermark [11, 12].

It is a procedure of concealing digital information in the carrier signal (have) and is ordinarily utilized for possession insurance [13]. The concealed information isn't really identified with the substance of the host [14]. Especially for video documents, video watermarking is applied to take care of the issue of unlawful control and illegal appropriation [15]. Along these lines, the Crow Search Optimization Algorithm (CSO) can be utilized to awaken from the storing procedure of the abundance sustenance sequestered from everything places at that point restoring it in the important time. Here the traditional CSO algorithm is improved by methods for updating process [16, 17].

2. Literature Review

In 2019 Mansouri, An., *et al*. [18] proposed an agreement assault was a major worry in the field of video watermarking. The author used the mode values, as accessible information, to give an energetic substance based key. The key was evaluated and observed to be hearty against basic packed domain video watermarking assaults. The key age system was proper for real-time application since the full decompression and recompression of the video stream were kept away from.

P.S., V., *et al*. [19] analyzed a bit stream video watermarking procedure. A test was led to analyze the execution time of addition and extraction procedure of bit stream watermarking on videos. Bit error tally and power devoured by cell phone was registered for analysis the bit stream video watermarking method. Experimental outcomes exhibit that; the method was practical to be executed utilizing a PC and cell phone. Image that was embedded on the video can be removed with a satisfactory PSNR value.

In 2019 Yao, Y., *et al*. [20] gave a novel substance versatile reversible obvious watermarking plan in encoded images. To accomplish the tradeoff between watermark perceivability and checked image quality, information embedding positions for obliging the watermark were adaptively chosen utilizing the visual perceptual model before encryption. Experimental outcome showed the benefits of the proposed plan as far as stamped image quality, watermark perceivability and watermark robustness.

3. Proposed Method

Watermarking is the process of hiding digital information in a carrier signal; Hidden the information must have a relationship to the carrier signal but is not required. The technique allows the owner's information to be embedded into the host image using the watermark; it is unnoticed by the human eye. Existing watermarking programs are few and

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far between the precision level and computational complexity are complex. To overcome the above drawbacks and to improve the efficiency of video watermarking two main processes are used namely watermark embedding and watermark extraction. Initially, the input video sequence converts into number of frames. Then the Discrete Wavelet Transform (DWT) is applied to the input frame for partitioning the blocks. Then the optimal position is found for all the blocks using improved crow search algorithm (ICSO). In this research, the updation process is developed by combining firefly with improved crow search optimization. The traditional CSO algorithm is improved by means of updation process. After chosen the optimal position the secret images are embedded in watermark embedding process before that, the secret images are encrypted using signcryption algorithm. Then each bit of encrypted image is embedded to the optimal position. Then by performing the reverse operation of the embedding process finally the watermarked bit is extracted.At last, merging all the modified blocks into one block to construct the watermarked image. Now, the quantity of a data is very large for digital video as well as memory of storage devices and transmission lines are not infinite. So it is not possible to store full digital video without processing. For that reason the proposed video compression H.264 encoder is utilized to reduce the data quantity. This standard noticeably reduces the bit size of an I-frame and maintains a high quality of smaller box of pixels. The overall flow diagram is shown in fig.1.

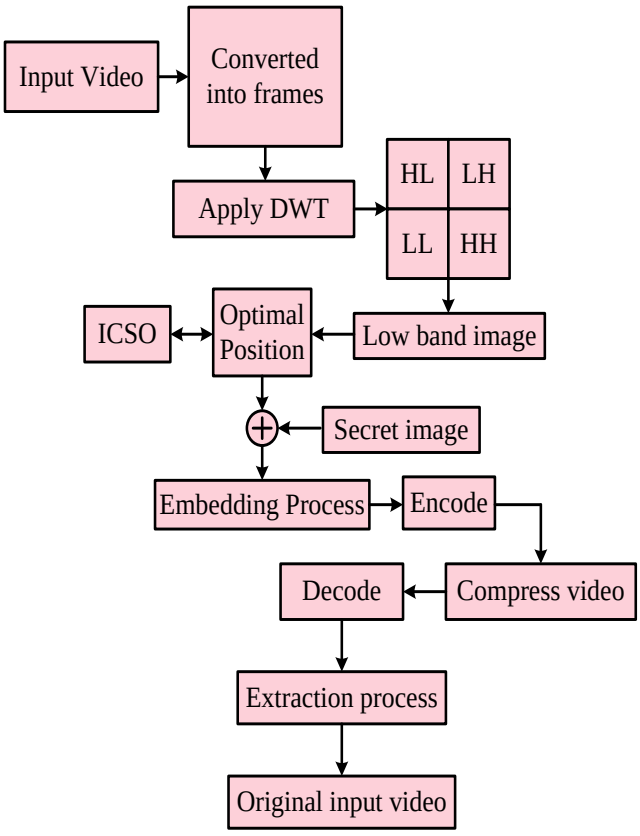

Figure 1: Overview of a Proposed Architecture

As shown in figure1, the input video sequences are converted into number of frames. Initially, DWT is applied to the input image and decomposing it into a number of sub-bands like HL, LH, LL and HH. The detailed enlightenment is illustrated in underneath;

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3.1 Discrete Wavelet Transform (DWT):

To improve the watermarking process Discrete Wavelet Transforms (DWT) is used. DWT is used to find the better coefficients of the embedding process. Discrete Wavelet Transform (DWT) is applied to the input frame for partitioning the blocks. In this, the converted frames are input to the DWT with that frames DWT start its process. The detail explanation is illustrated in beneath,

DWT involves decomposition of a video frames into frequency channel of constant bandwidth. This causes the similarity of available decomposition is done in multistage transformation. At level 1: converted video frame is decomposed into four sub-bands: lower (LL), vertical (LH), horizontal (HL), and diagonal (HH) detail components where LL denotes the coarse level coefficient which is the low-frequency part of the image. LH, HL, and HH denote the finest scale wavelet coefficient. Fig 2 shown in beneath,

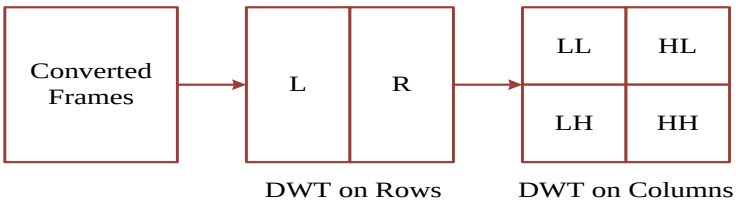

Figure 2: DWT Decomposition

The high frequency sub-bands are first-class sites for watermark insertion as the human visual system does not sense transforms in these sub-bands. However in high frequency sub-band HH has information about edges and textures of the video frames, so implanting is not desired in this band. Hence low band images are selected for watermarking. The chosen low band image can develop the watermark robustness. From the low band image, the position for embedding the watermark is optimally chosen using the optimization algorithm.

3.2 Optimal position selection using ICSO:

A Crow Search Optimization algorithm is used to decide the coefficient range of DWT for Secure Video Watermarking. After applying DWT the optimal position is found for all the blocks using improved crow search algorithm (ICSO). The CSO has demonstrated its potential to find the optimum solution for certain search spaces. The Crow Search Algorithm (CSO) is a recent metaheuristics method based on the intelligent group behavior of crows. The idea of CSO is motivated from the storing process of the excess food in hiding places then restoring it in the necessary time. The drawback of CSO is that search agents do not follow the best solution yet, as well as significantly reduce the effectiveness of CSO when search agents update their status to a random location. To overcome the above drawback here the traditional CSO algorithm is improved by means of updation process based on firefly optimization algorithm. Advantage of FF is the entire population can be automatically subdivided into subgroups, and each group can gather around each mode or local optimum. With all these methods, the best global solution could be found. In this the coefficient range is calculated using the following steps,

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- Initialize the sub bands
- Calculate the initial fitness value of each sub band and select global best (gb) and local best (lb), and partition the original image into two portions.
- Start iteration and discover the average mean values of the two new frames.
- At each particles, update the position and velocity
- Evaluate the fitness function f(x) and update local best and global best.

3.3 Watermark Embedding:

The process of watermark embedding is using a watermarking key and the embedding algorithm, to produce the watermark video. The embedding method based on which image domain is being processed, e.g. space, frequency domain or the wavelets.In proposed watermarking process initially, the secret image is encrypted using signcryption algorithm after completing the encryption process secret image is converted into watermark bit stream and their mixture is used for embedding the watermark in the selected position of blocks after that H.264 encoder is used to compress the video.The process involved in watermarking is shown in figure 3

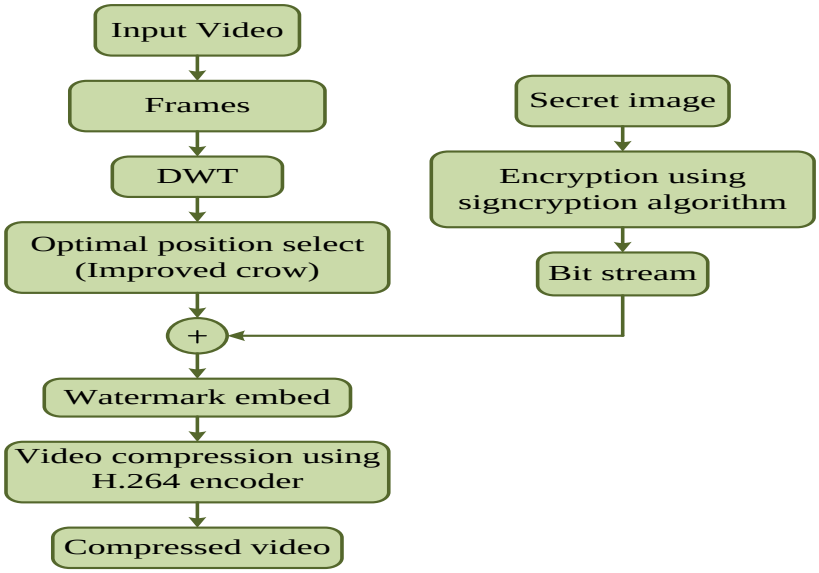

Figure 3: Watermark Embedding Process

3.4 H.264 Video Coding and Compression:

Video Compression (or video coding) is an essential technology for applications such as digital Television, DVDVideo, mobile TV, videoconferencing and internet video streaming. Standardizing video compression makes it possible for products from different manufacturers (e.g. encoders, decoders and storage media) to inter-operate. An encoder converts video into a compressed format and a decoder convert's compressed video back into an uncompressed format. H.264/AVC builds on the concepts of earlier standards such as MPEG-2 and MPEG-4 Visual and offers the potential for better compression efficiency (i.e. better-quality compressed video) and greater flexibility in compressing, transmitting and storing video. H.264 is an industry standard for video compression, the process of converting digital video into a format that takes up less capacity when it is stored or transmitted. It

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defines a format (syntax) for compressed video and a method for decoding this syntax to produce a displayable video sequence. The standard document does not actually specify how to encode (compress) digital video - this is left to the manufacturer of a video encoder - but in practice the encoder is likely to mirror the steps of the decoding process.

Video Compression technique has large demand in the field of video engineering due to storage and bandwidth requirements. The data quantity is very large for digital video and memory of storage devices and transmission line are not infinite. So it is practically not possible for us to store full digital video without processing. Thus, video compression standards, techniques and algorithms had been developed to reduce the data quantity. For the proposed video compression H.264 encoder is utilized. This standard noticeably reduces the bit size of an I-frame and maintains a high quality of smaller box of pixels. The performance is evaluated in terms of peak signal-to-noise ratio, normalized coefficient value.

H.264 was defined targeted towards a wide range of applications from low bit-rate low-resolution such mobile video conferencing to high-rate high-definition such as Ultra HDTV, there will not be a single implementation method that fits all. One can implement a baseline version for low end application with software running on an embedded microprocessor or a DSP core with possible video-specific instruction extension. For very high end application, hardwired acceleration of critical functions such as motion estimation/compensation and deblocking filter, or even the whole system, might be necessary. There is yet another approach called application-specific instruction set processor (ASIP) that defines custom instructions based on the function of video coding.

4. Result and discussion:

In this section, we discuss the result obtained from the proposed digital image watermark embedding and extraction process. For implementing the proposed technique, we have used Mat lab version (7.12). This proposed technique is done in windows machine having Intel Core i5 processor with speed 1.6 GHz and 4 GB RAM. The proposed system has been tested on the data set available on the web. We have utilized “512×512” sized images which are publicly available.

4.1 Database Description

To testify the effectiveness of the proposed method, the watermarking scheme images are taken from the UCF50 data set for compressing the video and extracting that video. https://www.crcv.ucf.edu/THUMOS14/UCF101/UCF101/ is the link for the UCF data set. Here we taken five different videos 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’, some of them given below,

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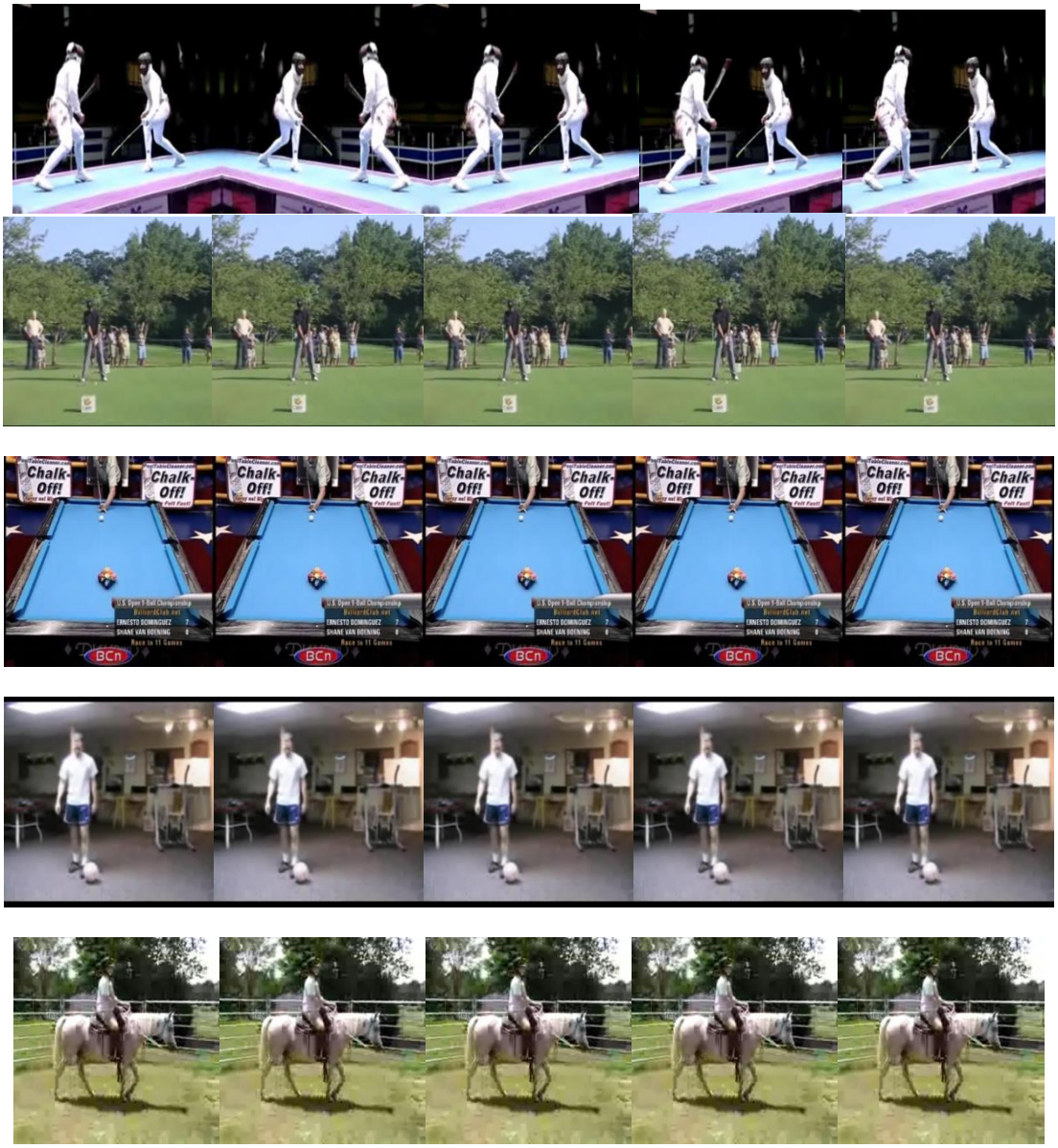

Figure 4: Sample dataset

4.2 Evaluation Matrices

The proposed system performance is analyzed by using the most common performance measures known as Average difference, Compression, Minimum difference, Mean Square Error, Normalized Absolute Error, Normalized Correlation Co-efficient, Peak Signal to Noise Ratio, Structural Content.

4.3 Comparative Analysis

In this section we analyzed the comparative analysis of the proposed and existing methods with attack. In our work, proposed digital image watermark embedding and extraction process is used to extract the input videos. Firstly, the input video sequence converts into number of frames. Then the Discrete Wavelet Transform (DWT) is applied to the input frame for partitioning the blocks. Then use the improved crow search algorithm (ICSO) to find the optimal position. After choose the optimal position the secret images are embedded in

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watermark embedding process, before that the secret images are encrypted using signcryption. Finally, merging all the modified blocks into one block to construct the watermarked image.

Table 1: Comparative analysis of the proposed method with attack

(i)

Input videos		PSNR			MSE			NCC		
		ICSO	CSO	GWO	ICSO	GSO	GWO	ICSO	CSO	GWO
Video1	Noise	52.33	52.01	51.85	0.94	1.02	2.85	4.6	4.15	3.98
	Filter	55.32	54.99	54.58	0.98	2.48	3.58	4.6	4.58	4.21
	Cropping	52.99	52.32	51.98	0.81	2.84	3.94	4.6	4.32	3.92
	Blurring	53.65	53.12	52.86	0.81	1.97	2.87	4.6	4.22	3.86
Video2	Noise	52.33	51.78	51.05	0.93	1.08	2.57	4.6	4.13	3.84
	Filter	55.31	55.07	54.84	0.99	2.84	3.57	4.6	4.13	3.84
	Cropping	52.99	52.27	51.68	0.8	1.87	2.84	4.6	4.13	3.84
	Blurring	53.65	53.48	52.87	0.81	1.16	2.48	4.6	4.13	3.84
Video3	Noise	52.34	52.08	51.84	0.94	2.8	3.48	4.68	3.97	3.21
	Filter	55.35	54.98	54.28	0.99	2.57	4.84	4.68	3.97	3.21
	Cropping	53.01	52.84	52.17	0.8	2.78	1.57	4.68	3.97	3.21
	Blurring	53.68	53.12	52.84	0.8	1.78	2.78	4.68	3.97	3.21
Video4	Noise	52.44	52.17	51.72	0.94	1.24	2.32	5.24	5.01	4.54
	Filter	55.6	55.27	54.91	0.99	2.78	3.18	5.24	5.01	4.54
	Cropping	53.16	52.84	52.49	0.81	2.87	3.15	5.24	5.01	4.54
	Blurring	53.88	53.48	52.75	0.8	0.99	2.14	5.24	5.01	4.54
Video5	Noise	52.33	51.87	51.07	0.93	1.81	2.48	4.61	3.87	3.15
	Filter	55.32	54.84	54.18	0.99	2.82	3.21	4.61	3.87	3.15
	Cropping	52.99	52.21	51.87	0.8	1.68	2.46	4.61	3.87	3.15
	Blurring	53.66	53.03	52.37	0.81	1.38	2.38	4.61	3.87	3.15

(ii)

Input videos		AD			MD			NAE			SC		
		ICSO	CSO	GWO	ICSO	GSO	GWO	ICSO	CSO	GWO	ICSO	CSO	GWO
Video 1	Noise	14.95	14.28	13.84	22.67	23.48	24.49	0.86	0.96	1.02	0.14	0	0
	Filter	0.42	0.35	0.27	54.33	55.18	55.94	1.01	1.27	1.53	0	0	0
	Cropping	15.16	14.81	14.48	85	85.18	85.52	1.46	1.51	1.81	0.14	0	0
	Blurring	0.33	0.3	0.27	42	42.84	43.08	1.01	1.54	1.88	0.02	0	0
Video2	Noise	15.02	14.98	14.15	22.33	22.88	23.18	0.87	0.91	1.05	0.1	0	0
	Filter	0.45	0.35	0.24	41	41.84	42.48	1.01	1.05	1.57	0	0	0
	Cropping	13.99	13.45	12.97	85	85.87	86.18	1.14	1.57	1.91	0.1	0	0
	Blurring	0.33	0.24	0.15	40.33	40.48	41.84	1.01	1.24	1.84	0.01	0	0
Video3	Noise	12.22	11.91	11.47	22	22.84	22.18	0.92	0.99	1.05	0.1	0	0
	Filter	0.32	0.29	0.21	35.33	35.81	36	1.01	1.28	1.82	0.01	0	0
	Cropping	6.29	6.01	5.97	85	86.8	87.48	1.05	1.21	1.59	0.05	0	0
	Blurring	0.31	0.29	0.18	62.33	63.81	64.41	1.01	1.27	1.59	0.03	0	0
Video4	Noise	13.37	13.15	12.84	26	27.05	28.84	0.92	1.07	1.57	0.17	0	0

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	Filter	0.16	0.1	0.08	35.67	36.87	37.48	1	1.84	1.99	0	0	0
	Cropping	9.02	8.48	7.04	85	86.18	86.91	1.18	1.29	1.42	0.11	0	0
	Blurring	0.12	0.09	0.05	43.33	43.81	44.18	1.01	1.57	1.81	0.02	0	0
Video5	Noise	15.82	15.48	15.07	24.33	24.91	25.18	0.84	0.92	1.03	0.16	0	0
	Filter	0.41	0.37	0.24	54.67	55.48	56.18	1.01	1.27	1.84	0.01	0	0
	Cropping	11.41	11.18	10.94	85	85.91	86.18	1.22	1.35	1.84	0.12	0	0
	Blurring	0.33	0.28	0.2	42	42.84	43.41	1.01	1.23	1.84	0.02	0	0

The above table 1 represents the performance analysis of the proposed method with various attacks. Here the method considers the attacks are noise, filter, cropping and blurring. For cropping, 35% area is cropped in the input image. For filtering, the suggested method uses average filter. Table 1(i) describes the performance of PSNR, MSE and NCC.Larger PSNR value will indicate that highwatermarked image quality. Normally, it must exceed30db such that it will prove the good quality ofwatermarking technique which is pointed out. Here the PSNR value is higher than the other two existing methods such as CSO and GWO. And the Table (ii) represents the performance of Average Difference (AD), Minimum Difference (MD), Normalize Absolute Error (NAE), and Structural Content (SC). The Average difference is higher than the existing method. Then the figure 6 evaluates the various attacks of the input frames.The performance of the algorithm has been measuredin terms of its imperceptibility and robustness against the possible attacks like noise addition, filtering ,cropping and blurring. From the experimental results, it is clear that the suggested method attains the maximum performance value when compared to the existing methods.

Conclusion:

Digital Image Watermark Embedding and Extraction Using discrete wavelet transform, Improved Crow Search Algorithm using Fire Fly.To improve the security, the secret images are encrypted using signcryption algorithm and for video compression H.263 encoder is proposed in this paper. Our proposed method is implemented with the help of MATLAB. The performance of the proposed method is evaluated using quality metrics in terms of peak signal-to-noise ratio, normalized coefficient value and compression ratio. Our proposed work was evaluated with each metrics and then the results of each metrics were also analyzed with existing methods. As a result, we could be proved that our proposed work is better PSNR and normalized coefficient value when compared to the existing methods. The overall normalized correlation value of the proposed method is high and the error value of our proposed method produce a minimum value when compared to the existing techniques. From the results, the suggested technique outperforms than existing technique and achieves a better result.

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