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Watermarking application on video file using DCT transformation

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Abstract: This paper presents a developed algorithm for encrypting and hiding messages, which combine two technique of data security. The algorithm based on two dimensional discrete wavelet transform 2D-DWT, logic gates and JK flip- flops to generate a secret key which relies to encrypt the massage. Then the encrypted massage hide in an AVI file, the hiding process depend on two steps of discreet cosine transform 2D-DCT &1D-DCT in the same time. The proposed algorithms evaluated by normalized correlation NC and Peak signal to noise ratio PSNR to measure the efficiency and accuracy of the algorithm.

Keyword: DCT, Video steganography, DWT, PSNR, NC.

1. Introduction

The continuous evolution and growing of computer technology and Internet increase the need for developed methods for data protection and security, in terms of adoption for developed systems encryption or in terms of hiding data to one goal, which is promote properly the arrival data and the transmitted information to the authorized person. As a result, it became necessary to use more sophisticated methods of encryption to keep the transferred data and address secure, so it is difficult for unauthorized person access to the hidden data, many algorithms presented by researcher to achieve this this principle. A researcher [1] presented an algorithm for hiding an image in AVI video using 2D- DCT (8x8 block). Other researcher [2] presented another technique for image steganography by using 3-levels DWT. Another researcher [3] presented Enhanced Image Steganography System by combine ERBP and DWT algorithms. Other researcher [4] presented an algorithm based on a hybrid characteristics extraction mechanism based on local (average pixel values of local blocks) and global characteristics (DCT). The proposed algorithm in this paper combines DWT and DCT. The algorithm passes through three step of process:

1 - Process to generate the encryption key.

2 - Process to encrypt the message using the encryption key

3 - Process to hide the encrypted message into multimedia files (video).

2. Steganography techniques in frequency domain:

There are many techniques used to transform multimedia data file from spatial domain to frequency domain:

2.1 Discreet Cosine Transform DCT

The DCT transformation used to convert signal or image to frequency domain. DCT transformation watermarking are more coherent compared with spatial domain watermarking techniques. 1D-DCT transformation applied to each frame in on dimension array which framing into (1x8), (1x7), (1x6), (1x5) .the 1D-DCT equation is[5][6][7]:

$$c(u) = a(u) \sum_{x=0}^{N-1} f(x) \cos\left[\frac{(2x+1)u\pi}{2N}\right] \ldots\ldots\ldots 1$$

And the inverse transformation is:

$$f(x) = \sum_{u=0}^{N-1} a(u)\, c(u) \cos\left[\frac{(2x+1)u\pi}{2N}\right] \ldots\ldots\ldots 2$$

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Where u=0, 1, 2, 3….N-1 and $a(u)$ for both equations is define as:

$$a(u) = \begin{cases} \sqrt{\frac{1}{N}}, & u = 0 \\ \sqrt{\frac{2}{N}}, & u \neq 0 \end{cases} \quad \ldots\ldots\ldots 3$$

In 2D-DCT transformation applied in each bloke of image ,the image broken into (8x8),(7x7),(6x6),(5x5) pixels /block working from left to right top to bottom. The 2D-DCT is given by equation:

$$c(u,v) = a(v)\, a(u) \sum_{x,y=0}^{N-1} \sum f(x,y)\, cos\left[\frac{(2x+1)u\pi}{2N}\right] \cos\left[\frac{(2y+1)v\pi}{2N}\right] \ldots\ldots\ldots 4$$

The inverse transformation is defined as:

$$f(x,y) = \sum_{u,v=0}^{N-1} \sum a(v)\, a(u)\, c(u,v)\, cos\left[\frac{(2x+1)u\pi}{2N}\right] \cos\left[\frac{(2y+1)v\pi}{2N}\right] \ldots\ldots\ldots 5$$

Where u, v=0, 1, 2, 3…N-1 and$a(u)$,c(u) for both equations is define as:

$$a(v) = \begin{cases} \sqrt{\frac{1}{N}}, & v = 0 \\ \sqrt{\frac{2}{N}}, & v \neq 0 \end{cases} \quad \ldots\ldots\ldots 6$$

$$a(u) = \begin{cases} \sqrt{\frac{1}{N}}, & u = 0 \\ \sqrt{\frac{2}{N}}, & u \neq 0 \end{cases} \quad \ldots\ldots\ldots 7$$

2.2 Discreet Wavelet Transform DWT

The discreet wavelet transform is mathematical function. it can be implemented in one and two dimension .the 2D-DWT is processes each rows in image and the same process applied on column resulted from pervious process (two images matrix), the output of this process is four types of coefficients (LL,HL,LH,HH) . Approximation coefficients named LL, vertical details in LH , horizontal details in HL and diagonal details in HH, The details of 2D-DWT is showing in the figure[2][5][6][7][8][9]:

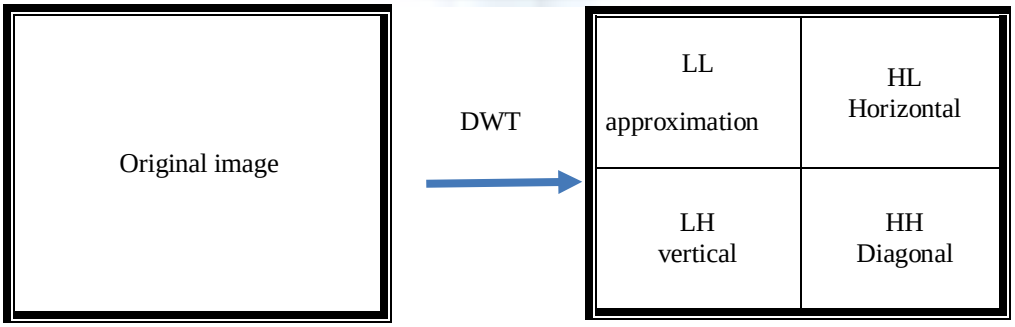

Figure (1) one phase decomposition in 2D-DWT.

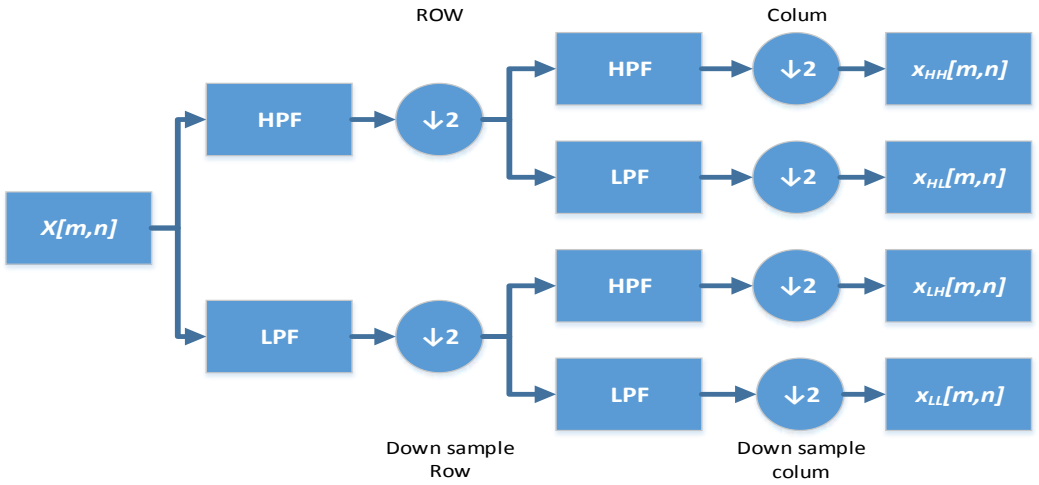

Figure (2) block diagram of 2D-DWT

3-The Developed Algorithm

The developed algorithm implemented by the following three sub algorithms:

3.1. Secret Key Generation:

1-Read (AVI) video file and convert it into no. of frame.
2- Segment one of frame into number of segments with size (n×n).
3- Determine the framework segment and find a DWT and generate four matrices [LL LH HL HH].
4- Each generated matrix has a series of binary numbers. [LL LH] matrix enter as input for (J-K flip-flop) to generate another matrix. The generate matrix input with[HL] matrix to the Xnor gate to generate another matrix, as also it with (HH) matrix to the second (J-K flip-flop).the output matrix take from the invert output of J-K flip-flop. The output is the encrypted key.

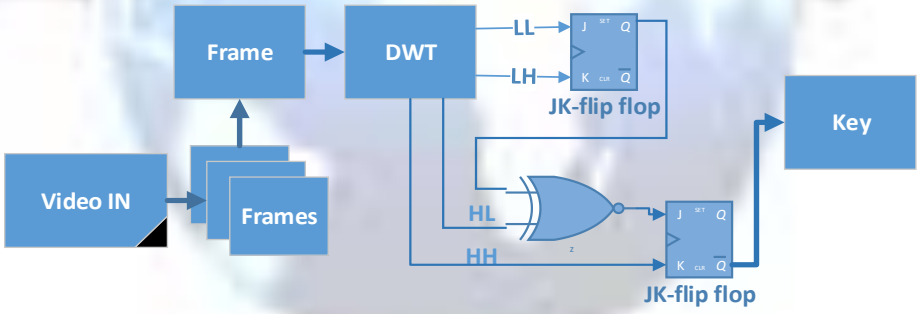

Figure (3) block diagram to generate secret key

3.2. Embedding Algorithm

1- The message encrypted by XNOR the encrypted key with the message.
2- Read the (AVI) video file and convert it into no. of frame. Locate frame for hiding encrypted massage.
3- Segment each frame into number of blocks with different size.
4- Each block transforms by 2D-DCT. Then determine the main diagonal elements. These elements are processed by 1D-DCT then embed one bit of encrypted massage in each block.
5- Evaluate 1D-IDCT and 2D-IDCT for each block.
6- Repeat step (4, 5) until the end of encrypted secret massage.
7- Embed string length, frame number and creating new (AVI) video file.
8- Evaluate PSNR value.

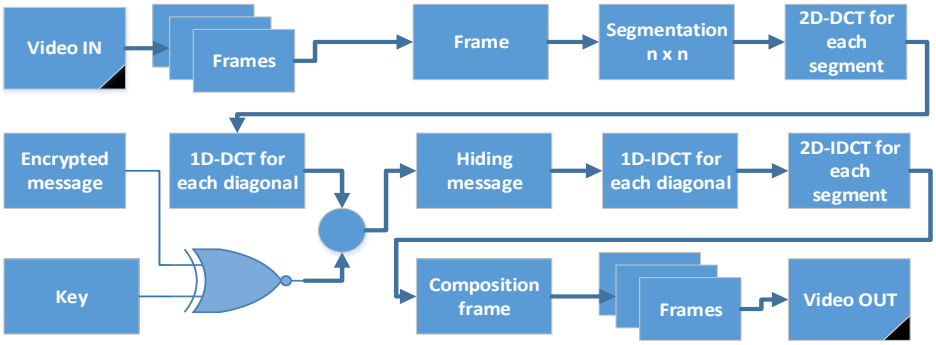

Figure (4) block diagram to hid watermarking message

3.3. Extracting algorithm

1- Read (AVI) video file and convert it into no. of frame. Then locate the frame that contain encrypted massage. The frame enters the following step. Generate the encrypted key, extract string length and segment frame into number of blocks with deferent size.
2- Each block transformed by 2D-DCT .then determined the main diagonal elements. The diagonal transformed by 1D-DCT and extracting one bit from each block.
3- Repeat step (2) until the number of bit equal to the string length. Covert binary value to the text and decode the massage by using encrypted key.
4- Display the retrieved message and evaluate (NC) value.

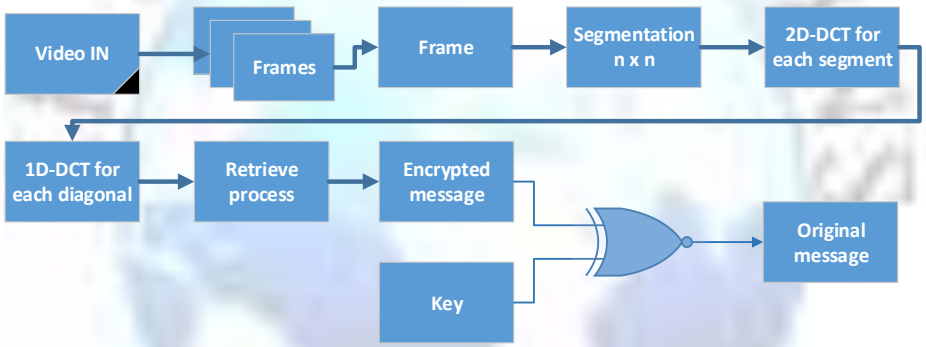

Figure (5): block diagram to extract watermarking message

4. Result

Performance of the developed algorithms evaluated Measurement [1] [6] [7] [10][11] :

1-peak signal to noise ratio(PSNR) which is define as:

$$PSNR = 10 \log_{10}\left(\frac{255^2}{MSE}\right) \ldots 8$$

Where MSR (Mean Square Error) is define as:

$$MSE = \left(\frac{1}{mn}\right)\sum_{i=1}^{m}\sum_{j=1}^{m}[I(i,j) - I'(i,j)]^2 \ldots\ldots 9$$

The pixels value of original and host frame is represented by I, I' respectively.

2- Normalization correlation (NC) define as:

$$NC = \frac{\Sigma_i \Sigma_j W(i,j).W'(i,j)}{\sqrt{\Sigma_i \Sigma_j W(i,j)^2}\sqrt{\Sigma_i \Sigma_j w'(i,j)^2}} \ldots\ldots\ldots 10$$

The original and watermarking message is representing by W, W' respectively.

After applying the algorithm on a set of AVI video files that used to hide the encrypted message using the proposed method, for each AVI file the algorithm perform with different segment block size (8×8, 7×7, 6×6, 5×5). The result of the algorithm is showing in table (1):

Table (1): Result

AVI file	Massage length (bit)	Block size	Main diagonal length	NC	PSNR
Video1	480	8×8	1×8	1	39.919
Video1	480	7×7	1×7	1	41.129
Video1	480	6×6	1×6	1	41.433
Video1	480	5×5	1×5	1	43.306
Video2	560	8×8	1×8	1	38.683
Video2	560	7×7	1×7	1	41.981
Video2	560	6×6	1×6	1	41.324
Video2	560	5×5	1×5	1	44.156
Video1	936	8×8	1×8	1	38.832
Video1	800	7×7	1×7	1	38.999
Video2	820	6×6	1×6	1	39.6
Video2	400	6×6	1×6	1	41.650
Video3	504	5×5	1×5	1	41.623
Video3	820	5×5	1×5	1	41.102

5. Conclusions

The paper proposed a developed algorithm for message encrypted and hiding. The message encrypted by a key that generated by DWT transformation .furthermore, the encrypted message hide in side AVI video file by two transformation of 2D-DCT and 1D-DCT. The algorithm applied to a deferent Video file with deferent block size to hide encrypted massage. The value of normalization correlation equal to one (NC=1) which mean that the retrieved encrypted message is the same message that is hiding in the video file.as a result, that the algorithm is effective and reliable.

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