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DIGITAL IMAGE WATERMARKING USING ERROR CORRECTING CODES

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Abstract: Nowadays, there is a rapid increase in the digital multimedia and hence the protection of ownership of the digital media is very important. The digital image watermarking plays an important role in the multimedia security fields for content protection of digital data such as video, image and audio etc. without the loss of original information. In this proposed system the logo is coded using ECC before embedded into the watermarked image, increases the robustness of the watermark and different codes like hamming and cyclic codes are used. The encoded and embedded watermarking image is considered to be encountering an AWGN noise while transmission. Hence ,it will be observed that the SNR and PSNR of the watermarked image in AWGN channel will give better performance when logo is code before embedding. Also, shows the result that Hamming codes SNR and PSNR are much more superior to cyclic codes.
Keywords: Discrete Wavelet Transform, Error Correcting Codes, SNR & PSNR.

I. INTRODUCTION

Digital image watermarking techniques have been widely used in all feilds. Digital image watermarking is the process of embedding information into a digital image. It has various applications such as authentication, copyright protection, proof of ownership etc. Properties of the watermarking techniques are as follows:

1.The embedded watermark must not introduce visible artifacts and it should not be easily removable.
2.The embedded watermark must be resilient to lossy data compression such as JPEG.
3.The embedded watermark must be resilient to image processing method such as median filtering.
4.The embedded watermark can only be extracted by privileged individuals by the security key provided.

II. DISCRETE WAVELET TRANSFORM(DWT)

The Wavelet Transform provides a time-frequency analysis of the signal. Wavelet transform was used to overcome drawback of the short coming of the Short Time Fourier Transform (STFT). The STFT results in a constant resolution at all frequencies and the Wavelet Transform provides a multi-resolution technique in which different frequencies are analyzed with various resolutions. The Discrete Wavelet Transform (DWT) is a sub-band coding and results in a fast computation of Wavelet Transform, easy to implement ,reduce the computation time and resources required. [1][5] By using successive low pass and high pass filtering of the discrete time-domain signal the DWT is computed. This procedure is known as Mallat algorithm or Mallat-tree decomposition. The signal is represented by the sequence x[n] in fig(1), where n is an integer. The high pass filter is denoted by H0 while the low pass filter is denoted by G0. The high pass filter provides adetail information and denoted by d[n] and the low pass filter with scaling function provides coarse approximations denoted by a[n] at each levels. [6][7]

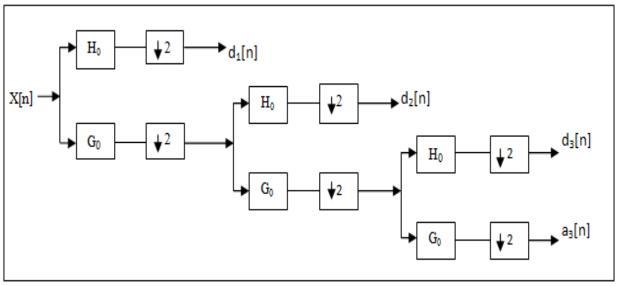

Fig.1: Wavelet Decomposition process in three – levels.

The process of spanning only half the frequency band by using half band filters produces signals at every decomposition level. And hence, uncertainty in frequency is reduced by half which doubles the frequency resolution. According to the Nyquist's rule the original signal has a highest frequency of ω with a sampling frequency of 2ω radians and it has a highest frequency of ω/2 radians. It can be sampled at a frequency of ω radians. Discarding half of the samples without any loss of information can be done. After this the entire signal is represented by only half the of the samples by decimating the time resolution into 2 halves. Similarlly, half band low pass filtering halves the resolution which removes the half of the frequencies and decimating by 2 doubles the scale. At low frequencies the frequency resolution becomes arbitrarily good and the time resolution becomes arbitrarily good at high frequencies.The process of filtering and decimation is continued until the desired level is reached.

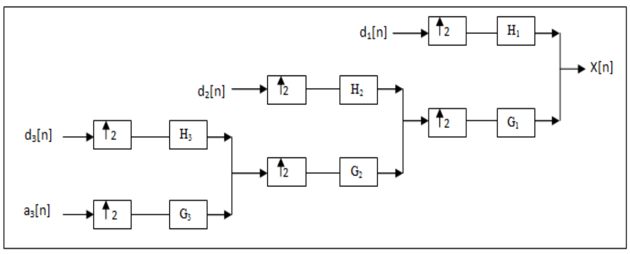

Fig. 2: Wavelet reconstruction process in three – levels.

Fig.(2) shows the reconstruction of the original signal from the wavelet coefficients. Normally, the reconstruction is the reverse process of decomposition. By passing through the low pass and high pass synthesis filters approximation and detail coefficients at each level are up sampled by two and then added. Through the same number of levels as in the decomposition process it is continued to obtain and the original signal.

III. ERROR CORRECTING CODES (ECC)

Due to the errors introduced during transmission of information from the source to a receiver and thus communication channels are subject to channel noise. Errors can be detected by using error detection techniques by detecting such errors and error correction techniques helps in the reconstruction of the original data. Through noisy pathways data is sent and it is made in such a way for an occasional bit to flip. In order to add redundancy to the bits and to correct and detect the errors can be can be done by using Hamming and cyclic codes. Hamming code is a linear block code and main advantage of linear block codes is their simplicity in implementation and low computational complexity. Usually linear block code is composed of two parts and the 1st part contains the information bits, nothing but the original bits to be transmitted and the parity checking bits comes in the second part. A (n, k) code denotes linear block code with length n and k information bits. Let C denotes a linear code over a finite field GF(q) of block length n. And aslo for every codeword c=(c1,...,cn) from C, the word (cn,c1,...,cn-1) in GF(q)n obtained by a cyclic right shift of components is again a codeword 'C' known as cyclic code.And,hence n − 1 left shifts is equal to one right shift. The linear code 'C' becomes cyclically precise,When it is invariant under all cyclic shifts.

IV. EMBEDDING AND EXTRACTION OF WATERMARK PROCESS BY DWT USING ECC

Embedding and extraction of the watermark are the two types of procedures of splitting the Watermarking in the DWT domain. Initially for embedding a bit stream is transformed into a sequence v(1)...v(L), where L is the length of the bit stream and (k=1,...,L) and by using digital error correcting codes like Hamming and Cyclic codes, the bit streams are coded. The sequence is used as the watermark and by the help of discrete wavelet transformation original image is first decomposed into several bands in the form of pyramidal decomposition structure. Haar filter with two decomposition levels are used to perform decomposition process and which represent the high and middle frequencies of the image. To the largest coefficients in all bands watermark is added. Let p(m,n) denote the DWT coefficients which are not located at the approximation band LL2 of the image. The embedding procedure is performed according to the following formula and as shown in Fig.(3):

p'(m,n)=p(m,n)+q p(m,n)v(k)……………(1)

where q is the strength of the watermark controlling the level of the watermark v(1)…v(L). By this, DWT coefficients at the lowest resolution which are located in the approximation band are not modified.

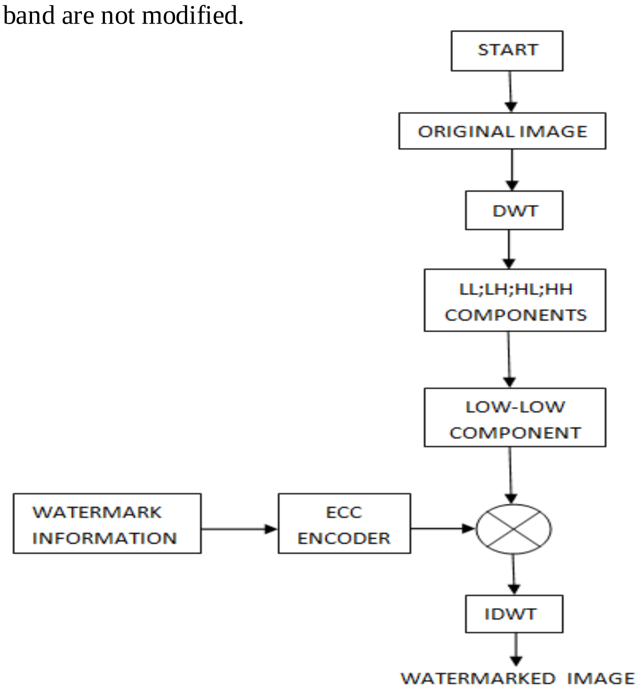

Fig.3: Flow diagram using DWT with ECC for embedding Watermark

Fig.(4) shows the flowchart for watermark extraction.

By applying the inverse discrete wavelet transform (IDWT) the watermarked image is obtained. Both the received and the original image are decomposed into the two levels in case of the watermark extraction procedure and for extraction the original image taken. The extraction procedure is described by the formula

vr(k)=(pr'(m,n)- p(m,n)/qp(m,n)…………….(2)

where pr´(m,n) denotes the DWT coefficients of the received image. The extracted sequence vr(1)...vr(L) consists of positive and negative values due to noise added to the image by attacks or transmission over the communication channel. In order to get a noise free logo the detected and coded received noisy logo is again decoded. [8][10]

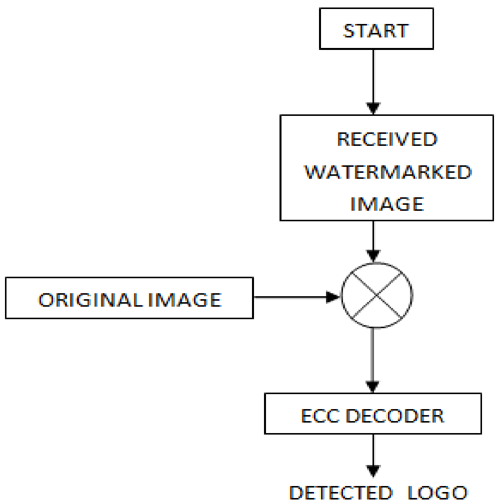

Fig.4: Flow diagram using DWT with ECC for extraction of Logo

V. RESULT

From the family of DWT for image watermarking the db1 or Haar wavelet is chosen. Fig.(5).shows the 'Lena' image taken as the original image to be watermarked.

Fig. 5: Original Image

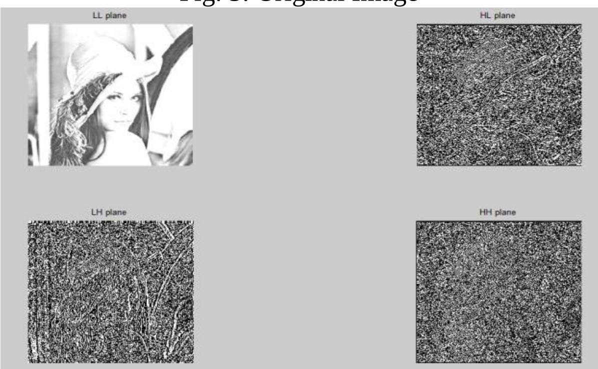

Fig. 6: DWT Decomposition of the main image

Fig.7: a): DWT decomposition of LL Plane,b) added logo in LL plane, c) Watermarked image.

Fig.8: Extracted coded logo

It is observed that the Hamming code incorporated with the Discrete Wavelet transform gives the highest value of signal to noise ratio and peak signal to noise ratio as compared to Cyclic codes as shown in the following observation tables.

Table 1: Comparision of the values of SNR with and without ECC of the DWT watermarking in presence of AWGN

Signal to Noise ratio			
TEST IMAGES	DWT without ECC	DWT with ECC	
		Hamming	Cyclic
Image 1	2.6342	16.7592	6.3159
Image 2	0.4919	12.5866	0.8624
Image 3	2.1049	8.2384	0.5842
Image 4	3.1156	12.9177	6.0674

Table 2: Comparision of the values of PSNR with and without ECC of the DWT watermarking in presence of AWGN

Peak Signal to Noise ratio			
TEST IMAGES	DWT without ECC	DWT with ECC	
		Hamming	Cyclic
Image 1	5.5287	19.6537	9.2104
Image 2	5.5285	18.607	6.8828
Image 3	5.1811	11.3147	3.6604
Image 4	5.9282	15.7303	8.88

VI. CONCLUSION

By the clear observation of the above results shows that the usage of error correcting code in watermarking drastically improves the SNR and PSNR values. This proves that even when the watermark is transmitted through the AWGN channel the robustness of watermarked image is increased. And hence, the watermark becomes more efficient and reliable to be used in highly noisy channels and also results shows that the Hamming code provides much better results compared to the cyclic codes.

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