Real time video watermarking scheme based on HVS and DWT

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Abstract**—**This paper proposes a discrete wavelet transform on video sequence characteristics and the moving target detection technology. It finds and tracks the moving objects from video sequence in real time. The watermarking scheme fully deem the characteristics of Human Visual System (HVS) and moving object detection technology, it endow with valid data for the application of the next target tracking, classification and feature extraction done using inter-frame difference method. In the watermarking embedding process Discrete Wavelet Transform (DWT) is performed on the video frames also Arnold scrambling transform is used to acquire good imperceptibility and high robustness for diverse attacks. The proposed method can make out the moving object/objects with good accuracy and the watermark is robust against attacks with low Mean Square Error (MSE) and high Peak Signal to Noise Ratio (PSNR).

Keywords*-Video Watermarking; Discrete Wavelet Transform; Human Visual System; Arnold Transform; Mean Square Error;Peak Signal to Noise Ratio.*

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I. INTRODUCTION

Video Watermarking refers to embedding watermarks in a multimedia video files so as to protect them from unlawful copying and identifying manipulations. Video Watermarking in the moving object of a video sequence is one of the most exigent research topics due to its unique representation in every video frame. However it also required to trace out the moving object in every successive frame with various methods.

Lu and Ge proposed a adaptive block based classification video watermarking algorithm for performing Discrete Cosine Transform (DCT) on high speed and high complexity texture block by modifying the AC and DC coefficient to embed watermark information. The algorithm overcomes the adaptive watermarking algorithm that cannot blind extract. He-Fei proposed a real time video watermarking algorithm based on human perception model to adjust low frequency coefficients of DCT block and using Watson visual perceptual model. Xinxing Jing et al., proposes algorithm based on the characteristics of video sequences and the video is divided into sub-regions where DCT were applied accordingly [1].

Moving object detection has been widely used in diverse discipline such as intelligent transportation systems, airport security systems, video monitoring systems, and so on. An efficient moving object detection method using enhanced edge localization mechanism and gradient directional masking for video surveillance system is used [2].

Digital watermarking is a technology being developed to ensure and facilitate data authentication, security and copyright protection of digital media. This incorporate the study of watermarking definition, concept and the main contributions in this field such as categories of watermarking process that tell which watermarking method should be used. It covers overview, classification, features, framework, techniques, application, challenges, limitations, performance metric of watermarking and a comparative analysis of some major watermarking techniques [4].

A robust digital image watermarking scheme that combines image feature extraction and image normalization is proposed. The goal is to resist both geometric distortion and signal processing attacks [5]. Digital watermarking refers to embedding watermarks in a multimedia documents and files in order to protect them from illegal copying and identifying manipulations. However a technique named Hybrid DWT-SVD method for digital video watermarking is divided in 2 parts. They are 1.Embedding watermark and 2.Extracting watermark. In embedding and embedding process, Compared Hybrid Method with DCT method, calculated PSNR ratio, elapsed time and check robustness, imperceptibility of video [6].

The development of information security, the traditional image encryption algorithm has been far from to ensuring the security of images in the transmission process. This presents a new image encryption algorithm, which can improve the security of image during transmission more effectively. The traditional scrambling algorithm based on Arnold transformation only applies to the square area, which is a big limitation. Focus on this, a multi-region algorithm for image scrambling encryption model is proposed, which splits the non-square image to multiple square regions, and scrambles each region. Experimental results show that the new algorithm improves the image security effectively to avoid deciphering, and it also can restore the image as same as the original image almost, which reaches to the purposes of image safe and reliable transmission [7].

II. VIDEO WATERMARKING AND INTER FRAME DIFFERENCE METHOD

The General video watermarking Embedding and Extraction process is shown in “Fig. 1” and “Fig. 2”. Video watermarking approach is classified into two main categories based on the technique of hiding watermark bits in the host video. The two categories are: Spatial domain watermarking where embedding and detection of watermark are performed by directly manipulating the pixel intensity values of the video frame. Transform domain techniques, amend spatial pixel values of the host video according to a predetermined transform and are tougher than spatial domain techniques since they scatter the watermark in the spatial domain of the video frame making it difficult to remove the watermark through malicious attacks like cropping, scaling, rotations and geometrical attacks [3].

By modifying the pixel values in every frame the spatial methods are not robust to attacks and to various common signal distortions. In contrast, other techniques are more robust to distortions when they add the watermark in the frequency domain. In these types of schemes, the watermark is embedded by modifying the transform coefficients of the frames of the video sequence. The most commonly used transforms are the Discrete Fourier Transform (DFT), the Discrete Cosine Transform (DCT), and the Discrete Wavelet Transform (DWT). Several researches concentrated on using DWT because of its multi resolution characteristics, it provides both spatial and frequency domain characteristics so it is compatible with the Human Visual System (HVS) [1] [3].

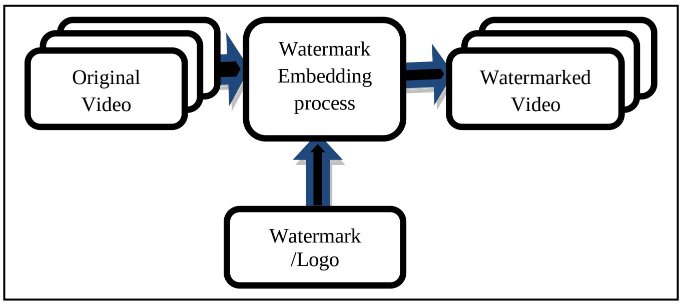

Figure 1. Embedding Process

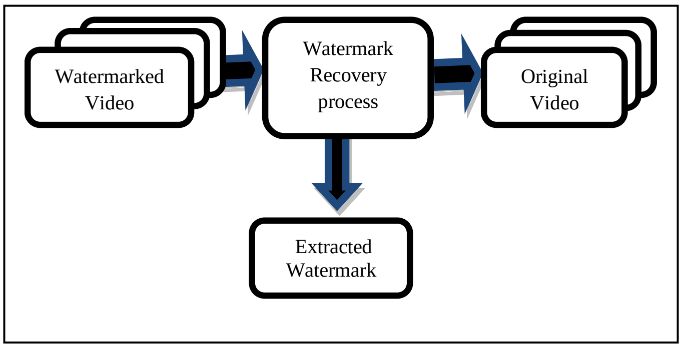

Figure 2. Extraction Process

III. VIDEO WATERMARK EMBEDDING PROCESS

A. *Steps involve in watermark embedding process*

a. The Real time Video is captured and its various properties are measured. All the video frames are extracted using MAT Lab programming.

b. Absolute difference between the successive frames is calculated using the "(1)" where $f_i(x,y)$ is the present image and $f_{i+1}(x,y)$ is the next successive image.

c. The difference images are processed over morphological filter to reduce the noise.

$$G_i(x,y) = |f_{i+1}(x,y) - f_i(x,y)| \qquad (1)$$

d. The area/region of the moving object is clearly noticed, marks it as M1 and coverts into Binary Images. Watermark Logo/Image is scrambled using Arnold Transform as given by the below "(2)".

$$\begin{bmatrix} X' \\ Y' \end{bmatrix} = \begin{bmatrix} 1 & 1 \\ 1 & 2 \end{bmatrix} \begin{bmatrix} X \\ Y \end{bmatrix} \bmod (N) \qquad (2)$$

Where $\begin{bmatrix} X' \\ Y' \end{bmatrix}$ is the Arnold Transform, and the input image $\begin{bmatrix} X \\ Y \end{bmatrix}$ and N is the size of the image.

e. The Static area/region in the video frames is marked as S1 and 2level of DWT is applied. The static area/region is divided into LL, LH, HL and HH, the diagonal elements LH and HL have less information content than LL and HH so these two regions are marked as S1,1 and S1,2.

f. The "H" shape of the scrambled logo is embedded in morphological filter frames M1 and 2level of DWT is embedded in S1,1 and S1,2

g. 2level Inverse DWT of entire embedded frames are converted to video and video watermark embedding is successfully achieved. The MSE and PSNR between Original video and Watermarked video individual frames are obtained and tabulated in Table 1.

The proposed work Embedding process is shown in "Fig. 3".

IV. WATERMARKING RECOVERY PROCESS

A. *Steps involve in Watermarking Recovery process*

a. In the view of extracting the watermark logo/image from the video, embedded video is converted into frames and as similar in the embedding process the moving and static frames are obtained.

b. The difference /moving frames are converted to binary form and morphological filter is performed and marked as M'1 and the Static frames as S'1.

c. The "H" shape of scrambled data is scanned from the region M'1 and the Watermarked Logo extracted from S' 1, 1 & S'1, 2.

d. Anti Arnold transform is applied to the frames and 2level DWT and Inverse DWT is applied to S'1, 1 and S'1, 2 as above process.

e. The watermark logo/Image is processed from each video frame separately and checked with various types of attacks and the robustness is calculated.

f. The video is extracted from the recovery process vice versa as the embedding process, and the block diagram is shown in the "Fig. 4".

g. Various attacks are performed and MSE and PSNR values are calculated.

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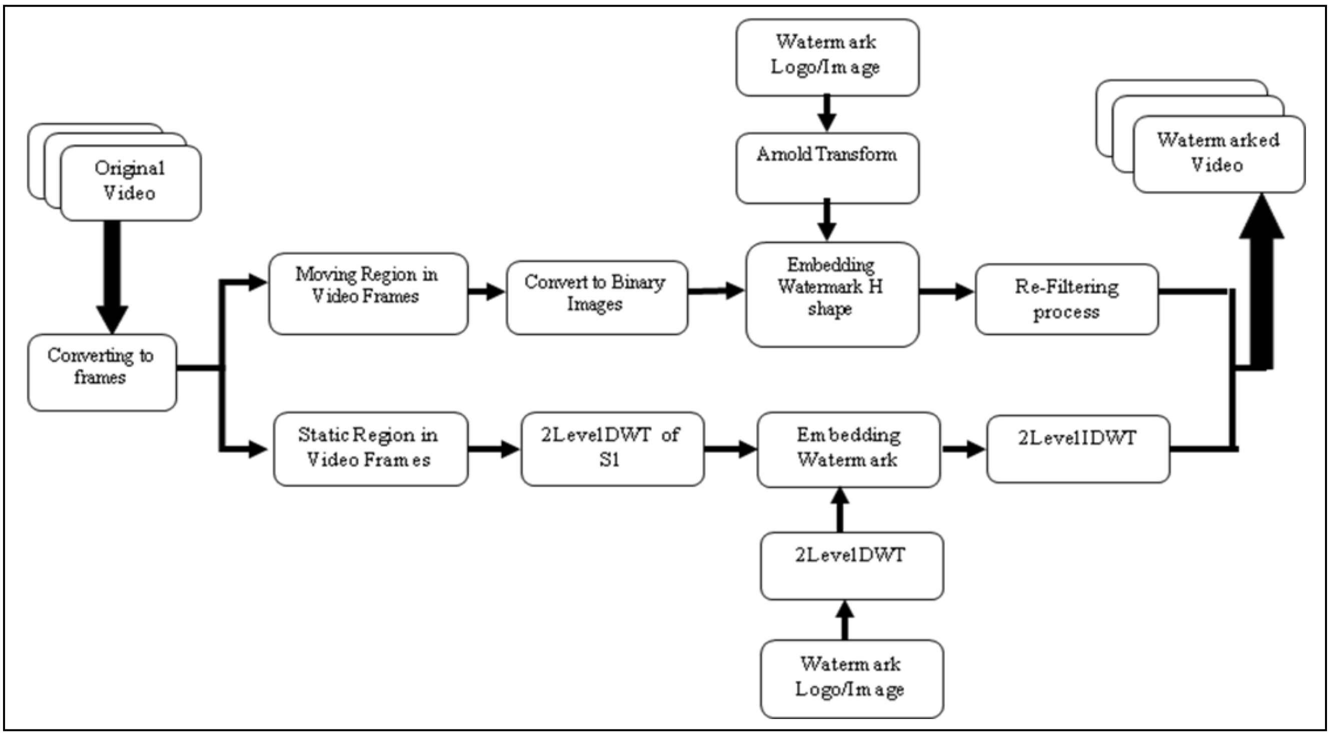

Figure 3. Video Watermarking Embedding Process

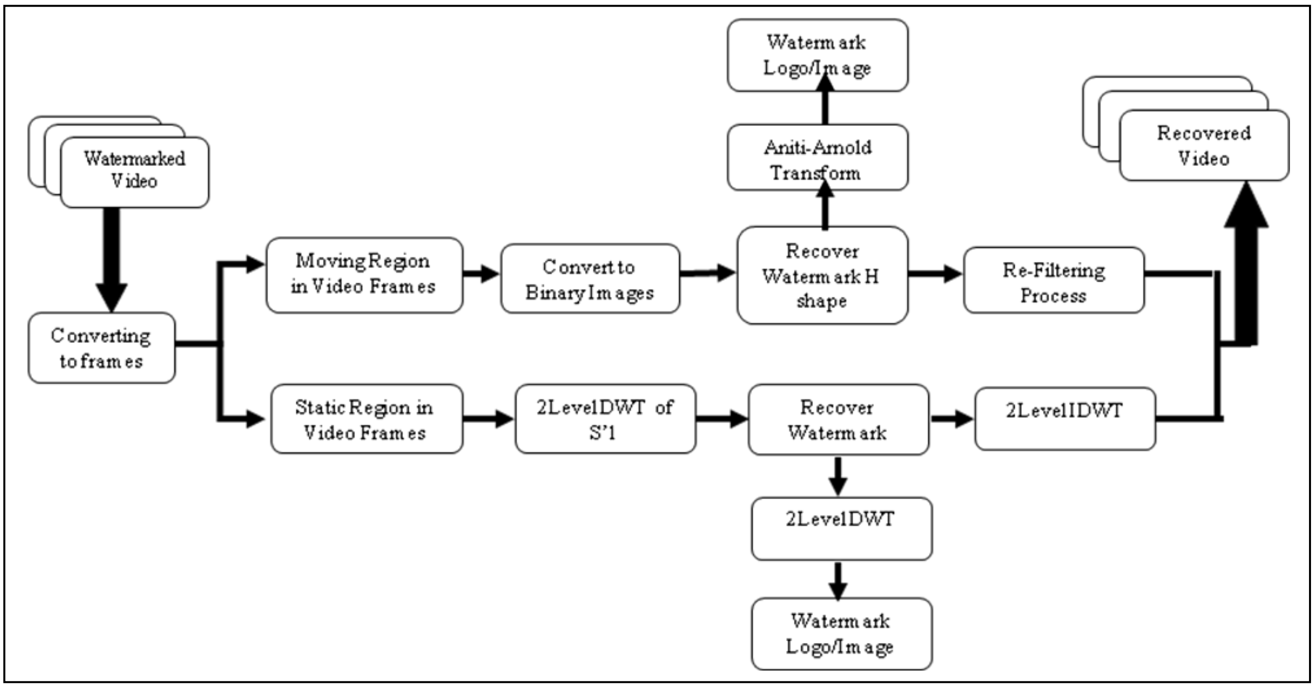

Figure 4. Video Watermark Recovery Process

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Table 1. PSNR values of every successive frame in viptraffic.avi video with watermark

FRAME NO	PSNR IN DB									
1-10	64.3	64.3	64.3	64.3	64.3	64.3	64.3	64.3	64.3	64.3
11-20	64.3	60.78	60.78	60.78	60.78	60.78	61.35	64.94	64.94	64.94
21-30	58.92	58.88	61.1	70.54	70.72	56.98	64.52	56.42	64.3	64.3
31-40	64.77	64.41	64.3	70.9	79.9	64.8	70.96	56.98	79.9	60.74
41-50	64.34	70.5	80	80	60.2	64	61.07	61.07	61.07	61.21
51-60	79.9	70.61	78.57	70.47	70.54	70.54	70.96	70.58	64.66	60.96
61-70	64.7	70.5	70.5	70.75	79.9	79.9	79.9	70.5	70.65	70.72
71-80	64.56	70.75	70.96	61.42	70.29	69.6	64.15	61.03	79.9	64.41
81-90	79.9	60.96	61.24	60.93	64.45	58.85	70.96	61.28	70.54	58.53
91-100	79.9	61.42	47.76	58.17	51.65	51.92	58.17	54.91	79.99	79.99
101-110	79.99	79.99	79.99	79.99	79.99	79.99	79.99	79.99	79.99	70.21
111-120	60.67	70.21	64.19	64.19	64.19	70.7	61.13	61.13	61.13	61.13

Figure 5. 25th video frame

Figure 6. 25th Static Luminance frame

Figure7. 25th Binary frame

Figure 8. Watermark Logo/Image

Figure 9. Extracted Watermark
PSNR=53.4 dB

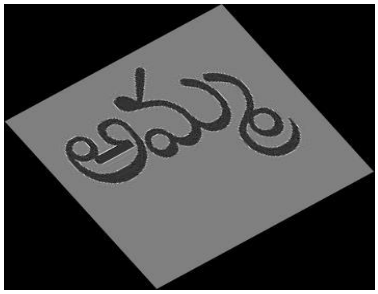

Figure 10. Rotation Attack 30 degree
PSNR= 53.04 dB

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V. RESULT ANALYSIS

In this proposed work audio video file format is taken and watermarking is done on the video only. The video file contains 120frames with 15 Frames per second (fps) each frame and its successive frame absolute difference frames that is moving object frames and static frames were successfully obtained with zero loss in data. The "Fig. 5" is the 25th frame is shown above; "Fig. 6" is the static luminance frame, "Fig. 7" is difference binary frame. Several steps have taken to attain good robustness. The Watermark Logo/Image in "Fig. 8" is embedded in every difference video frame (M1) and every static video frame (S1). Here both the domains have been processed that is M1 is processed under time domain and S1 is processed in frequency domain independently. The extracted Logo/Image is compared with the original watermark Logo mathematically and the performance of the system is calculated without and with attacks "Fig. 9" is extracted watermark and "Fig. 10" is rotation attack with 30 degrees and the PSNR is 54.04 dB.

$$\mathrm{MSE} = \frac{1}{m\,n}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i,j) - K(i,j)]^2 \qquad (3)$$

i-Noise free Image, j-noisy image

$$\mathrm{PSNR} = 10\log_{10}\left(\frac{\mathrm{MAX}^2}{\mathrm{MSE}}\right) \qquad (4)$$

(or)

$$\mathrm{PSNR} = 20\log_{10}\left(\frac{\mathrm{MAX}}{\sqrt{(\mathrm{MSE})}}\right) \qquad (5)$$

(or)

$$\mathrm{PSNR} = 20\log_{10}(\mathrm{MAX}) - 10\log_{10}(\mathrm{MSE}) \qquad (6)$$

MSE and PSNR are calculated using the above equation 3 and equation 4 or 5 or 6. MAX is the maximum possible pixel value of the image. For color images with three RGB values per pixel, the definition of PSNR is the same except the MSE is the sum over all squared value differences divided by image size and by three components. PSNR values of every successive frame of video with and without watermark are calculated and the values are tabulated in "Table 1". The average PSNR obtained for 120 video frames is 67.069dB.

VI. CONCLUSION AND FUTURE SCOPE

The basic 2 Level Discrete Haar wavelet Transform and Arnold Image scrambling method are used for improved level of watermarking in the video frames, the imperceptibility is measured using MSE and PSNR for various attacks, in this work only video have been chosen to embed the watermark for very high robustness watermark can be done in every audio file of each frame to obtain improved level of watermarking and it is complex process. Even better lifting wavelets can be used to obtain the better imperceptibility and Robustness to various attacks. In the spatial domain where improved Arnold transform is taken can be altered depending upon video to have good robustness on the Watermark Logo/Image.

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