ABSTRACT
Recently, digital watermarking algorithms are widely applied to digital image, audio or video for ownership protection and tampering detection. Digital watermarking is the process of reversibly or irreversibly embedding information into a digital signal. In this paper, Video watermarking algorithm based on discrete wavelet transform scheme is proposed. In which, the video is firstly divided into frames and each frames are divided in to three images of red, blue and green, then 4-level DWT (Discrete Wavelet Transform) is performed on each digital image. Here watermarking data is also color binary video, which is also first divided into frames and then three images are taken from each frame. Watermark frames are embedded into the original video frames according to the attribute of the sub-band (LH, HL) of every wavelet images. The interesting point and usefulness of the algorithm lies in that watermark video can be exactly embedded into the original video, and the watermarking is robust to all video attacks because we do not require original video and watermarked video for extracting original video and watermark video. The simulation results show the effectiveness of the scheme.

KEY WORDS: Video watermarking, 4-level discrete wavelet transform, etc.

I. INTRODUCTION
We have seen an explosion of data change in the Internet and the extensive use of digital media. Consequently, digital data owners can transfer multimedia documents across the Internet easily. Therefore, there is an increase in the concern over copyright protection of digital content [1, 2, and 3]. In the early days, encryption and control access techniques were employed to protect the ownership of media. They do not, however, protect against unauthorized copying after the media have been successfully transmitted and decrypted. Recently, the watermark techniques are utilized to maintain the copyright [4, 5]. In this paper, we focus on engaging the digital watermarking techniques to protect digital multimedia intellectual copyright and propose a new algorithm for video watermarking. Video watermarking introduces some issues not present in image watermarking. Due to large amounts of data and inherent redundancy between frames, video signal are highly susceptible to pirate attacks, including frame averaging, frame dropping, frame swapping, statistical analysis, etc [4]. However, the currently proposed algorithms do not solve these problems effectively. In our scheme, we use the video watermarking scheme by using the video as a watermark. So using this technique we apply different watermark on each frame of the video. In watermark and original video recovery we are not using the original video and watermarked video so this scheme which is proposed in this paper is always robust against the video pirate attacks. This paper is organized into four sections. The next section presents the details of the novel video watermark scheme and the simulation results are shown in Section3.
Section 4 provides a conclusion and the future improvement of this scheme.

II. VIDEO WATERMARKING SCHEME
The new watermarking scheme what we propose is based on 4 level Discrete Wavelet Transform. Fig. 1 shows an overview of our watermarking process. In this scheme, an input video is split into audio and video stream and video undergoes for watermarking process [8]. On the other hand, a watermark video is decomposed into frames and each frame of original video and watermark video is decomposed into three images R, G, B. In this way each watermark video frame is embedded in each original video frames. Block diagram of our scheme shown below. As applying a fixed image watermark to each frame in the video leads to the problems in maintaining statistical and perceptual invisibility, our scheme employs independent watermarks for successive frames. With these mechanisms, the proposed method is robust against the attack of frame dropping, averaging, swapping, and statistical analysis.

A). Watermark color Video pre-process.
Overview of Watermark preprocess is shown in Figure 3.2. First the watermark binary color image is decomposed into three components (Red, Green and Blue) and these three components are applied to the secret key generation algorithm. Finally three watermark images are generated which will be embedded in three different components of original color video frame. The length of the generated watermark image must be same as data to be embedded.

B). Original color Video Pre-process
In our approach of watermark is based on 4 level DWT. All frames in the video are transformed to the wavelet domain, Independent watermarks are embedded in each video frames. Each video frame is decomposed in three color images R, G, B, 4 level DWT is applied on each image. Finally, watermark video frame is embedded in each original color video frames.

Figure. 1 Overview of watermarking process using video watermark.

Length of generated watermark image=length of original watermark image + length of secret key

Figure 3.2 Overview of watermark preproces.

Figure 3.3 Flow Chart of the watermarking process.
C. Embedding Algorithm:

![Flow chart for watermark embedding.](image)

Figure 3.4. Flow chart for watermark embedding.

Figure 3.5 Shows how to embed the Watermark and secret key in to the video frames here we apply the watermark in to only mid frequency band of the image because of the effect of the human visual system. The power present in the frequency bands varies greatly from image to image.
image. If the image energy in a particular band is very low and the watermark energy in that band is high, then some artifacts are created in the image, since the watermark energy is too strong relative to the image. In addition, with such a scheme, it is not possible to add more watermark energy at a particular frequency, in which the image energy is high, in order to improve robustness. LL band contains the most of energy of the image, so we apply the watermark in mid frequency bands, it will not creates some artifacts in the image and invisibility of the watermark can be increased.

Figure.3.5 Embedding watermarks in a frame

Higher frequency coefficients are embedded to higher frequency part of the video frame. Also, only the middle frequency wavelet coefficient of the frame (middle frequency sub-band) is watermarked [6].

Figure 3.4 shows the Flow chart of embedding algorithm to embed the watermark in to color video.

- first of all convert the video in to frames and then frame to image. decompose each image in to three color components (R,G,B).
- Apply 4-level DWT to each component. Here we apply watermark in to HL and LH bands (mid frequency bands) of each level so convert each pixel value in to binary.
- To increase the robustness we apply the watermark in the 5th bit of every pixel. If 5th
bit is equal to 1 then $SC(i, j, k)$ is equal to 2 else $SC(i, j, k)$ is equal to 1, where $SC$ is the array to store the information for original video Extraction and $(i, j)$ is the pixel position of particular band and $k$ is the frame number.

- Then if $W(i, j) = 1$ then $5^{th}$ bit of pixel is equal to 1 else it is 0. We start to embed the watermark from HL4 ($4^{th}$ level mid frequency band) and then sequencely in to LH4, HL3, LH3, HL2, LH2, HL1 and LH1.
- At last store the watermarked video frame data in to array $sc(i, j, k)$ for watermark Extraction before applying inverse DWT.

C). Extraction Algorithm:

Figure 3.6 shows the Flow chart of extraction algorithm to extract the watermark and secret key from the watermarked video.

![Figure 3.6 Flow chart for watermark and secret key Extraction.](image)
Load the watermarked data stored in array sc(i,j,k) , where (i,j) is the pixel position in particular frequency band and k is the frame number.

Let convert each pixel of mid frequency band in to binary.

Check if 5th bit of pixel value is ‘1’ then WR(i,j)==1 , where WR is the recovered watermark and secret key matrix. if 5th bit of pixel value is ‘0’ then WR(i,j)==0.

Decompose watermark data and secret key from the matrix WR.

Apply these algorithms to three different watermarked images so we can get three different watermark data, and then combine these data to retrieve the watermark image.

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**Figure 3.7** Flow chart for original color video Extraction.
Figure 3.7 shows the Flow chart of extraction algorithm to extract the original video from the watermarked video.

- Load the watermarked data stored in array sc(i,j,k) and stored array SC(i,j,k), where SC contain the original value of the 5th bit before watermarking.
- Let convert each pixel of mid frequency band in to binary.
- Check if SC(i,j,k) is ‘2’ then 5th bit of pixel sc(i,j,k) is ‘1’ else it is ‘0’.
- Convert each binary pixel value in to decimal.
- Combine three array sc(i,j,k) for three images R,G,B so the original video will retrieved.

After extracting and refining the watermark, a similarity measurement of the extracted and the referenced watermarks is used for objective judgment of the extraction fidelity and it is defined as:

\[
NC = \frac{\sum_{i=1}^{N} \sum_{j=1}^{N} w(i,j) \times w^*(i,j)}{\sum_{i=1}^{N} \sum_{j=1}^{N} w(i,j)^2} \quad \text{......(1)}
\]

which is the cross-correlation normalized by the reference watermark energy to give unity as the peak correlation.

Where \(w(i,j)\) is the original watermark, \(w^*(i,j)\) is the extracted watermark.

In order to evaluate the quality of image, we use parameter peak value signal-to-noise ratio (PSNR).

\[
\text{PSNR}_{\text{dB}} = 10 \log_{10} \left( \frac{255^2}{\frac{1}{N \times N} \sum_{i=1}^{N} \sum_{j=1}^{N} (f(i,j) - f'(i,j))^2} \right) \quad \text{......(2)}
\]

where \(N\) is the size of image, \(f(i,j)\), \(f'(i,j)\) is the pixel gray value of host image and pending detection image respectively. The bigger the value of PSNR, the better the quality of image.

![Figure 3.8 Original Color Video Frames](image-url)
III. SIMULATION RESULTS
In this experiment, original color video with 90 frames of size 240*240 and watermark binary color video of size 128*128 are taken as an input. Then watermarked video is taken as an output. Watermark bits are embedded in 5th bit of each frequency component of original color video frames. At last PSNR between the original video frames and watermarked video frames is calculated to see the invisibility of watermark. Then NC between the watermark frames and recovered watermark frames are calculated to see the robustness of the scheme. We apply different watermark image for different original video image, this technique is used when there is a requirement of embedding large amount of data. Using this technique we can embed large number of information, but it will require more time for embedding than first scene change based method. Here the NC value is 1 for all images, this shows the 100% recovery of watermark images, the PSNR value is between 31 to 44 db. This is comparatively higher than experiment no 1 and 2. So watermark embedding in 4th bit is more advantageous than experiment no 1 and 2. But it is less secure than experiment 1 and 2 so generally watermark embedding done in the middle bit (5th bit) of Frequency coefficient. The PSNR value shows that the algorithm keeps the quality of the image and invisibility of embedded watermark without any attacks.

![Figure 4.9 Binary Color Watermark Video Frames.](image-url)
Figure 4.10 Watermarked Color Video Frames.

Figure 4.11 PSNR Between Original And Watermarked Video Frames.
Figure 4.12 Recovered Original Video Frames from Watermarked video.

Figure 4.13 NC Between Watermark Video And Recovered Watermark Video Frames.
IV. CONCLUSION AND FUTURE WORK

Proposed work an innovative blind video watermarking scheme with watermark as video. The process of this video watermarking scheme, including watermark preprocessing, video preprocessing, watermark embedding, and original video recovery is described in detail. Simulations are performed to demonstrate that our scheme is robust against various video attacks because of immediate watermark changing on every frame. The scheme can be improved by making the video much smaller than the original video by key frame extraction and the new video will look like same as the original video. This improvement will reduce the processing because there is no need to apply watermark on every frame. We will conduct this improvement in the future even.

REFERENCES

