DIGITAL INVISIBLE ROBUST VIDEO WATERMARKING ON UNCOMPRESSED COLOR VIDEO USING N-LEVEL DWT

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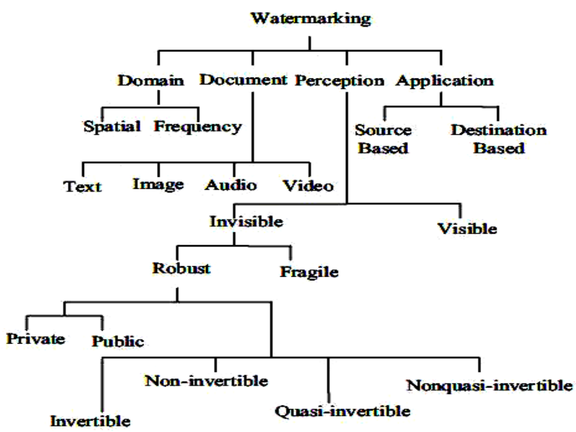
Abstract:* In this report, i propose a highly robust perceptual digital video watermarking procedure to embed a watermark image in digital video frames using the 2-D 4-Level DWT technique. In which, the video is firstly divided into frames and key frames detection algorithm is applied to find the key frames. 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 image, which is also first divided into three images. Watermark images are embedded into the original video frames according to the attribute of the sub-band (LH, HL) of every wavelet images. Different watermark is applied for different key frame. The method adopted embeds the watermark (a binary logo image) in an uncompressed video sequence by modifying the values of the mid-range coefficients of individual 2-D 4 Level DWT blocks, in accordance with sensitivity of the 3-D human visual system model. The sensitivity of human eye in this frequency range is known to be minimum. This makes the proposed method highly robust against common signal processing manipulations such as frame averaging, frame dropping, noise addition, cropping and lossy compression Because it does not require the original as well as watermarked video for watermark extraction. In second proposed method watermark data is also color binary video, and different watermark is applied for each frame of original color video. So we can embed more information in to the original data. The significance of secret key in our method is to embed the secret information with watermark data.

***Keywords:* Video watermarking, Key frames extraction, DWT, Embedding Algorithm, Extraction Algoritham**

I. INTRODUCTION

A. Different Watermarking methods



B. Video Watermarking

Digital watermarking for still images has been extensively studied. Today however, growing popularity of video based applications such as Internet multimedia, wireless videos, personal video recorders, video-on-demand, set-top box, video phone and videoconferencing has increased the demand for a secure distribution of videos. Apparently any image watermarking technique can be extended to watermarking videos, but in reality video watermarking techniques need to meet other challenges than that in image watermarking schemes. Some of the video characteristics that impact watermarking include:

- High correlation between successive frames. If independent watermarks are embedded on each frame, an attacker could perform frame averaging to remove significant portions of the embedded watermark.
- Some applications like broadcast monitoring require real time processing and therefore should have low complexity.
- The unbalance between the motion and motionless regions. Watermarked video sequences are very much susceptible to pirate attacks such as frame averaging, frame swapping, statistical analysis, digital-analog (AD/DA) conversions and lossy compressions.

C. Discrete Wavelet transform (DWT)

We need some method so that our watermark image (logo) must be at the location, where it is not much different from the original image one. By using the wavelet, we will be able to find the location where even if we change the intensity value, it will not change the look of image. Second thing is to avoid logo from various attacks we need the algorithm for protection too so that even if the attacker knows the pixel position, where we have embedded the logo, he will not be able to identify the logo image. Discrete Wavelet transform (DWT) is a mathematical tool for hierarchically decomposing an image. It is useful for processing of non-stationary signals. The transform is based on small waves, called wavelets, of varying frequency and limited duration.

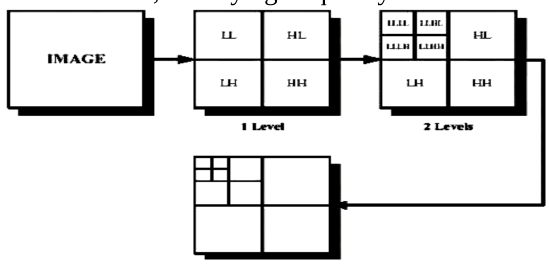


Figure 1 2-D DWT for Image

This section analyses suitability of DWT for image watermarking and gives advantages of using DWT as against other transforms. For 2-D images, applying DWT corresponds to processing the image by 2-D filters in each dimension. The filters divide the input image into four non-overlapping multi-resolution sub-bands LL1,LH1, HL1 and HH1.The sub-band LL1 represents the coarse-scale DWT coefficients while the sub-bands LH1, HL1 and HH1 represent the fine-scale of DWT coefficients. To obtain the next coarser scale of wavelet coefficients, the sub-band LL1 is further processed until some final scale N is reached. When N is reached we will have 3N+1 sub-bands consisting of the multi-resolution sub-bands LLN and LHx, HLx and HHx where x ranges from 1 until N.

II. KEY FRAMES EXTRACTION VIDEO WATERMARKING SCHEME

The new watermarking technique i propose is based on Key frames detection (extraction). Figure 2 shows an overview of watermarking process. In this technique, a color video and a watermark video are taken as the input, and the color binary watermark is then decomposed into three different components (R,G,B) which are combine in corresponding components of frames of the original color video. As applying a fixed image watermark to each frame in the video leads to the problem of maintaining statistical and perceptual invisibility, In this technique employs independent watermarks for successive but different scenes. In addition of, applying independent watermarks to each frame also presents a problem if regions in each video frame remain little or no motion frame after frame. These motionless regions may be statistically compared or averaged to remove the independent watermarks. Consequently, we use an identical watermark within each motionless scene. With these mechanisms, the proposed method is highly robust against the various attacks of frame dropping, averaging, swapping, and statistical analysis. This newly proposed technique consists of four parts, including: (i)watermark preprocess, (ii)video preprocess, (iii)watermark embedding, and (iv)watermark detection. Details are described in the following sections. Figure 3 shows Flowchart of our watermarking process. In our scheme, a video and a watermark are taken as the input, and the watermark is then decomposed into different components which are embedded in corresponding frames of different scenes in the original video. In the first step all original color video is stored in the sequence of one array, then it is converted in to different frames. Then key frames detection algorithm is applied on to the consecutive frames. If key frames found then i have to change the watermark image else apply the same watermark within one frame of the video. Decompose the original video frames and watermark video frames in to three different components (R, G, B). And then apply the 4-level DWT on each component (R, G, B) of video frame, then generate the secret key and add in to watermark data. Because the watermark image bits are not enough to embedding in to original image. Apply the embedding algorithm, then combine the original color video frames and watermark color video frames and generate sequence of array watermarked color video frames. Apply the 4-level inverse DWT to watermarked video frames. And then repeat all the step up to number of frames. After that combine R,G,B component of each watermarked video frames and generate the watermarked color video.

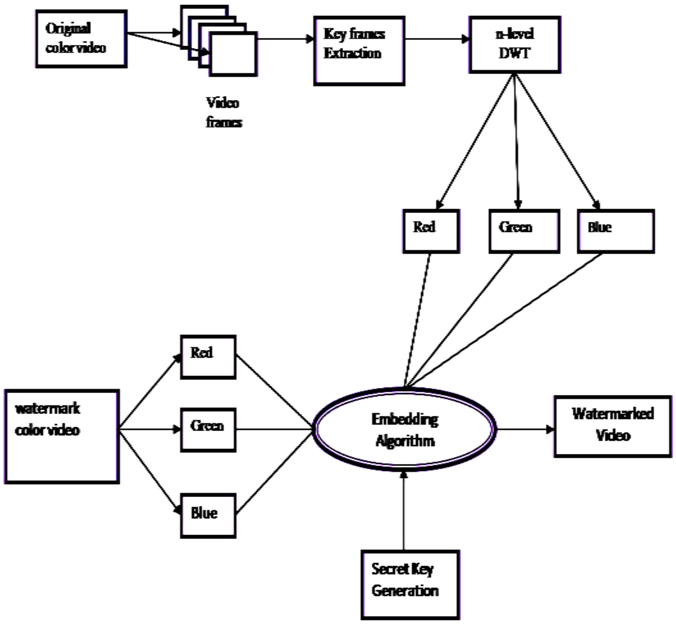
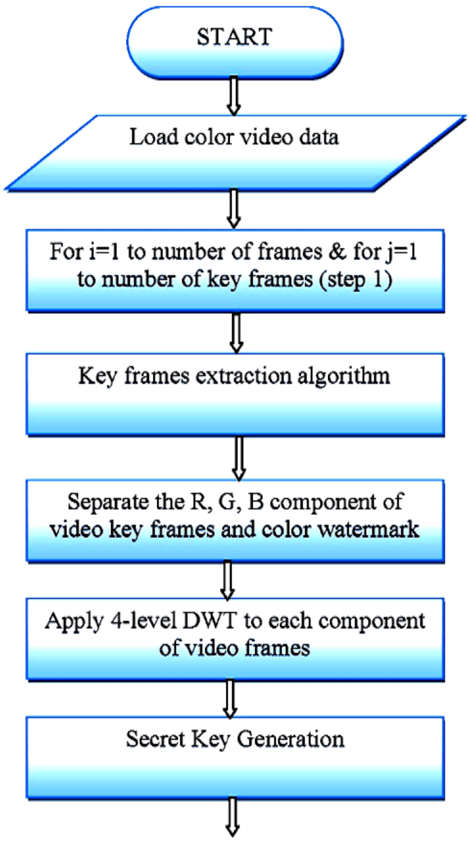


Figure 2: Overview of the watermarking process

Flow chart of watermarking process



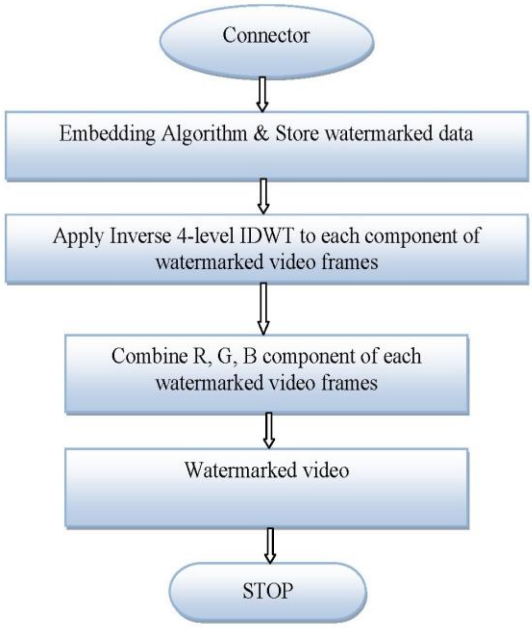


Figure 3 Flow Chart of the watermarking process.

III. KEY FRAMES EXTRACTION

A original colour video consisting of total 'i' numbers of frames is taken as an input where i is 1 to N. And, for each pair of consecutive key frames 'j' and 'j+1' having feature vectors respectively for nth frame as 'Fjn' and 'Fjn+1'.
The diff(i) is a difference between two consecutive video frame feature vectors seven similarity measures used to calculate the diff(n) in proposed method are the mean square error(MSE), Euclidean Distance, Canberra Distance, Squared-Chord Distance, Sorensen Distance between the frames is calculated. Then calculate the Mean(M) and standard deviation(S) of all the index frames. After this calculation the threshold(T) value is computed by adding mean(M) and multiplying constant 'a' with standard deviation(S). Then finally comparing this threshold value with the difference of consecutive colour video frames the key frames are computed as given in equations A, B and C.

$$Mean(M) = \frac{\sum_{i=1}^{N} diff(i)}{N-1} \quad \text{........(1)}$$

$$Standard\ Deviation(S) = \sqrt{\frac{\sum_{i=1}^{N-1}(diff(i) - M)^2}{N-1}} \quad \text{.....(2)}$$

$$Threshold(T) = M + a \times S \quad Here\ a = Constant \quad \text{.......(3)}$$

(1)Mean Square Error:
In Mean Square Error (MSE) two different error metrics which is used and comparing the various image compression schemes. Mean Square Error means the cumulative squared error between one reference image and the one target image. The Mean Square Error can be represented mathematically by equation D.

$$MSE = \frac{1}{N}\sum_{i=1}^{n} [P_i - Q_{i+1}] \quad \text{.........(4)}$$

(2)Euclidean Distance:
In the Euclidean distance measure distance between two points with the help of a ruler as given by equation E.

$$ED = \sqrt{\sum_{i=1}^{n} |P_i - Q_{i+1}|^2} \quad \text{..........(5)}$$

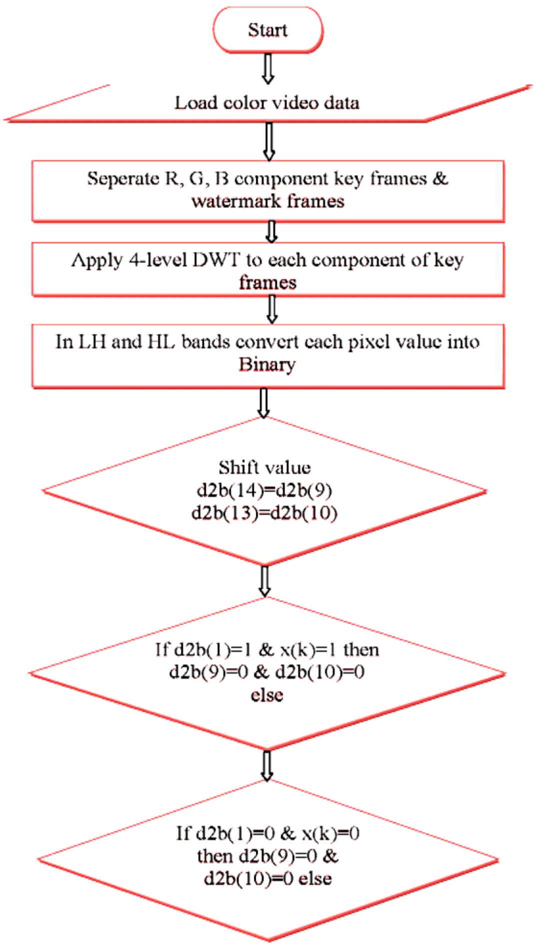
(3)Squared-Chord Distance:
Can be computed as given by equation F.

$$SC = \sum_{i=1}^{i=n} \left(\sqrt{P_i} - \sqrt{Q_{i+1}}\right)^2 \quad \text{..........(6)}$$

(4)Canberra Distance:
Lance & Williams (1967) introduced this distance method for the Manhattan metric calculated as equation G.

$$CD = \sum_{i=1}^{n} \frac{|P_i - Q_{i+1}|}{P_i + Q_{i+1}} \quad \text{............ (7)}$$

A. Embedding algorithm



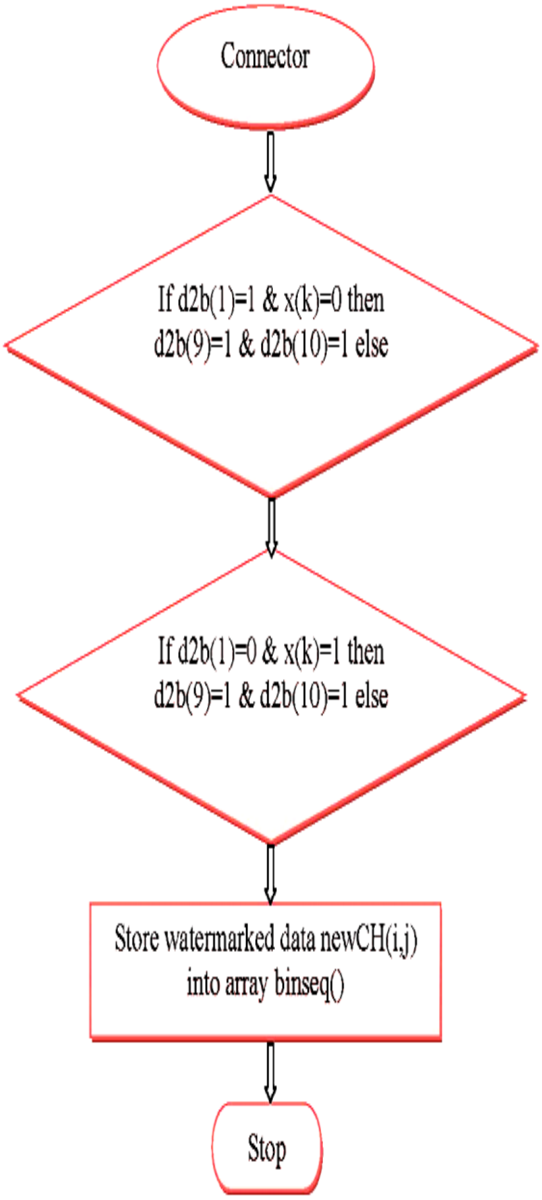


Figure 4. Flow chart for watermark embedding.

Figure 4 shows the Flow chart of embedding algorithm to embed the watermark in to color video. In the first step, convert the color video into different frames and then frame to image decompose each and every image in to three different color components (R, G, B).Then apply 4-level DWT to each component of image (R, G, B). Here we applying watermark in to HLx and LHx bands (mid frequency bands) of each level so convert each pixel value in to binary. Where x is 1 to NThen apply embedding logic on original color video and watermark video, then store watermarked data. At last store the watermarked video frame data in to array sc(i, j, k) for watermark Extraction before applying inverse DWT. Then apply inverse 4-level DWT (IDWT) to each component of watermarked color video frames. Then combine R, G, B component of each and every watermarked video frames, to compute the watermarked video.

B. Extraction algorithm

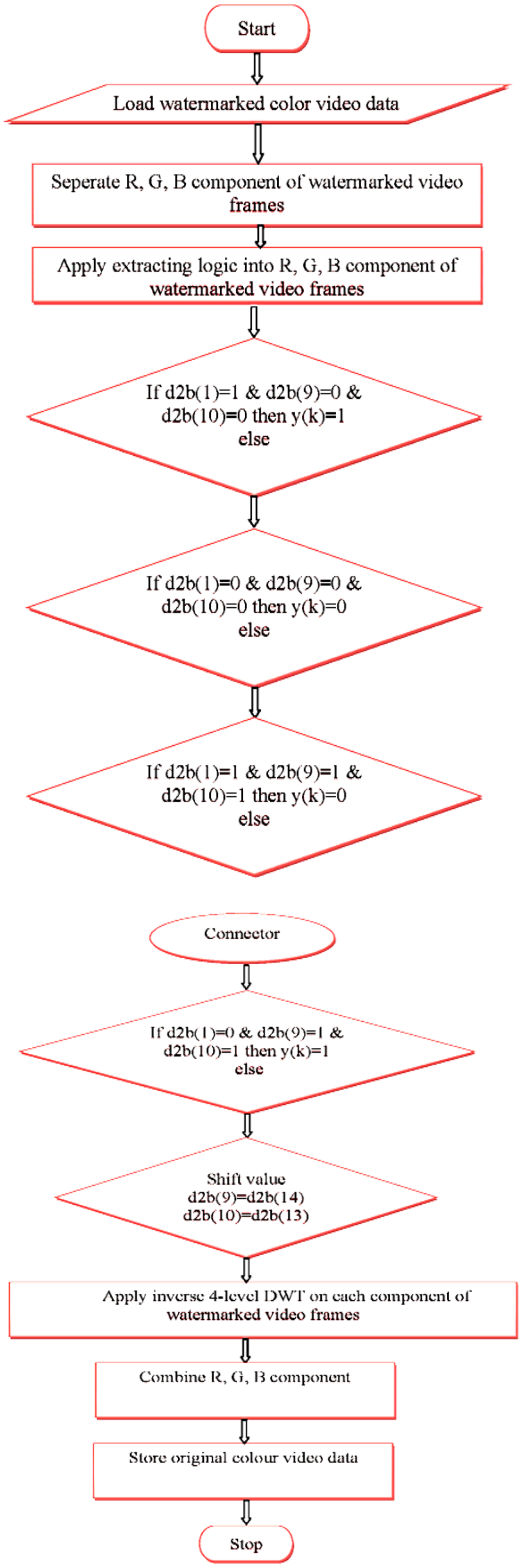


Figure 5. Flow chart for watermark extraction.

In Fig. 5 shows flow chart flow watermark extraction. In this extraction algorithm first step is load watermarked video frames. Then separate R, G, and B component from watermarked color video frames. Then apply extraction algorithm logic on it. After that process over it, then apply inverse 4-level DWT on each component watermarked color video frames.Then combine generated R, G, B component, and store original color video frames from separate the watermark frames.

IV. SIMULATION RESULT

In this experiment, original main color video with 113 frames taken as a input and generate 53 key frames. Then watermarked video is taken as a output. Finally generate PSNR between the original color video frames and watermarked video frames and calculated to see the invisibility of the watermark. Fig 6 shows the original color video frames of the video with 113 frames of size 240*320. Apply watermark embedding algorithm.

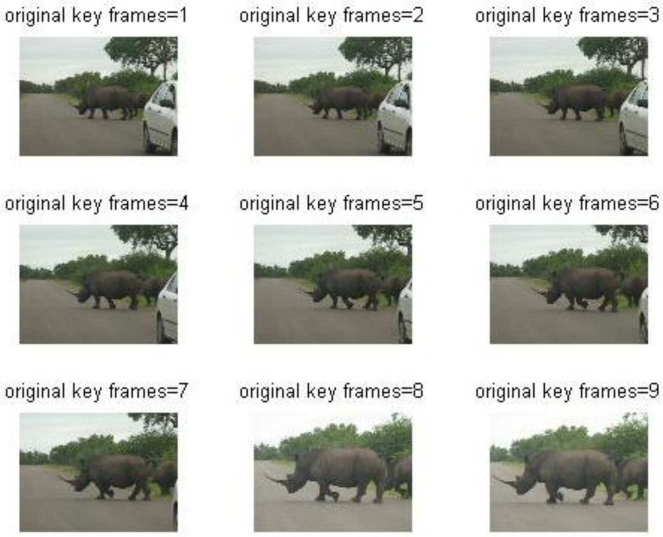


Figure 6 Original Color Video Frames

Fig 7 shows the binary color watermark frames of size 120*160 with 283 frames.

Figure 7. Watermark Images

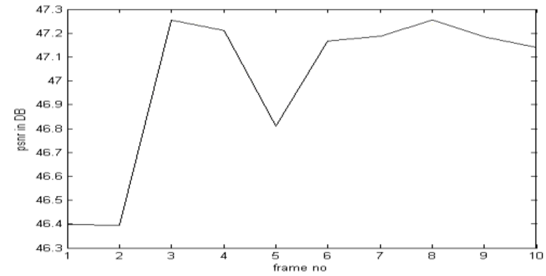


Figure 8 PSNR graph between Original and Watermarked Video Frames

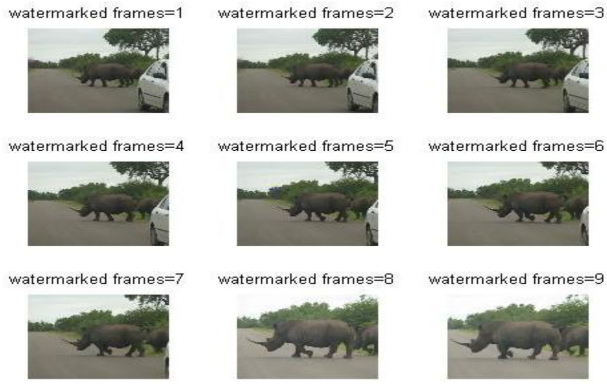


Figure 9 Watermarked Video Frames

After applying watermark extraction algorithm. Then Recovered back original color video frames from watermarked color video, and separate watermark frames.

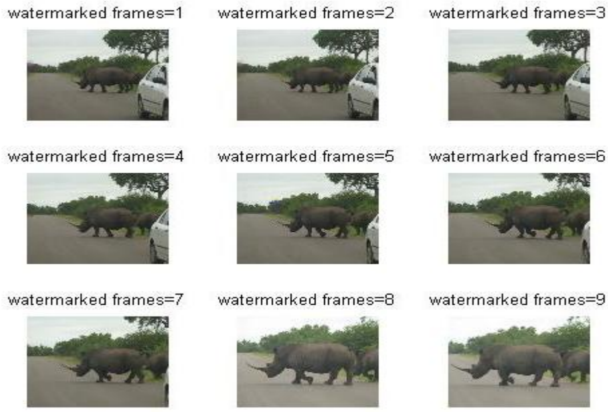


Figure 10 Recovered original Video Frames

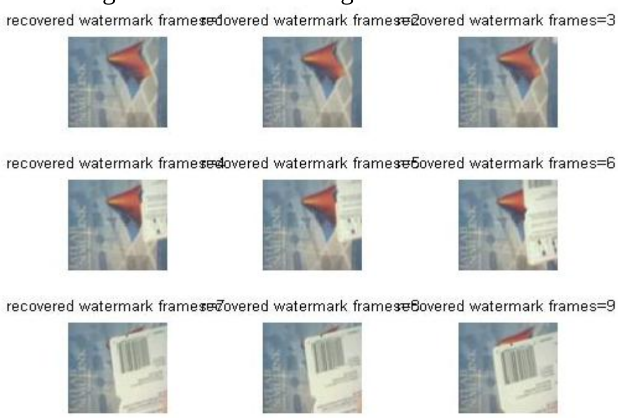


Figure 11 Recovered watermark Video Frames

V. CONCLUSION

From this experiment fundamental of key frame extraction or detection from the original color video is more clear and understandable so when embedding the watermark image on the key frame structure, the result of PSNR between watermarked video bit sequence are almost same as the original color video bit sequence. So the distortion at the output video is almost none, which is desired. After that at the receiver side extraction algorithm applied and key frame video structure and watermark are successfully separated.

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