A New Embedding and Extraction Algorithms for Robust Video Watermarking in Wavelet Domain

Suman Mishra, S. Poongodi, and K. Karthik

Abstract Watermarking is an innovation that is utilized for giving the security to the multimedia/digital information and digital media copyright assurance. Late years, there are numerous scientists who had created watermarking algorithms based on LeaSe noteworthy Bit (LSB), Discrete Fourier Transform (DFT), Discrete Sine Transform (DST), Discrete Cosine Transform (DCT), Discrete Wavelet Transform (DWT) and Principle Component Analysis (PCA) and so on., Here, we proposed "a new embedding and extraction algorithms for robust video watermarking in wavelet domain". In terms of consistency, the proposed algorithm indicates that the proposed algorithm was superior to the current algorithms. such as Structural Similarity Index (SSIM), CoVariance (CV) and Peak Signal To Noise Ratio (PSNR).

Keywords Digital watermarking · LSB · DFT · DCT · DWT · SVD · PSNR and SSIM

1 Introduction

It's a digital world, everything has gotten to be digital in this day and age. Consistently Gega bytes of information have been sharing over web. Subsequently, one must need to give the security to the mutual multimedia/digital information. One conceivable arrangement is watermarking, which is a piece of information covering up otherwise called steganography [1, 2] and [3]. These systems used to install the

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information to be covered up into the spread media. Along these lines, if the information is replicated by someone, then the concealed information will be duplicated and. Many techniques for digital picture watermarking were suggested. The vast majority of the analysts have done their examinations on dim scale image which are 2D images. Be that as it may, the greater part of the organization logos are in multi color and information sharing is likewise should be shading as of late. Subsequently, one needs to create RGB image watermarking to give security and copyright insurance. RGB watermarking is likewise same as grayscale watermarking, just distinction is here in RGB images there are three components i.e., red, green and blue though dark scale images have stand out component. Be that as it may, there are a few issues brought up in creating RGB watermarking algorithms. As of late, the interest in security of copyrights has been brought up in different fields [3], for example, military, bio-restorative, common, web and bio-metric and so on. Copyright protection encloses authentication, for instance, of knowledge on ownership of traditional media material and their trademarks without compromising the quality of traditional images [4]. When a debate exists, the public media evokes verified facts that may be seen as definitive documentation to show possession. Watermarking is the procedure that inserts the information to be shrouded which is called as a digital mark into the digital multimedia questions with the end goal that this watermarked information can be evoked later to make an asseveration about the article. All digital watermarking proposals must follow imperceptibility requirements and, in turn, protection against every threats against watermark extraction and expulsion. From the previous decades there are such a variety of algorithms have been executed for digital image watermarking utilizing slightest noteworthy bit (LSB) approach [6, 7] and [8], Separable four transformations (DFT), discrete transforming cosines (DCT) [9] and [10], discrete transforming sines (DST), transforming radons (RdT) [11] and [12] etc., However, every one of them or neglected to create higher imperceptibility and absence of perceptual quality. Here in this letter, an imperceptibility and strong embedding and extraction algorithms have been proposed. DCT, DFT and also separate transformations are more powerful than Wavelet. It is computer-efficient than other strategies of transformation [13]. It is exceedingly rational to classify areas in the RGB picture where imperceptibility may be inserted for the watermark details because of their fantastic spatial frequency limitation properties. We know that any relation among wavelet coefficients also exists after disintegration of the RGB edge using the wavelet transformation.

2 Existing Approaches

2.1 LSB Approach

Minimum Significant Bit (LSB) addition is a typical, straightforward way to deal with installing information in a spread video. Video is changed over into various

edges, and after that change over every casing into an image. Afterwards, a few or most of the bytes inside an image will be replaced to a bit of each part of the Red, Green and Blue shading as each is spoken to by one byte. At the end of the day one can store 3 bit in every pixel. We executed our undertaking with the end goal that it can acknowledge and video of any size.

2.2 Discrete Fourier Transform

Frederic suggests a 2-D DFT solution in 1999 [5] and a secured video protection, which is primarily to reduce the copying and dispersal of proprietary materials. The strategy is based on the DFT of the picture scene borders, which then in existing commitments proposed separately a screen shot. In fact, the details to be contained in the film will be programmed using the private encryption key, to maintain the confidentiality of the frame and placed in the DFT range of the camera edges.

$$F(u, v) = 1/MN \sum_{-} (x = 0)^{\wedge}(M - 1) \sum_{-} (y = 0)^{\wedge}(N - 1)$$
$$\left(f(x, y)^* e^{\wedge}((-j2\pi (ux/M + vy/N)))\right) \tag{1}$$

where, u=0,1,2,…., $M-1$,
$v = 0, 1, 2,…., N-1$ and $j = \sqrt{(-1)}$
The inverse DFT (IDFT) is given by

$$F(x, y) = \sum_{-} (u = 0)^{\wedge}(M - 1) \sum_{-} (v = 0)^{\wedge}(N - 1)$$
$$\left(F(u, v)^* e^{\wedge}((-j2\pi (ux/M + vy/N)))\right) \tag{2}$$

The frame 's size is M and N. DFT will help you recognize enough portions of the watermark image to insert the text, which in effect increases perceivability and robustness. It is really helpful as a watermarking algorithm.

2.3 DCT

DCT is one of the ways in which host signal may be decomposed into many frequencies and the insertion into the mid-band watermark becomes much smoother because the host video frames are left without any large optical sections of the bands [14]. The mid-frequency bands were also picked for integrating the details into the recording of the host. That block is inserted in the initial video picture, which is transformed into a spatial domain in motion and is separated into 8×8 pixel sections. The DCT is given in two dimensions

$$C(0, 0) = 1/K \sum_{} (a = 0)^{\wedge}(L - 1) \sum_{} (y = 0)^{\wedge}(K - 1)(f(a, b)) \quad (3)$$

$$C(i, j) = 1/(2K^{\wedge}3) \sum_{} (a = 0)^{\wedge}(L - 1) \sum_{} (b = 0)^{\wedge}(K - 1)$$
$$(F(a, b)^*[\cos(2a + 1)i\pi]^*[\cos(2b + 1)j\pi]) \quad (4)$$

where, i=0,1,2,…., $K-1$,
  j=0,1,2,…., $K-1$ and $j=\sqrt{(-1)}$
  The IDCT is given by

$$f(a, b) = 1/K\, C(0, 0) + 1/(2K^{\wedge}3) \sum_{} (a = 0)^{\wedge}(L - 1) \sum_{} (b = 0)^{\wedge}(K - 1)$$
$$(f(a, b^*[\cos(2a + 1)i\pi]^*[\cos(2b + 1)j\pi]) \quad (5)$$

Many architectures in the watermarking phase have been found by DCT. In certain instances the DCT image coefficient has been applied to watermark coefficients [9] and [10] or other DCT inputs have been selected to be inserted. The DCT scope also contains [15] and [16] articles. Authors in [16] was checked on automated watermarking policies like LSB, DCT and DWT. These methods are applied and measured. The DWT-based algorithm [17] has recently been created. Nevertheless, they both suffer from a loss of imperceptibility, higher computing difficulty and time. Within this letter a modern video watermarking algorithm was introduced to address these drawbacks and increase protection standards. The algorithm suggested has been found to have much superior watermarking algorithms than previous models.

Wavelet analysis: This is a moving window system of different regions. Wavelet analysis enables us to use longer periods, low-frequency comprehensive and shorter areas where information on high frequency is needed (Fig. 1).

Some of the main benefits of wavelets is that it can evaluate the region locally from a wide-ranging signal. Find a slight discontinuity in the sinusoidal signal which is so low that it is hardly noticeable [18]. Throughout the modern world, this signal can easily be produced by a fluctuation of power or a noisy turn.

Fig. 1 CWT

3 Proposed Methods

3.1 Wavelet Domain

The wavelet is more main stream in sign handling applications. In the beginning we must disintegrate a video from a host into a variety of frames and then the edges into pictures. One edge would then be selected to mount the information after it has been connected and deteriorated three subtle components, one speculation, across four sub-bands. The guess-coefficients comprise fewer inputs (LL), and the higher precision knowledge (HL), vertical(LH), and corner-to-corner(HH) components is given by the implicit input-coefficients. The most prefered point of view for the wavelet transformation is its consistency with the HVS model portion in comparison to FFT or DCT. For the deployment phase are agreed on the suggested algorithm substrands LL and HH of the wavelet transition level 2 of the event. The accompanying Fig. 2 illustrates how the degradation and leisure tree works.

We anticipated utilizing low frequency substrips here in this document. Since the usage of watermarks in low substrates enhances the strength of different assaults, for instance, RST, distortion, Gaussian clamor, and middle filtering, rendering the design more fragile for shifting variations, gamma alteration, and histogram change. Implanting watermarks in high frequency subbands renders the watermark imperceptible and allows it safer against a range of threats when embedded in low frequencies.
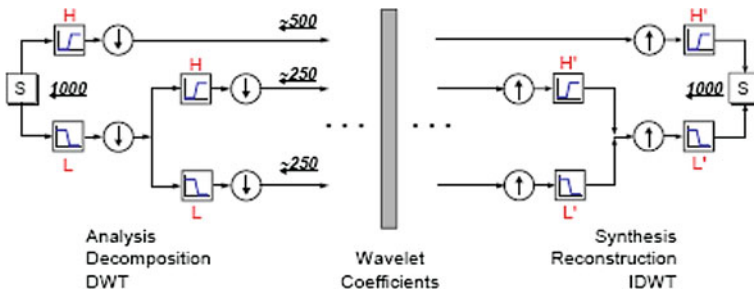

Fig. 2 Wavelet decomposition and reconstruction tree

3.2 Algorithms

Proposed watermarking consists two algorithms, those are

1. RGB image watermarking
2. RGB video watermarking

Both of them consists of embedding and extraction processes.

I. **RGB image Watermarking**

A. **Embedding Process**

Step 1: DW is included in the 4 subbands of Cover A: LSLS, HSLS, LSHS and HSHS Figure A.

Step 2: SVD applies to any image of the subband $M^n = P\_m^n \sum\_ m^n J\_m^n R n = 1, 2, 3, 4$ where k denotes LSLS, HSLS, LSHS, and HSHS bands, and $\lambda\_g^n, g = 1, \ldots n$ are the singular values of $\sum\_ m^m$

Step 3: Place the visual watermark on SVD: $P = P\_V \sum\_ V S\_P^R$ where $\lambda\_pg, g = 1, \ldots, n$ are the singular values of $\sum\_ P$

Step 4: Adjust the singular values of the cover picture for the singular values of the graphic watermark of each subband:

$$\lambda\_g^{\wedge}(*n) = \lambda\_g^n + \alpha\_n \lambda\_pg, g = 1, \ldots, i, \text{ and } n = 1, 2, 3, 4.$$

Step 5: Get the 4 sets of DWT coefficients changed:

$$M^{\wedge}(*n) = P\_m^n \sum\_ m^{\wedge}(n*)V\_m^n R, \ n = 1, 2, 3, 4$$

Step 6: To create a watermarked cover image add the reverse DW to the 4 sets of adjusted DW coefficients.

Extraction Process

Step 1: Decompose (and likely attack) picture A^* with a watermark on the DW into 4 subbands: LSLS, HSLS, LSHS and HSHS.

Step 2: Place the visual watermark on SVD: $M^{\wedge}(*n) = P\_m^n \sum\_ m^{\wedge}(*n)V\_m^n R, \ n = 1,2,3,4$, where n is, LSLS, HSLS, LSHS, and HSHS bands.

Step 3: Remove special values from any subband: $\lambda\_pg^n = (\lambda\_g^{\wedge}(*n) - \lambda\_g^n)/\alpha\_n, g = 1,\ldots, i$, and $n = 1,2,3,4$.

Step 4: Build the four visual watermarks with the same vectors: $P^{\wedge}n = R\_P \sum\_ P S\_P^R n = 1, 2, 3, 4$ (Fig. 3).
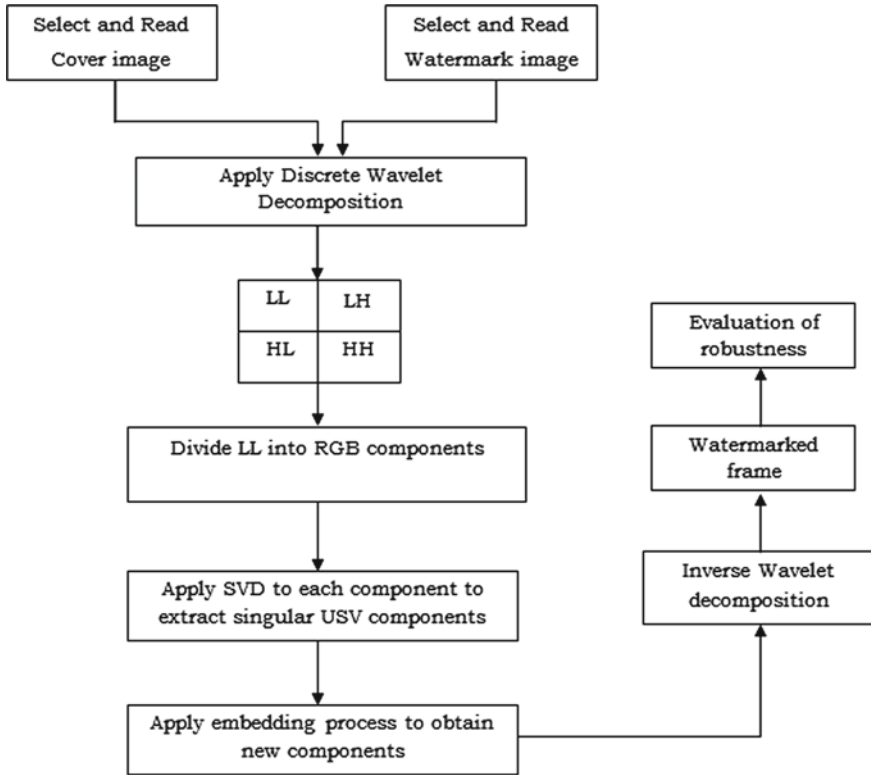
II. **Video Watermarking**

**Fig. 3** RGB image watermarking algorithm

Get video frames and camera frames This analysis work applies to video frame steganography. We are separating all the frames from the video until the subject is inserted in the camera frames. We receive video frames by means of a simple algorithm (Fig. 4).

It is very necessary to break the RGB picture into its elements, then continue the cycle, to obtain the very same RGB message picture. The picture of the notification shows us red, green and blue sections in gray scale (Fig. 5).
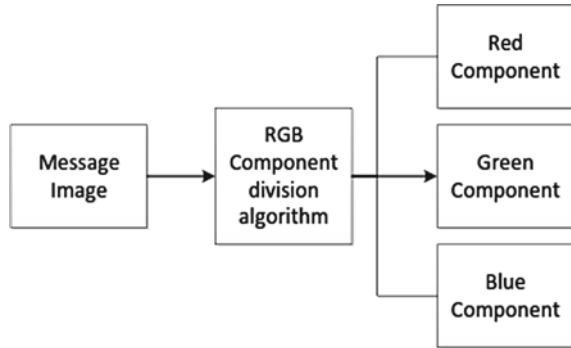
The proposed Decimated Wavelet (DW) and Singular Value Decomposition (SVD) based video watermarking embedding process on video frame is as follows:

Step 1: Select and read source video from the MATLAB current directory.

Fig. 4 Split video into frames
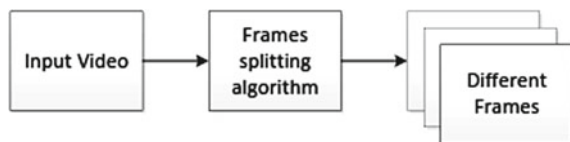
Fig. 5 RGB component of
input image

Step 2: Split the input watermarking video into number of frames and select a cover
frame in which we want to embed the message

Step 3: Select and read the watermark image

Step 4: With DW, the cover F is broken down into 4 sub-bands: LSLS, HSLS,
LSHS, and HSHS.

Step 5: SVD is applied for each surface $H^\wedge n\,Pm^\wedge n == 1.2, 3-4$ for every band
of LSLS, HSLS, LSHS, and HSHS bands $-g^\wedge n$, g=1,… i are the specific
values of ˆ $m^\wedge n$ SVD for every subface of the picture is applied, $H^\wedge n = P$
$m^\wedge n$ ˆ $m^\wedge n\,R\,m^\wedge nV\,n = 1,2,3,4$ for any subband of the band of the same
name, where k is LSLS, HSLS, LSHS and HSHS, and $\mu\,g^\wedge n$, g=1,…

Step 6: SVD is placed in watermark: $P = S\_P \sum\_ P J\_P^\wedge R$ where $\lambda\_pg, n =$
1,…, i are the singular values of $\sum\_ P$

Step 7: Adjust the identical picture values with a special watermark for each
subband values:

$$\lambda\_g^\wedge(*n) = \lambda\_g^\wedge n + \alpha\_n \lambda\_pg, g = 1, \ldots, i, \text{ and } n = 1, 2, 3, 4$$

Step 8: Get 4 DWT coefficient sets modified:

$$F^\wedge(*k) = U\_a^\wedge k \sum\_a^\wedge(*k) V\_a^\wedge kT, k = 1, 2, 3, 4.$$

Step 9: Apply the reverse DW to the watermarked cover image with 4 sets of
modified DW coefficients.

The proposed Decimated Wavelet (DW) and Singular Value Decomposition
(SVD) based video watermarking extraction process on watermarked video frame is
as follows:

Step 1: Read watermarked frame

Step 1: Using DW to decompose a designated $F*$ frame into 4 parts of subtrips:
LSLS, HSLS, LSHS and HSHS. DW is used for this function.

Step 2: Apply SVD on any image of the subband: $R^{\wedge}(n*) =$ $P\_m^{\wedge}n \sum \_m^{\wedge}(n*) P\_m^{\wedge}nR$, $n = 1,2,3,4$, where n is LSLS, HSLS, LSHS, and HSHS bands.

Step 3: The every subband is extracted into the singular values: $\lambda\_pg^{\wedge}n = (\lambda\_g^{\wedge}(*n) - \lambda\_g^{\wedge}n)/\alpha\_n$, $g = 1, \ldots, i$, and $n = 1, 2, 3, 4$.

Step 4: Build 4 visual watermarks with single vectors: $P^{\wedge}n = V\_P \sum \_PT\_P^{\wedge}R$ $n = 1, 2, 3, 4$(Fig. 6).
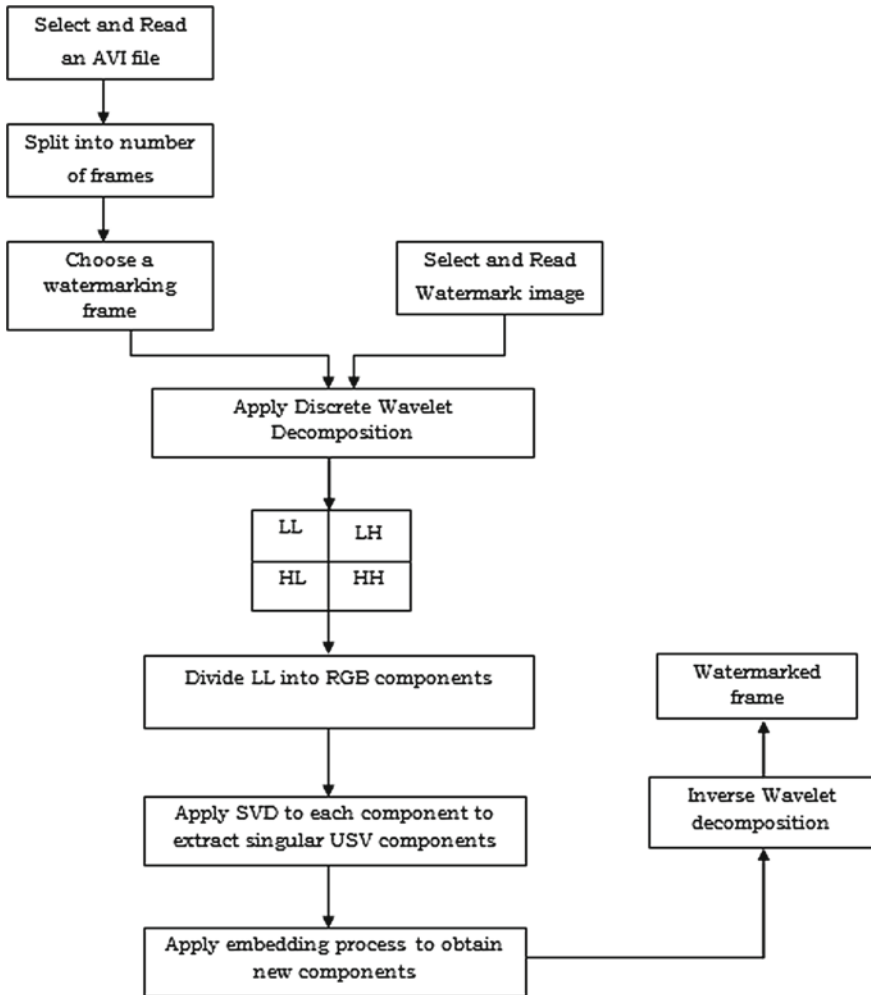

Fig. 6 Proposed video watermarking algorithm

4　Experimental Analysis

The MATLAB 2014 Update has conducted preliminary tests and evaluated various RGB photos and RGB recordings. They used the update 4GBRAM.Our proposed video watermarking algorithm has provided more security and robustness. We also compared the proposed quality metric algorithm with the current DWT method such as PSNR and SSIM. Figures 7 and 8 show that the embedding and extracted simulation results of DWT watermarking process.

Proposed RGB image watermarking outputs has shown in Fig. 9. We can see that the extracted watermark image is more robust and efficient than the DWT process

Fig. 7　a Cover image **b** watermark image **c** DWT decomposition of watermark image **d** watermarked image
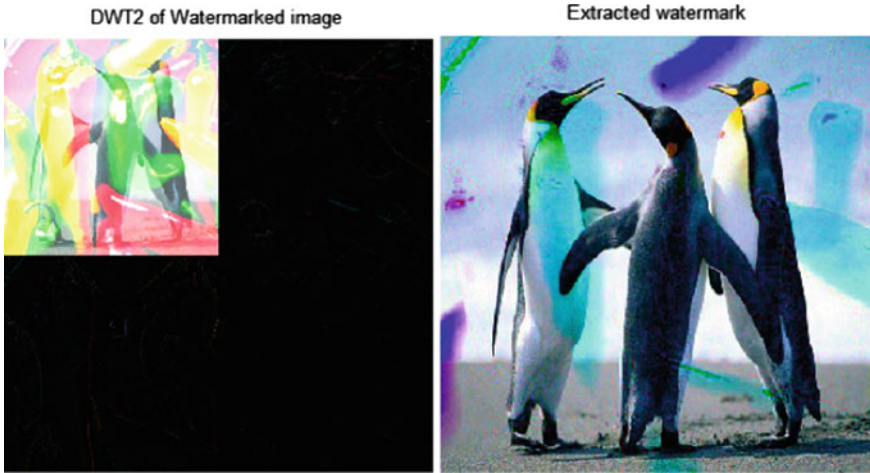
Fig. 8 Decomposition of watermarked image and extracted image

which has been shown in Fig. 9. Our new video watermarking approach has been shown in Fig. 10 and Figs. 11, 12.

5 Conclusion

In order to boost the reliability and stability of traditional watermarking algorithms, built for RGB images, a new encoding and decoding algorithm was suggested to be used for video marking in the wavelet transform domain. Simulation results suggest a higher performance than the traditional systems of the proposed algorithm. We had also measured the quality assessment of images (IQA) to improve the imperceptibility. We got higher imperceptibility for the proposed video watermarking also gained more PSNR value, which indicates that the higher perceptual quality of extracted watermark and watermarked image/frame.
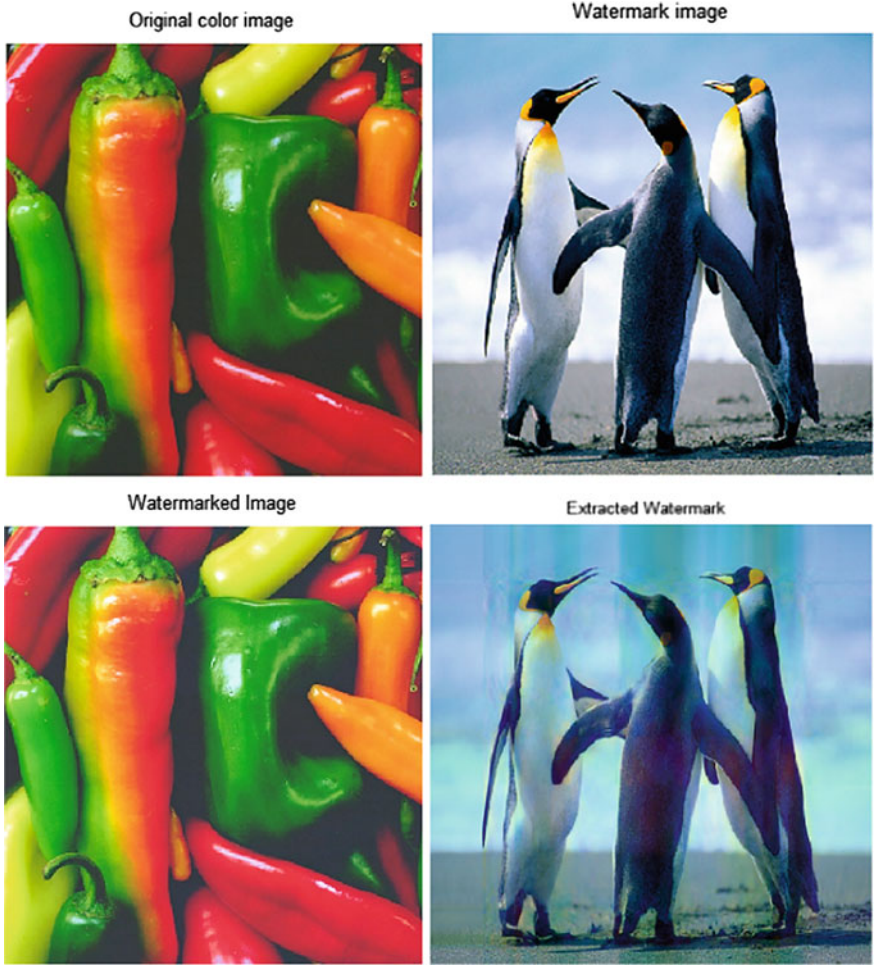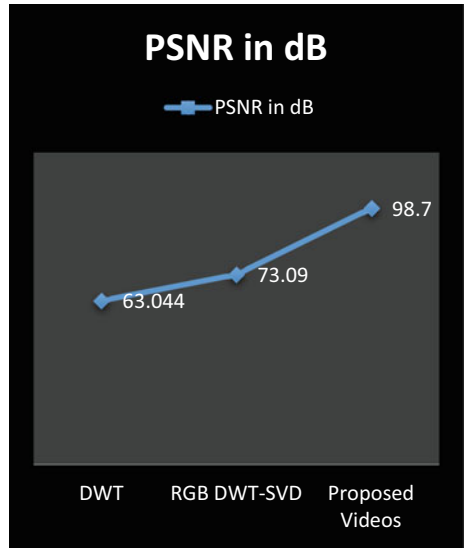
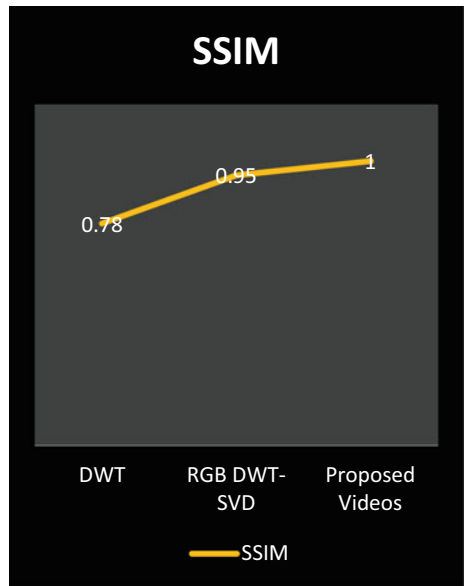**Fig. 9** Proposed RGB image watermarking results

Fig. 10 Proposed video watermarking **a** cover frame **b** watermark image **c** watermarked frame and extracted image

Fig. 11 Comparison of
PSNR values

Fig. 12 Comparison of
SSIM values

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