An improved Video Multiple Watermarking Techniques Based on Image Interlacing using three-level DWT

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Abstract - Video contents can be mentioned as the most valuable digital media, which are increasingly used illegally, resulting in a huge damage to filmmaking industry. Video watermarking is utilized for different video applications such as copyright protection, fingerprinting, broadcast monitoring, copy protection etc. In this paper, we have presented a video watermarking technique based on three levels DWT. In this work, YUV color space has been preferred over RGB color space as it increases the robustness of the algorithm. We also used Arnold transform to scramble the watermark content in order to increase security of the content. The algorithm has been tested using various types of attacks and robustness has been tested based on PS respect NR and NC parameters of the extracted watermark by comparing it with the original.

Keywords - *DWT, video watermarking, YUV color space, interlacing.*

I. INTRODUCTION

Digital watermarking [1] is the process of embedding information into digital media content, such that the information (i.e., the watermark) can later be extracted or detected for various purposes, including copyright protection and integrity verification. Digital media include anything presented in an aural or visual form (e.g., images, videos, and audios). Image watermarking has been widely studied over the past few years. Intuitively, a myriad of well-studied image watermarking techniques can be directly applied to videos because, in essence, a video is generated from a series of images shown in time sequence. However, such image processing techniques fail to address new issues arising from the additional temporal dimension of video media, such as the robustness against frame dropping and frame insertion attacks. Therefore, designing a good video watermarking scheme remains a challenge. With the widespread distribution of video media, video copyright protection based on watermarking technique has become an active area of research.

Existing video watermarking algorithms can be classified into three categories, namely, spatial domain methods [2], transform domain methods [3], and compressed domain methods [4]. In a spatial domain watermarking system, the watermark is embedded by directly modifying the pixel values in the original video. This kind of scheme is easy to implement and can achieve low computational complexity. In a transform domain watermarking system, the original video is represented in a transformed domain where the embedding is performed. The commonly used transforms include discrete cosine transform (DCT) [3], discrete wavelet transform (DWT) [5] [6], discrete Fourier transform (DFT) [7] [21], etc. In the transform domain, the watermark is dispersed throughout a video frame. This makes it more difficult to be removed. Furthermore, human perceptual characteristics can be fully exploited in the transform domain. Therefore, better robustness and imperceptibility can be achieved using transform domain methods compared with some of those spatial domain schemes. In a compressed domain watermarking system, the watermark is embedded during or after compression. This kind of scheme is more attractive for certain applications with real-time requirements, because most video media are distributed and stored in a compressed format. However, as demonstrated in [8], compressed domain watermarking schemes are bound to a specific video compression standard and may not survive the video format conversion attack. In contrast, transform domain watermarking techniques are not bound to any video compression standard and are expected to be more robust and practical.

II. LITERATURE REVIEW

Several typical video watermarking algorithms in the transform domain are briefly reviewed below. In [3], Sun et al. proposed a DCT-based video watermarking scheme, in which the watermark is embedded in the low frequency AC coefficients of DCT blocks. Good trade-off between imperceptibility and robustness is achieved by using the Watson's visual model to determine embedding intensity. In [9], Huang et al. proposed a video watermarking scheme based on pseudo-3-D DCT, in which the watermark is inserted by adjusting the correlation between DCT coefficients of selected blocks using a quantization index modulation (QIM) technique [10]. Due to the simplicity and good trade-off between embedding distortion and robustness, the QIM technique has become one of the best methods to embed data. The combination of pseudo-3-D DCT and QIM technique enables this scheme to effectively survive several attacks, such as filtering, luminance change, noise addition, and lossy compression. Other watermarking schemes in the DCT domain can be found in [999] [12]. In [5], Preda et al. proposed a watermarking scheme for video copyright protection in the DWT domain. Spread-spectrum and error correction code techniques are exploited to pre-process the watermark, which enhances the robustness of the scheme. In an improved version [6] of [5], an optimal quantization model based on the human visual system is used to replace the uniform quantization, resulting in better perceptual quality and higher resistance to video attacks. In [13], Li et al. proposed a video watermarking scheme based on a 3D wavelet transform, in which a spread spectrum watermark is adaptively added to the 3D wavelet coefficients of a video shot obtained using video segmentation. Later, a similar scheme [14] based on the 3D-DWT is given, in which a perceptual mask is used to make an efficient trade-off between robustness and imperceptibility. Some DWT-based watermarking schemes have also been reported in literature. In [21], Liu et al. proposed a video watermarking algorithm based on 1D-DFT and Radon transform, in which a watermark is embedded in frames with the highest temporal frequencies in the Radon transform domain. Strong robustness against video compression and geometric attacks is achieved by their scheme. In [7], another watermarking scheme based on 3D-DFT is presented, in which a perceptual model of an image in the DFT domain is designed and applied to video watermarking. Good performance with respect to imperceptibility is achieved by this scheme. The singular value decomposition (SVD) has two important features: (1) the singular values (SVs) with larger magnitudes can resist common image processing operations and geometric transforms, such as rotation, scaling, and translation; (2) small variations of SVs do not introduce noticeable distortion to the image. Therefore, some robust video watermarking schemes based on SVD have been proposed in literature. In [15], the watermark is embedded in the SVs obtained by performing SVD on a selected wavelet sub-band. Although the scheme can achieve good imperceptibility and strong robustness, it is non-blind, and the decoder needs the original video to extract the watermark. In [16], a blind SVDbased video watermarking scheme is proposed, in which SVD is applied to the AC coefficients located in the same position of each DCT block in a frame, and the watermark is embedded by modifying the relation of neighboring SVs. Strong robustness against MPEG2 compression, median filtering, small shift, and rotation attacks is achieved. In [17], Rajab et al. proposed a video watermarking scheme based on DWT and SVD techniques, in which the watermark is embedded by directly substituting the watermark bits for the least significant bits of the SVs, which are obtained by performing SVD on a selected wavelet sub-band. Later, a similar scheme [18] is proposed by Niu et al., in which SVD is applied to the coefficient frames obtained by first performing 2D-DWT on each frame of the original video and then computing 1D-DCT in the temporal direction. Finally, the watermark is embedded by directly substituting the most significant bits of the SVs with the watermark bits. The schemes proposed by Rajab et al. and Niu et al. can blindly extract the watermark and achieve good imperceptibility and robustness.

III. PROPOSED WORK

A. Methodology

During encoding process the cover video has been interlaced into four sub-videos. Out of four sub-videos, one video is used for embedding process and rest is kept as original. Embedding has been done on each frame of chosen sub-video in each R, G and B channel of the frames are first transformed to YUV color space and watermark is scrambled by Arnold transform. After that DWT has been applied on the video sub-frames as well as scrambled image following by alpha blending to carry out fusion. Next, IDWT was performed to reform the steno frames. This secure steno frame that keeps a secret image inside it is put in a matrix to make sub-video. Now this interlaced watermarked sub-video has been sent along with other sub-videos to any communication media. The alpha blending operation gives more security.

B. Watermark Embedding Algorithm

- Perform interlacing on original video frames and choose one sub-video out of four interlaced videos of original.
- Convert RGB frames into y, u, v color-space .Separate y, u, v channels of each frame of the chosen sub-video and perform the steps below
- Perform 2-D discrete wavelet transform (dwt) at level 3 of cover image
- Perform resizing of secret image to 64*64
- Apply Arnold transformation on secret image and get the scrambled secret image.
- Next extract the approximation co-efficient (LL2) and detail coefficient matrices LH2, LV2and LD2 of level 3 of the cover image.
- Apply alpha blending on cover image and secret image using horizontal detailed coefficient of cover image (LH2).
- Perform inverse discrete wavelet transform to form steno image.
- Perform de-interlacing to get the watermarked video and send through communication channel.

C. Watermark Extraction Algorithm

Extraction process is carried out in reverse way in which watermarked sub-video and one another sub-video from other three sub-videos are used. The steps performed in extraction process are briefed below.

- Perform interlacing on watermarked video frames and choose watermarked sub-video out of four interlaced videos of watermarked original video and separate R, G, B channels of each frame of the watermarked sub-video.
- Choose any single sub-video out of three non-watermarked sub-videos. And separate Y, U, V channels of each frame of this sub-video.
- Perform 2-D discrete wavelet transform (dwt) at level 3 of corresponding watermarked image and non-watermarked interlaced frames.
- Use alpha blending formula to extract the watermark using level three horizontal detailed coefficients of both frames.
- Apply inverse Arnold transformation on recovered watermark image and get the secret image.

D. Flow of Work

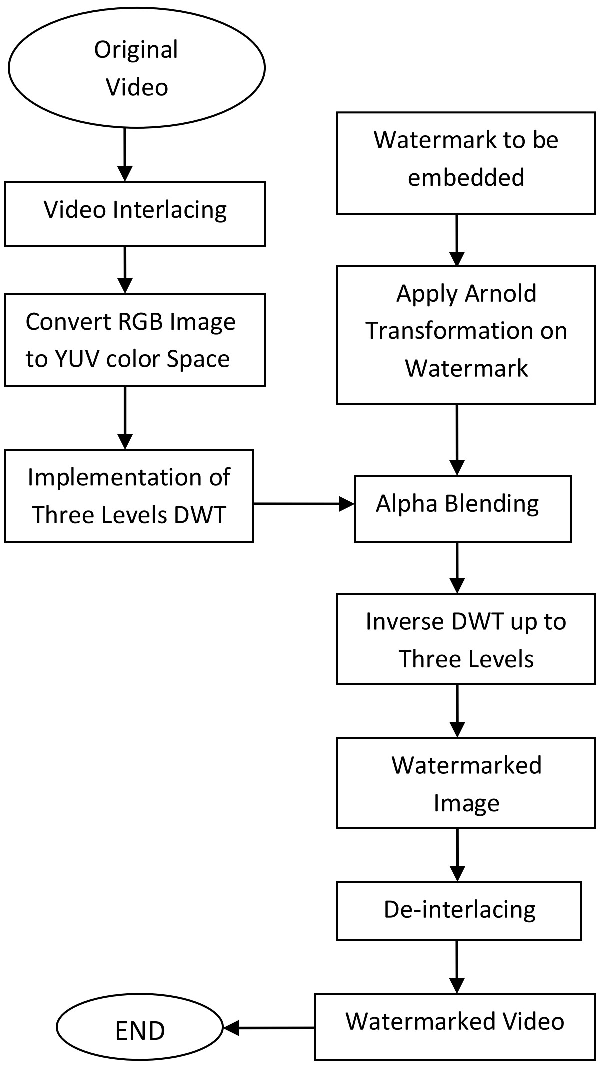

Fig.1: Flow of Work

IV. RESULTS AND EXPERIMENTS

In this we inserted various types of attacks on watermarked image and NC and PSNR has been calculated for different types of attacks. In this salt and paper attacks, Gaussian noise attack, contrast attacks, geometric attacks like rescaling, filtering attacks i.e. median filter etc. are applied on watermarked image and then watermark has been extracted from it. The effect of different attacks has been shown in terms of NC values. The table below shows the effect of each track on each video frame.

Table I: PSNR values at different attacks

PSNR	1	2	3	4	5	6	7	8	9
No attack	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf	Inf
JPEG compression	29.95	30.01	30.01	30.21	30.19	30.35	30.41	30.44	30.43
Median filter attack	22.21	22.27	22.34	22.37	22.44	22.51	22.52	22.57	22.60
Gaussian noise	25.56	25.60	25.66	25.70	25.75	25.86	25.83	25.87	25.93
Sharpening attack	21.09	21.15	21.18	21.34	21.46	21.55	21.56	21.64	21.69
Gamma attack	34.13	34.21	34.22	34.30	34.40	34.37	34.38	34.45	34.56
Contrast attack	19.18	19.58	19.63	19.65	19.69	19.71	19.68	19.73	19.78
Rescaling	18.04	18.08	18.12	18.14	18.19	18.23	18.24	18.26	18.29
Salt & peeper attack	28.94	29.01	29.01	29.08	29.20	29.29	29.29	29.34	29.34

Table II: NC values at different attacks

NC values	1	2	3	4	5	6	7	8	9
No attack	1	1	1	1	1	1	1	1	1
JPEG compression	0.964	0.956	0.967	0.969	0.971	0.9725	0.973	0.974	0.975
Median filter attack	0.966	0.967	0.969	0.970	0.971	0.973	0.974	0.975	0.975
Gaussian noise	0.958	0.959	0.962	0.963	0.066	0.968	0.979	0.969	0.970
Sharpening attack	0.967	0.969	0.970	0.971	0.973	0.974	0.975	0.975	0.976
Gamma attack	0.967	0.969	0.971	0.972	0.974	0.976	0.976	0.977	0.978
Contrast attack	0.883	0.886	0.889	0.891	0.895	0.899	0.901	0.903	0.903
Rescaling	0.962	0.964	0.966	0.967	0.969	0.971	0.972	0.973	0.973
Salt & peeper attack	0.967	0.968	0.970	0.972	0.973	0.975	0.976	0.977	0.977

V. RESULT ANALYSIS

Results in graphical form for NC are shown below for various attacks.

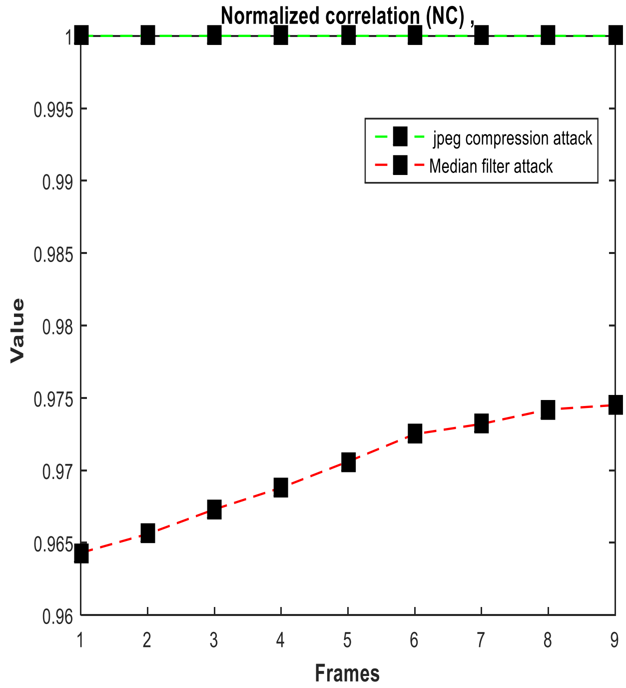

Fig.2: NC values (a) jpeg compression (b) median filtering attack

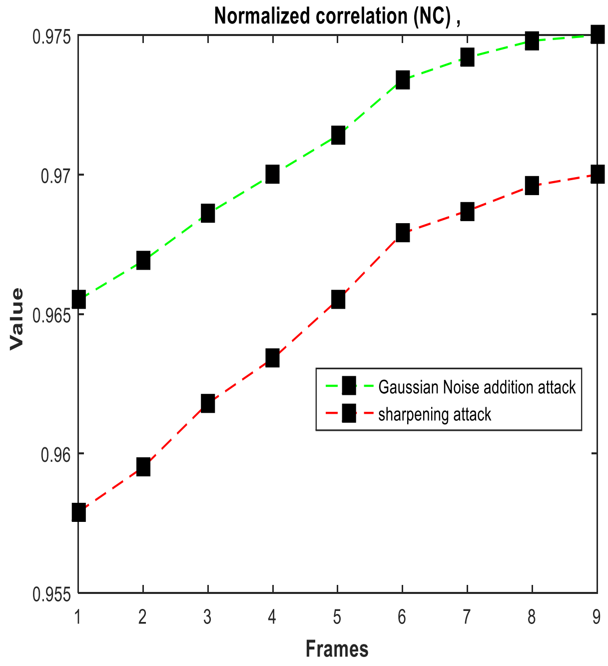

Fig.3: NC values (a) Gaussian Noise addition attack (b) sharpening attack

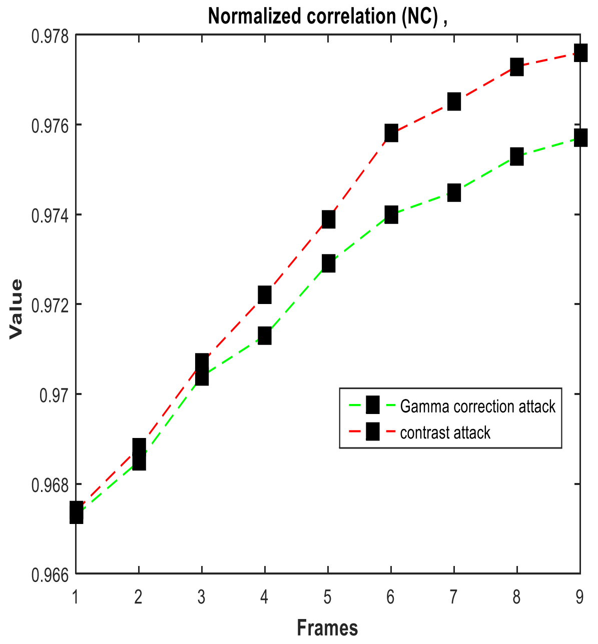

Fig.4: NC values (a) Gamma correction attack (b) contrast attack

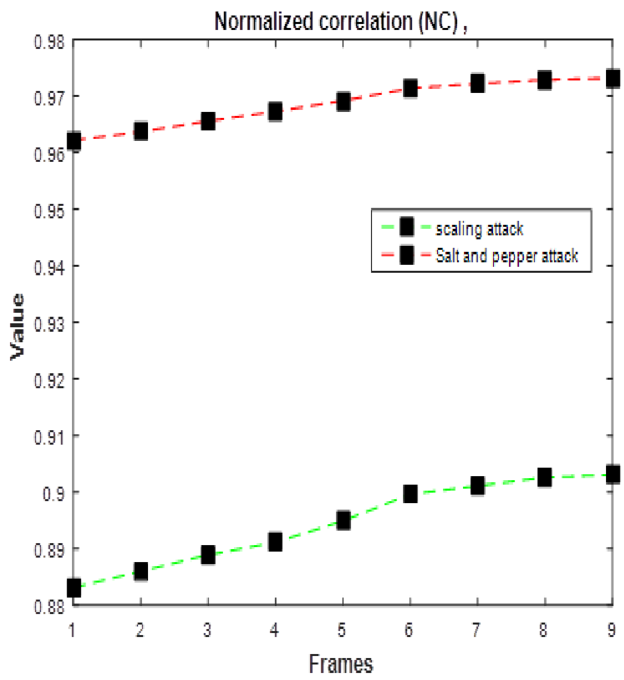

Fig.5: NC values (a) scaling attack (b) salt and pepper noise attack

VI. CONCLUSION AND FUTURE SCOPE

Video Watermarking is one of the most popular techniques among the various Watermarking techniques currently in use. This is because large amount occurrences of copyright infringement and abuse happen for video media. Video contents can be mentioned as the most valuable digital media, which are increasingly used illegally, resulting in a huge damage to filmmaking industry. Video watermarking is utilized for different video applications such as copyright protection, fingerprinting, broadcast monitoring, copy protection, etc. Distinct challenges have arisen in this field, as compared to image watermarking. Because of the more possibilities to perform the collusion attack on video streams, it is a main concern in designing video watermarking systems. In this work, we have proposed a YUV color space based video watermarking technique to effectively embed an image or video watermark in a video frames. As there is less bandwidth available for transmitting channel, first the video has been interlaced to produce four sub-videos and watermark has been inserted in one of the sub-video. In this, three-level DWT has been used for the video frames where alpha blending has been applied to insert DWT transformed watermark. For security purposes, watermark has been scrambled with Arnold transform before evaluating its DWT. And then inverse DWT has been applied to make a steno or watermarked image. Then signal is transferred through channel as sub-videos or by re-combining through de-interlacing depending upon channel bandwidth. In this we have inserted some noisy attacks to check the robustness of the proposed method with respect to attacks. Different attacks behave differently but overall the obtained watermark has acceptable perceptibility. In future other color spaces will be examined to increase the robustness of the algorithm from attacks. In this gray level watermark has been used for embedding. In future, color watermark can be used for embedding.

VII. REFERENCES

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