Middle-East Journal of Scientific Research 25 (5): 988-994, 2017
ISSN 1990-9233

DOI: 10.5829/idosi.mejsr.2017.988.994

CS and ABC Algorithm Based Video Watermarking Scheme Using Audio Watermark

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Abstract: An efficient video watermarking scheme is developed to embed the audio watermark based on optimal location to increase the robustness. The segmented video shots are partitioned addicted to number of frames for the embedding process. In this process, the PSNR values are calculated for each frames and select the best frame by using CS algorithm. The audio data is utilized as a watermark to embed into the digital video sequence. In watermarking embedding process, segmented video data is given to the discrete wavelet transform and the encrypted audio watermark data is embedded based on optimal location analysis that is carried out using ABC algorithm. Later, the original audio data is extracted from the watermarked video. The performance of video watermarking is analyzed in terms of various attacks.

Key words: Cuckoo Search (CS) Algorithm · Artificial Bee Colony (ABC) · Peak Signal-to-Noise Ratio (PSNR) · Normalized Correlation (NC)

INTRODUCTION

Video watermarking is relatively a recent technology that has been proposed to solve the problem of illegal manipulation and distribution of digital video. It is the process of embedding copyright information in video bit streams [1]. Need of video watermarking issue is increasing every year by year, at the same time the complexity and adjustability of the solution space for the watermarking of video is remarkably greater than that of images because of the existence of time dimension even though video streams in the raw form are ordered sets of image frames [2]. The illicit duplicating and evidence of ownership problems as well as manipulations detection have been addressed by several proposed robust and fragile video watermarking methods [3]. Several features are considered necessary not only in the watermarking process but also the watermark for digital watermarking of videos.

An attractive digital watermarking techniques are focused to protect the digital multimedia intellectual copyright protection and proposed a new algorithm for video watermarking due to the large amount of data and natural redundancy between the frames which are highly liable to pirate attacks containing frame dropping, frame swapping and statistical analysis for different scenes, different parts of the watermarks are used for making the scheme robust, besides the frame being statistical with frame averaging analysis. Simultaneously, an audio watermark is also including enhancing the robustness of the scheme. The Proposed approach is an innovative idea in embedding different parts of watermark according to the scene changes and in embedding its audio as a watermark although the algorithm is quite simple and the effectiveness of the scheme is verified.

A proficient video watermarking scheme is developed to embed the audio watermark based on optimal location. Prior to embed the audio watermark into the video, the video sequence is segmented into shots using discrete cosine transform. The segmented video shots are partitioned keen to quantity of frames for the embedding process. In this course, the PSNR value is considered for each frames and chosen the most excellent frame by using CS algorithm. The audio data is utilized as a watermark to embed addicted to the video sequence. Firstly, the audio data are changed into 9 bit sequence and subsequently, it is encrypted. In watermarking embedding process, segmented video data are specified to the discrete wavelets transform with the encrypted audio watermark data are embedded based on optimal location analysis that is conceded out using CS algorithm. Later, the unique audio data are extracted from the watermarked video using the intended watermarking extraction procedure. The presentation of video watermarking is analyzed in terms of various attacks.

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In the present work, now cuckoo search algorithm have been implemented due to the fact that numerous papers earlier studied are lagging behind this intelligent and hybrid concept. In this method video watermarking embedding process, the segmented video data are specified to the Discrete wavelet transform and the encrypted audio watermark data are embedding based on optimal location analysis are carried out using ABC algorithm. Consequently, the original audio data are extracted from the watermarked video using the considered watermarking extraction process.

Related Work: Mahesh R. Sanghavi *et al.* [4] proposed a robust scheme for digital video watermarking based on scrambling and then embedding the watermark into different parts of the source video according to its scene change. A.Essaouabi *et al.* [5] presented a novel video watermarking systems operating in the three-dimensional wavelet transform is here presented. Specifically, the video sequence is partitioned into spatio-temporal units and the single shots are projected onto the 3D wavelet domain. First a gray- scale watermark image is decomposed into a series of bit planes that are preprocessed with a random location matrix. Then, the preprocessed bit planes are adaptively spread spectrum and added in 3D wavelet coefficients of the video shot. Reyes R. *et al.* [6] presented a public video watermarking algorithm, the robustness of which relies on the embedding energy. A visibly identifiable binary pattern, such as owner's logotype has been embedded by their proposed algorithm. After separating the video sequences into distinct scenes, the scene blocks have been selected at random and the binary watermark pattern has been embedded into their Discrete Wavelet Transform (DWT) domain.

A video watermarking scheme based on wavelet decomposition in which the watermark is embedded in the randomly selected frames is presented in [7]. Blue channel of the frames has been chosen for embedding. Watermark is embedded in mid-frequency component in order to make it robust against the low-frequency attack. Mahesh R. Sanghavi *et al.* [8] presented a Fibonacci series based embedding of a watermark in frames of the video. Fibonacci series based watermarking method proves to be the most suitable alternative for key-frame based watermarking scheme. Puja Agrawal *et al.* [9] developed a digital video watermarking scheme that can embed invisible and robust watermark information into the video streams of MPEG-1, MPEG-2, H.264/AVC, MPEG-4 standards. Trade off between transparency and robustness is considered as optimization problem and is solved by Genetic Algorithm - Particle Swarm Optimization (GA-PSO) based hybrid optimization technique. M. undararajan *et al.* [10] developed a video watermarking scheme to embed audio watermark based on optimal location using CS algorithm. The input video is segmented into shots using discrete cosine transform before embedding the audio watermark. The present work is motivated by a number of existing works available in the literature to improve the efficacy of the watermarking methods.

Proposed Video Waterking Scheme

Video Watermarking Algorithm to Embed Audio Watermark based on Optimal Location:

Earlier than embed the watermark into the digital video sequences, the following process should carry out to improve the security of the hiding information as well as to extend the efficiency of projected technique. The process gives the following:

- Shot segmentation process of input video sequence
- 9-bit plane conversion of message audio data
- Decomposition of Audio using discrete wavelet transform
- Finding frames sing CS algorithm
- Finding locations for embedding the watermark audio using ABC algorithm

9-Bit Plane Conversions of Message Audio Datal: The audio data are used as a watermark to embed into the digital video sequence. Initially, the audio data (.wave file) are transformed into 9 bit sequence and subsequently it is encrypted. Fig. 1 shows a 9 bits conversion process.

The 9 bit conversion process is concerned in following steps:

Firstly, the audio file (wave file) is converting it into decimal to binary format. The audio file contains 8 bits (0's and 1's).

The primary aim in this section is 9 bits conversion. So, first 8-bit is generated based same binary format and 9^{th} bit (sign bit) is generated based on the .wave file. If it is positive means have to put 1 else put zero.

Decomposition of Shot Segmented Video Using Discrete Wavelet Transform: Here, we have used coif lets wavelet transform for this purpose that decomposed the video into four sub-bands such as HH, HL, LH and LL. Normally, the Discrete wavelet transform is an orthogonal multiresolution wavelet transform, hence it has scaling functions with vanishing moments. For that reason, the wavelet function can be defined at scale p and location q as:

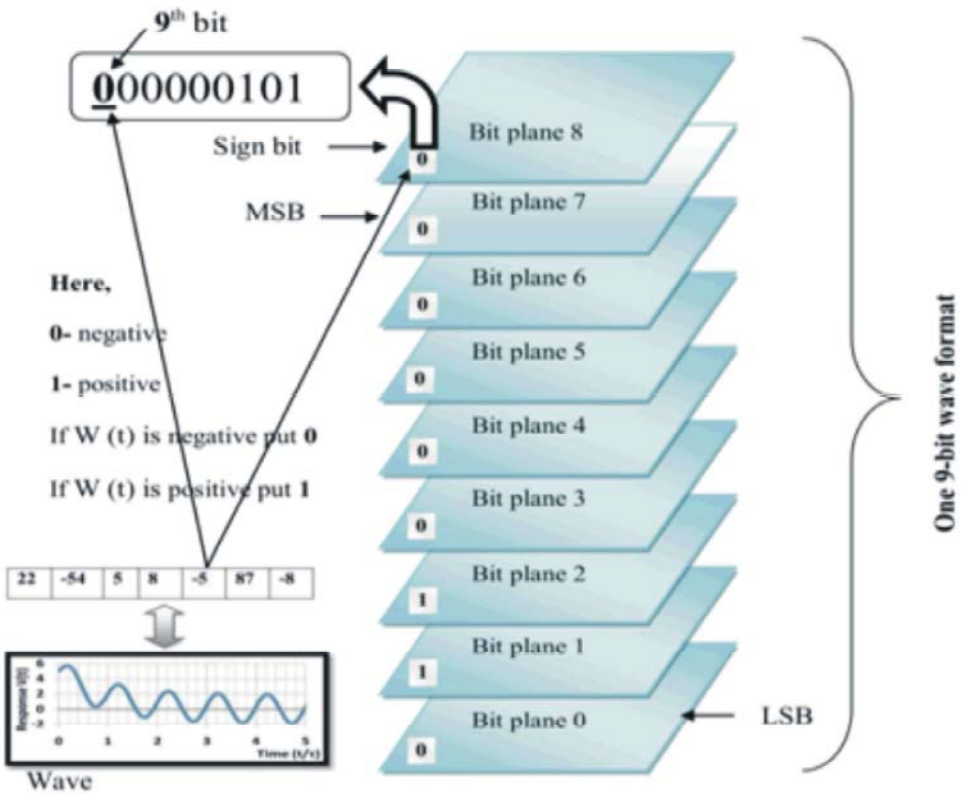

Fig. A 9-Bit Plane Conversion Process

$$\psi_{p,q}(t) = \frac{1}{\sqrt{a_0^m}} \psi \left[\frac{t - nb_0 a_0}{a_0^m} \right] \quad (1)$$

where, ψ is the mother wavelet, a_0 is the fixed dilation parameter and b_0 is the location parameter.

Finding Optimal Locations for Embedding the Audio Watermark using ABC Algorithm: In this module, the frame and location where the embedding has to take place is found out by the use of Artificial Bee Colony. The ABC is motivated by the intelligent behavior of honey bees and uses control parameters such as colony volume and maximum cycle number. The ABC as an optimization means provides a population-based search procedure in which individuals called foods positions are tailored by the artificial bees with time and the bee's aim is to discover the places of food sources with elevated nectar amount and finally the lone with the utmost nectar. The ABC algorithm consists of employed bees, onlookers and the scouts. A bee for the future on the dance area for making a decision to decide a food source is called onlooker and lone going to the food source visited by it prior to be named employed bee. Further the kind of bee is scout bee that carries out arbitrary search for new sources. The position of a food source represents a probable solution to the optimization problem and the nectar amount of a food source corresponds to the superiority (fitness) of the associated solution. In ABC system, the artificial bees fly in the order of in a multidimensional search space and some choose food sources depending on the skill of themselves and their nest mates and adjust their positions. Some (scouts) fly and choose the food sources randomly without using knowledge.

Fitness Function Evaluation: For every colony, in the population set, the watermark embedding and extraction process is repeated with respect to the locations defined in the colony. Here, the location of embedding is identified by the bit 1 placed in the colony and the embedding and extraction process is carried out using the procedure. The fitness function of the ABC which composed of PSNR along with the similarity measure of NC value is computed. The fitness value computes with the aid of the following formula.

$$Fitness = PSNR + NC \quad (2)$$

Here, we have considered the PSNR and the NC values for computing the fitness of colony. The ultimate aim of the proposed scheme is to maximize the PSNR and the NC value so that the watermarked image will have the perceptual quality and the extracted watermark signifies the original information embedded in the cover image. According to that, we have incorporated the 'perceptual quality-dependent parameter' and the 'extracting accurate information from the embedded data-dependent parameter' in the fitness function that will automatically improve the perceptual quality without distressing the hided information.

Frame Selection Based on Cuckoo Search (CS) Algorithm: We utilize the cuckoo search algorithm in order to search for optimal steps, in order to optimize together the quality of watermarked image with robustness of the watermark image. Cuckoo Search algorithm is applied in the watermark embedding with the watermark extracting processes for the optimization process. The evaluation function of this process is computed with PSNR and NC that relate to both imperceptibility and robustness of a watermark. A high quality extracted watermark image and robust watermark is achieved.

Generation of Nest: To select the optimal location or best solution, initially, the cuckoo search algorithm chooses the number of nest N_k. Consequently, it assigns dimension to every nest (N_i) randomly named as X_1 and X_2. Here, X_1 have sound wave values and X_2 with number of frames. The sound wave consists of 9 bit format (0 and 1) and the information of frames is based on the input videos. Table 1 depicts the initial nest generation process.

Calculation of Fitness: The fitness value of the every nest helps to find the finest nest amongst the set of available nest. We have to concatenate those X_1 and X_2 and consequent PSNR with NC value seeing that fitness value to cuckoo search algorithm. To calculate the fitness of each nest, initially, the Cuckoo Search algorithm calculates the Peak Signal to Noise Ratio and Normalized Correlation for find the initial fitness of the nest.

Table 1: Nest Generation Process

Nest	X1	X2
N_1	Sound Wave	No. of Frames
N_2	Sound Wave	No. of Frames
⋮	Sound Wave	No. of Frames
N_{k-1}	Sound Wave	No. of Frames
N_k	Sound Wave	No. of Frames

The structural design of the proposed video watermarking method is given in Fig. 2.

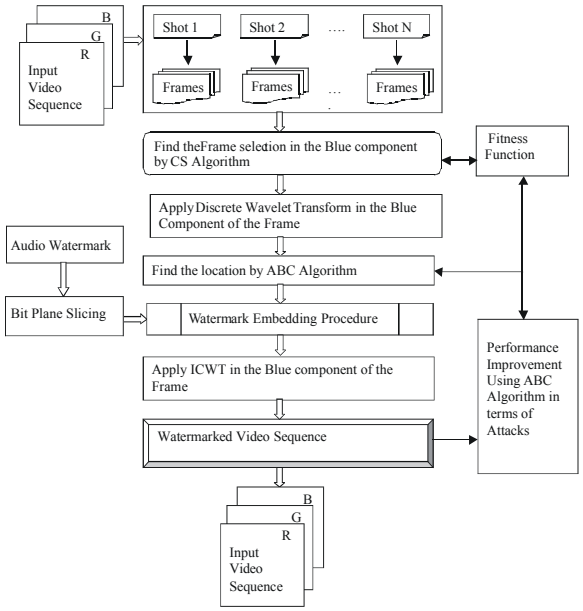

Fig. 2: Structural Design of Color Video Watermarking

Watermark Embedding Process:

Step 1: The input video sequence is segmented addicted to number of non-overlapping shots and then converted into Frames

Step 2: Slice the watermark audio divided into 9 bit planes by means of bit plane slicing.

Step 3: The blue components of all the separated frames are extracted in the selected frame using CS Algorithm.

Step 4: Decay the blue components of each partitioned frame into four sub-bands with the Discrete wavelet transform

Step 5: Find the similarity matrix of the video to embed into the chosen sub-bands. The superior part of the similitude matrix in the HL sub-band and the lesser part of the similarity matrix in the LH sub-band.

Step 6: Compute the fitness function of each possible location the ABC Algorithm that is composed of the PSNR and NC values.

Step 7: The maximum value of PSNR in consequent locations and find the finest nest and embed.

Step 8: Embed the watermark bits 0 or 1 in a zig-zag manner in the chosen embedding part, since the watermark is the audio. There are two watermark audio bits;

Case 1: For Embedding the Watermark bit '1'.

$$\begin{aligned}&if\ E_{p(i)} > 1\ then\\&E_p[x,y] << Abs\,[E_{p(i)}]\\&else E_p[x,y] << E_{p(i)} + \max(E_p)\\&end\ \ if\end{aligned}$$

Case 2: For Embedding the Watermark bit '0'.

$$\begin{aligned}&if\ E_{p(i)} < 0\ then\\&E_p[x,y] << Abs\,[E_{p(i)}]\\&else E_p[x,y] << E_{p(i)} - \max(E_p)\\&end\ \ if\end{aligned}$$

Step 9: Renew the nest with levy flights to find optimal solution using following equations.

$$Y_i^{t+1} = Y_i^t + \alpha \oplus Levy(\lambda)$$

$$Levy(u) = t^{-\lambda},\ 1 < \lambda \le 3$$

where λ, is levy flight parameter, *u* is the local mean flow velocity (m/s)

Step 10: Likewise, the lower part of the similitude matrix in the LH sub-band. Also, each audio is embedded into all the frames of every shot.

Step 11: Allow partition to all the embedded frames by means of the embedding strength to get better the quality of the video.

Step 12: Position the adapted sub-bands and relate the inverse discrete wavelet transform to achieve the watermarked video sequence.

Watermark Extraction Process: After embedding the watermark audio into the video sequence, it includes the extracted, embedded watermark audio message devoid of distressing the video.

Step 1: The input video sequence is segmented addicted to number of non-overlapping shots. It identifies the number of frames.

Step 2: The blue components of all the partitioned frames are extracted. Calculate the PSNR of the blue components of each frame

Step 3: The blue components of the frames with the aid of the discrete wavelet transform into four sub-bands.

Step 4: The low frequency sub-bands from the altered frames are selected.

Step 5: Extract the watermark bits from the embedding part in a zig-zag manner as of the HL and the LH sub-bands with the aid of the subsequent steps. If the embedded bit value is better than the fitness value, the extracted pixel value is one. If it is less significant, then the extracted pixel is zero.

Step 6: Structure the matrix with the dimension of the watermark image and the extracted bits are positioned in it to attain the watermark audio.

Step 7: By applying the repeal process of bit plane slicing, the watermark audio is obtained.

RESULTS AND DISCUSSION

The simulation results are carried out with various video sequences and the audio message as the information. The technique effectively embedded the watermark audio message into the original video sequence and extracted it rear as of the watermarked video sequence. The watermarked video sequences possess better PSNR and visual superiority for audio message. The visual quality is evaluated by the PSNR measure between the original video sequences and the watermarked video and the extracting fidelity is compared by the NC value between the watermark audio and the extracted watermark audio. The applicability of the proposed technique is established by the result obtained.

Simulation Results: The simulation results and the evaluation results of four video samples such as Akiyo, Claire, Football, Hall and its extracted Watermark audio message are shown in Fig. 3.

The PSNR and NC values for the four video sequences such as Akiyo, Claire, Football and Hall are given in Table 2. Table 3 shows the run time for four video sequences.

On comparing the performance evaluation of the PSNR and the NC of the proposed scheme with existing method [9], the proposed scheme outperforms the existing method. The results are tabulated in Table 4.

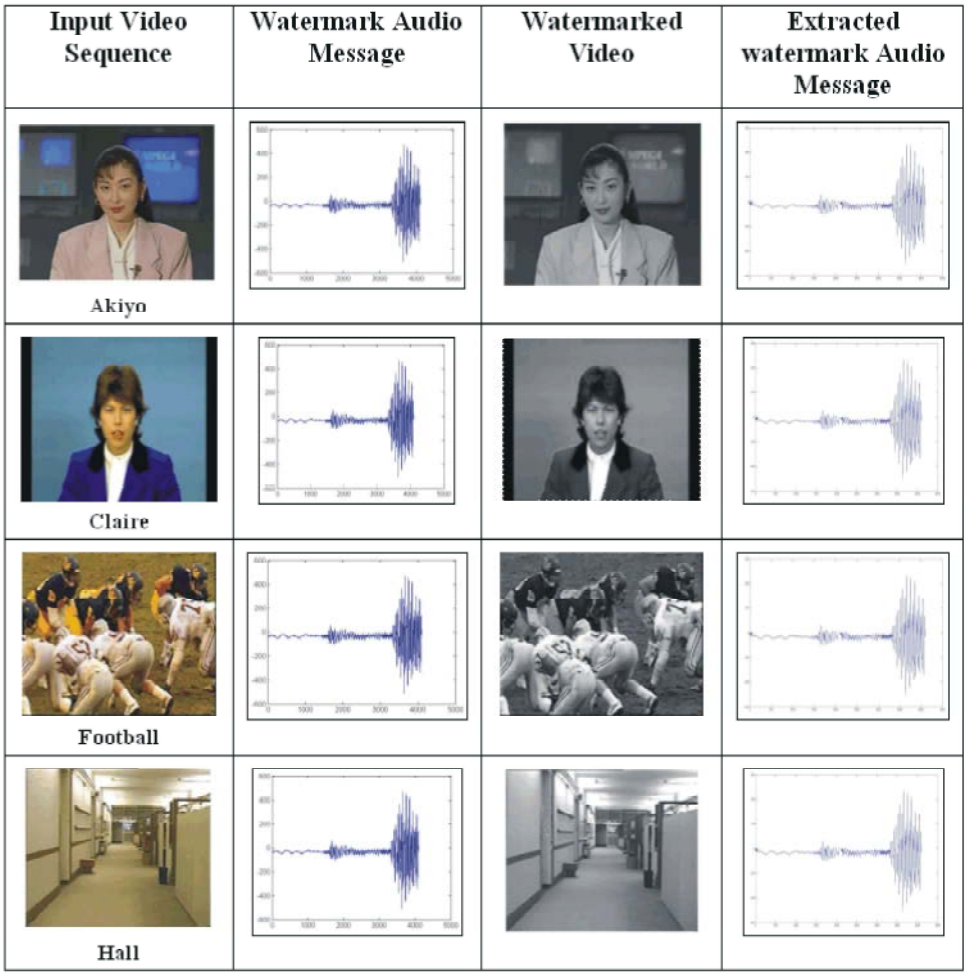

Fig. 3: Samples of Video Sequences with its Extracted Audio Watermark

Table 2: PSNR and NC for Four Video Sequences

		Embedding Strength = 1		Embedding Strength = 5		Embedding Strength = 10	
Video Sequence	Frames	PSNR (dB)	NC	PSNR (dB)	NC	PSNR (dB)	NC
Akiyo	20	46.07	0.9946	42.33	0.9801	39.74	0.9812
	40	46.10	0.9834	42.31	0.9716	38.30	0.9710
	60	42.59	09839	41.99	0.9684	37.47	09697
	80	41.90	0.9922	40.97	0.9787	36.89	0.9484
Claire	20	44.93	0.9687	43.27	0.9846	40.94	0.9637
	40	43.19	0.9541	41.63	0.9890	39.11	0.9440
	60	42.07	0.9654	40.41	0.9821	38.56	0.9512
	80	41.74	0.9407	40.85	0.9838	37.91	0.9301
Football	20	39.84	0.9759	36.02	0.9527	36.10	0.9648
	40	38.07	0.9528	38.67	0.9533	35.80	0.9428
	60	37.78	0.9484	34.57	0.9552	34.83	0.9394
	80	36.30	0.9395	35.95	0.9532	34.62	0.9599
Hall	20	35.22	0.9592	37.18	0.9773	37.10	0.9469
	40	35.80	0.9599	36.92	0.9560	37.25	0.9354
	60	35.65	0.9552	35.34	0.9452	35.62	0.9588
	80	35.93	0.9631	34.34	0.9357	33.88	0.9279

Table 3: Run Time

	Run Time (s)			
No. of Iterations	Akiyo Video	Claire Video	Football Video	Hall Video
0	22	24	25	27
25	27	28	31	29
50	56	56	59	59
100	107	109	112	114

Table 4: Performance Analysis of PSNR and NC for Various Attacks

		Puja Agrawal Existing [9]	Proposed	Puja Agrawal Existing [9]	Proposed
Video Sequence	Attacks	PSNR (dB)		NC	
Akiyo	Without Attacks	35.5613	45.1023	0.9920	0.9921
	Salt and Pepper (.001)	35.3612	43.9863	0.9865	0.9887
	Salt and Pepper (0 .02)	35.3609	42.9402	0.9865	0.9876
	Cropping	35.4617	43.9703	0.9898	0.9911
	Rotate (90)	35.4617	42.9621	0.9898	0.9903
	Rotate (180)	35.5222	43.9402	0.9881	0.9895
	Rotate (270)	35.5271	44.7943	0.9889	0.9897
Claire	Without Attacks	32.9895	44.2107	0.9675	0.9853
	Salt and Pepper (.001)	32.9889	43.9124	0.9675	0.9823
	Salt and Pepper (0 .02)	32.9889	42.8765.	0.9726	0.9812
	Cropping	32.9895	41.8714	0.9726	0.9887
	Rotate (90)	32.9486	41.8472	0.9509	0.9845
	Rotate (180)	32.9628	41.8120	0.9288	0.9721
	Rotate (270)	32.9474	40.8023	0.9253	0.9453

CONCLUSION

In this paper, a video watermarking technique to embed audio watermark based on ABC and CS algorithm is presented. The proposed approach is robust against widespread geometrical attacks. This proposed watermarking scheme can further be associated with diverse applications to achieve a refined system and the fidelity can be improved by applying CS and ABC algorithm. The scheme can be improved by making use of the information from the video, such as instant information, to enhance the robustness of the watermark.

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