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Video Watermarking using Genetic Algorithm

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***Abstract*—Digital video watermarking is a technique which allows an individual to add hidden copyright notices or other verification messages to a particular video. The video with hidden information stored in it is known as watermarked video. Ideally, a user viewing the video cannot perceive a difference between the original, unmarked video and the marked video, but a watermark extraction application can read the watermark and obtain the embedded information. In this paper, to solve the authentication problem, an effective and secure blind video watermarking algorithm is proposed. The performance of algorithm is tested using MATLAB Software. The experimental results show that the proposed scheme is highly imperceptible, less time consuming, more secure and highly robust against frame dropping & other manipulations.**

Keywords— Video Watermarking; Entropy; PSNR; MSE; BER.

I. INTRODUCTION

Image is an artifact that depicts visual perception. These may be two-dimensional, such as a photograph, screen display, and as well as a three-dimensional, such as a statue or hologram. A digital image is a numeric representation (normally binary) of a two-dimensional image. Depending on whether the image resolution is fixed, it may be of vector or raster type. By itself, the term "digital image" usually refers to raster images or bitmapped images. In earlier days, one would require a, great level of expertise to duplicate images and it was very rare that counterfeit would exactly resemble the original. However, in today's digital world it is much easier to duplicate images. Watermarking is an important tool to solve problem of illegal manipulation, distribution and piracy of digital data. Video watermarking is the process of embedding copyright information in video bit streams. The important information to be embedded is known as Watermark. It can either be some text or an image. Digital watermarks can be categorized into two forms: Visible watermark and Invisible or Hidden watermark. It is very important for Watermarking Algorithm to be imperceptible and robust in nature means embedding of watermark and different signal processing operations should not affect the quality of original digital data [1].

II. PROBLEM STATEMENT

A large number of watermark techniques are utilized to maintain the copyright. Main goals to be achieved while designing a watermarking scheme are: better robustness (watermark strength) and higher fidelity (media quality index) [1, 2].

In this paper GA (Genetic Algorithm) is employed to improve both robustness and fidelity of watermarking scheme which is used for embedding secret information in a particular video.

GA is a heuristic search technique for determining the global maximum/minimum solutions for problems in the area of evolutionary computation. Any optimization problem is modeled in GA by defining the chromosomal representation, fitness function, and application of the GA operators [3,4]. GA process is initialized by randomly selecting genes in first generation, called population. Each individual in the population corresponding to a solution in the problem is called chromosome, which consists of finite length strings. Fitness function evaluates the quality of each chromosome in the population. Chromosomes that possess good quality are said to be fit and they survive and form a new population of the next generation [2, 3]. After watermarking the frames, these frames need to be placed to their respective places in the original video. To extract the watermark from watermarked frames again same encryption key is required to find the watermarked frames. In this paper GA is applied to the frame -based video watermarking scheme, because of which the watermarked video quality is improved while still keeping the robustness of the watermark against image manipulation.

III. THEORETICAL BACKGROUND

The proposed work requires certain theoretical considerations and important performance measures in its implementation. The following sections contain a brief description of these concepts.

A. Entropy

Entropy is an important parameter to measure the texture content of an image or a video. This texture content includes smoothness, coarseness and regularity of that particular image or video. The part of an image with higher entropy will be less visible to humans because human eyes are insensitive to higher entropy regions. Thus, if a watermark is embedded into a region with higher entropy value, then higher imperceptibility will be obtained, which is required in a watermarking scheme. Let P contains histogram counts, then entropy, E is given as:

$$E = -\sum P \log_2(P) \qquad (1)$$

B. Performance Measures

1) *Mean Squared Error (MSE):* To measure the similarity between the original video frame and watermarked frame an error signal is computed by subtracting the watermarked frame from the original frame, and then computing the average energy of the error signal. The MSE is given by equation

$$MSE = \frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}(x(i,j) - y(i,j))^2 \qquad (2)$$

Where x(i, j) is represents the pixel values of original video frame and y(i, j) represents the corresponding pixel values of watermarked frame and i and j are the pixel position of the M×N image.
MSE is zero when x(i, j) = y(i, j).

2) *Peak Signal to Noise Ratio (PSNR):*The PSNR is evaluated in decibels (dB) and is inversely proportional the Mean Squared Error. It is given as

$$PSNR = 10log_{10}\frac{255}{\sqrt{MSE}} \qquad (3)$$

Higher the value of PSNR better is the quality of the watermarked frame.

3) *Bit Error Rate (BER):* BER is the reciprocal of the PSNR.

$$BER = \frac{1}{PSNR} \qquad (4)$$

The value of BER which is closer to zero represents more quality of the watermarked frame.

4) *Security:* Security describes if the embedded watermarking information cannot be removed beyond reliable detection.

5) *Complexity:* Complexity describes the effort and time that is required for watermark embedding and retrieval video. Another aspect addresses if we need the original data in the retrieval process or not i.e. the watermarking algorithm is non-blind or blind which influence the complexity.

6) *Capacity/Payload:* It indicates the total number of Information bits that can be embedded through a watermarking scheme.

7) Robustness: It describes if the watermark can be reliably extracted from the watermarked video.[3] In actual robustness of a watermarking algorithm is a measure of the immunity or resistance of the watermark against attempts to remove or degrade it from the video manipulations by different types of digital signal processing attacks

IV. PROPOSED ALGORITHEM

In this paper entropy concept is used for embedding watermark (Fig. 1). Algorithms for embedding and extraction if a watermark in a particular video are given below in detail

A. Watermark Embedding Algorithm

Step 1: At first select the video.
Step 2: Then, calculate the entropy of the video.
Step 3: After this, select the specific frame with the high entropy.
Step 4: Then Extract the frame, after selecting frame with high entropy.
Step 5: Now, Block division will take place.
Step 6: During this process watermark selection is done simultaneously.
Step 7: Although preprocessing of watermark is also done.
Step 8: Therefore, similarly as above in case of frame, here also division of blocks will take place.
Step 9: Now, both of the divided blocks will serve as input to the Genetic optimization for best block selection to replace in original video.
Step 10: After this fitness value is calculated from the inputs.
Step 11: Thereafter, condition is applied to check whether it is satisfied or not.
Step 12: If, yes then, save the population and create the video.
Step 13: If not then update the population with the G.A. optimization again.

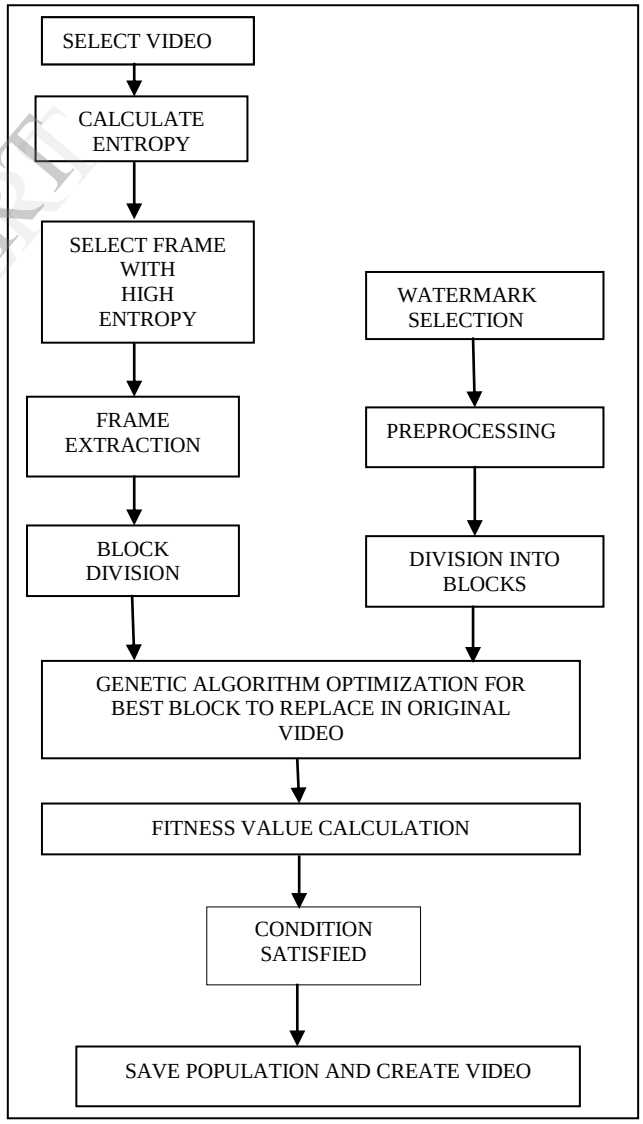


Fig 1: Flowchart of Proposed Algorithm

V. PERFORMANCE EVALUATION

MATLAB 7.10.0 is used as the platform for implementing the proposed work & conducting experiments. The performance of the proposed video watermarking algorithm is evaluated using many colored videos containing different number of frames at various frame rates. But here results are discussed for a 6 seconds video clip of "what is engineering" at a frame rate of 15fps. The watermark used in this was a binary image of 1024 X 768 (Fig. 2).

(a) (b) (c)

Fig. 2. (a) Original Video Frame, (b) Watermark Image & (c) Watermarked Frame

A. Imperceptibility performance:

To prove the proposed algorithm imperceptible, as a measure of quality of the watermarked video Mean Squared Error (MSE), Peak Signal to Noise Ratio (PSNR) and Bit Error Rate (BER) of watermarked frame and of watermarked video which includes that watermarked frame is calculated and represented in form of graphs (Fig. 3-9).

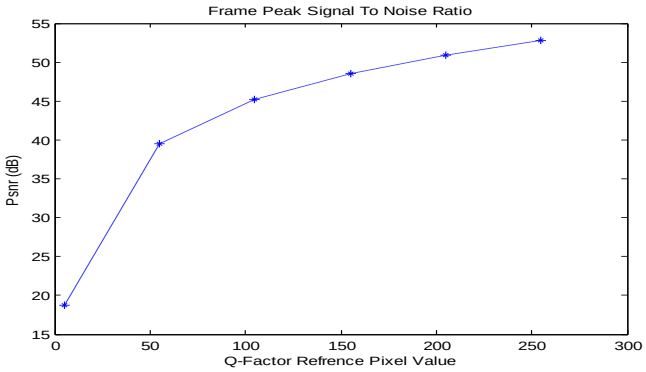


Fig. 3. PSNR values of watermarked frame

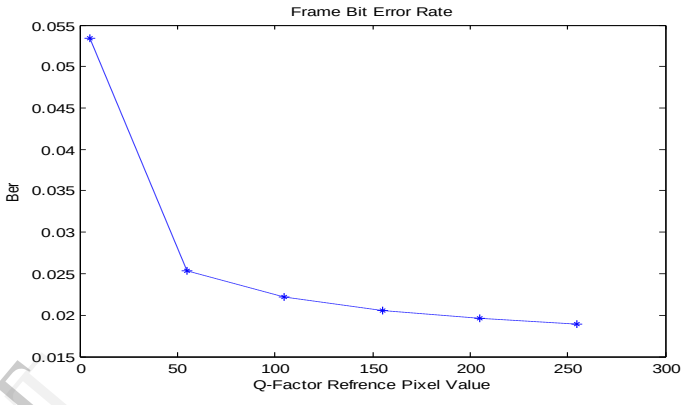


Fig. 4. BER values of watermarked frame

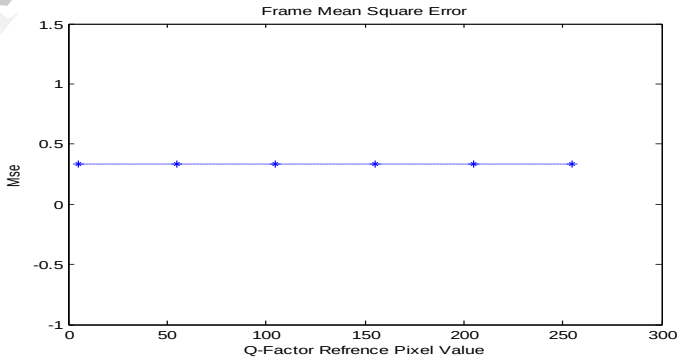


Fig. 5. MSE values of watermarked frame

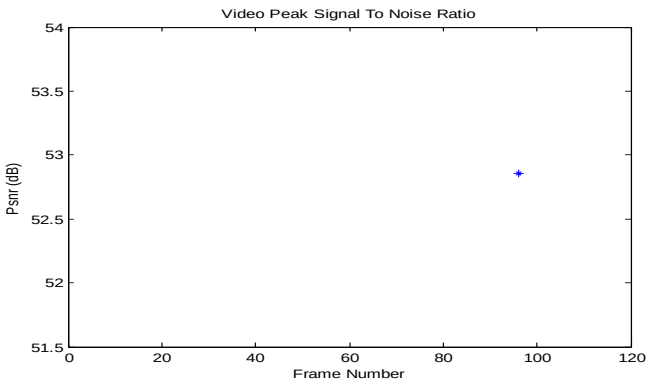


Fig. 6. PSNR values of watermarked video

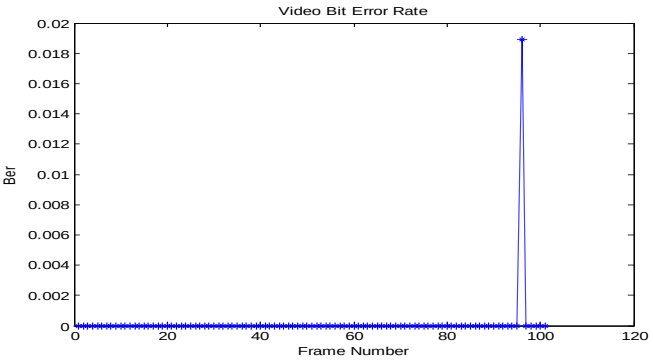


Fig. 7. BER values of watermarked video

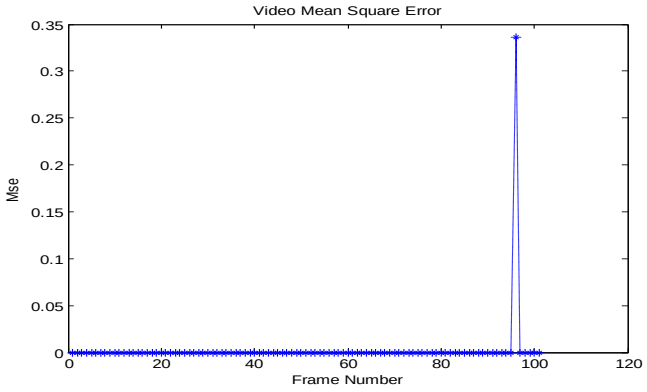
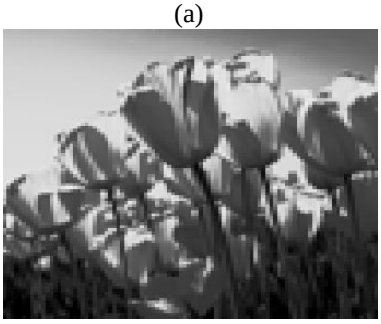


Fig. 8. MSE values of watermarked video

(a)



(b)

Fig. 9. (a) Original and (b) Extracted watermark image

VI. CONCLUSION

In this paper, a blind video watermarking algorithm is proposed in which frames from the whole video frames are selected for watermarking using an encryption key. To preserve the quality of the video, a particular selected frame is divided into blocks and the blocks of high entropies are selected for watermarking. Then watermark information is embedded to the selected block. The algorithm is evaluated in terms of imperceptibility, security, time consumption, data payload and robustness. To measure the imperceptibility of algorithm PSNR, MSE & BER of watermarked frame and watermarked video are computed. The calculated values of these parameters show the high imperceptibility of the algorithm. Also the algorithm is simple blind algorithm, less time consuming, more secure and highly robust against frame dropping & other manipulations.

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