Image Hiding In Selected Video Sequence Based On their Mean Square Error Rate

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Abstract: *This paper presents a novel approach of hiding image in selected video sequence. The proposed algorithm is a hybrid image-hiding scheme based on discrete wavelet transform (DWT) and singular value decomposition (SVD). First the video sequence is taken and then pre-processing is done to remove the noise using 2-D filters. Then it is converted into number of frames and MSE is calculated for each frame. Then select the frame from the video sequence which has low mean square error (MSE) rate. For this frame, the proposed technique DWT and SVD is applied. Here the secret image is not embedded directly on the wavelet coefficients but rather than on the elements of singular values of the cover image's DWT sub bands and also find the SVD of the cover image or each block of the cover image, and then modify the singular values to embed watermark. Finally, the secret image is extracted from the stego image. This technique satisfies both imperceptibility and robustness.*

Keywords: *Steganography, Image hiding, Imperceptibility, Robustness.*

1. INTRODUCTION:

The word Steganography is of Greek origin and means "covered or hidden writing". Data hiding can be used for clandestine transmission, closed captioning, or watermarking. It is in contrast to cryptography, where the existence of the message itself is not distinguished, but the content is obscured[1]. The steganography is implemented in different fields such as military and industrial applications. By using lossless steganography techniques messages can be sent and received securely. Traditionally, steganography was based on hiding secret information in image files [2,3].

Lately, there has been growing interest applying steganographic techniques to video files as well [4,5]. The advantage of using video files in hiding information is the added security against hacker attacks due to the relative complexity of video compared to image files [4].

Image-based and video-based steganograpy techniques are mainly classified in to spatial domain and frequency domain based methods [5-7]. The former embeds messages directly in least Significant Bits (LSB) of the intensity of pixels of image or video.

Spatial domain techniques either operate on pixel wise or block wise bases. In frequency domain, images are first transformed to frequency domain e.g. by using FFT, DCT or DWT and then the messages are embedded in some or all of the transformed coefficients.

An image is decomposed in to four sub bands denoted LL, LH, HL and HH at level 1 in the DWT domain, where LH, HL and HH represent the finest scale wavelet coefficients and LL stands for the coarse-level coefficients.

Several researchers have addressed the problem of video steganography. In [4] a comparative analysis between Joint Picture Expert Group (JPEG) image stegano and Audio Video Interleaved (AVI) video stegano by quality and size was performed.

The work presented in this paper is based on frequency domain processing of AVI video files as covert video. The image hiding mechanism provides imperceptibility and robustness.

2. METHODOLOGY:

a) LOAD VIDEO AND FRAME CONVERSION

In this paper, video is an input. So video is first converted in to number of frames after the video loading through AVI reader. Then the secret image is hided in to the selected frame.

After the video loading, split the frames from the video and then frame conversion is necessary to process this method on the frames.

b) PREPROCESSING

Median filter is the nonlinear filter used to remove the impulsive noise from an image. Furthermore, it is a more robust method than the traditional linear filtering, because it preserves the sharp edges.

Median filter is a spatial filtering operation, so it uses a 2-D mask that is applied to each pixel in the input image. To apply the mask means to centre it in a pixel, evaluating the covered pixel brightness and determining which brightness value is the median value.

c) MSE CALCULATION FOR EACH FRAME

In a sense, any measure of the centre of distribution should be associated with some measure.

If 't' is a good measure of centre, then presumably says that 't' represents the entire distribution better, in some way than other numbers. In this context, suppose that we measure the quality of 't', as a measure of the centre of the distribution, in terms of the mean square error.

MSE(t) is a weighted average of the squares of the distances between t and the class marks with the relative frequencies as the weight factors. Thus, the best measure of the centre relative to this measure of error, is the value of't' that minimizes MSE.

Many common image-processing techniques such as rank-order and morphological processing are variations on the basic median algorithm, and the filter can be used as a steppingstone to more sophisticated effects. Due to existing algorithms' fundamental slowness, its practical use has typically been restricted to small kernel sizes or resolution images. The low-resolution data(whose values are no longer unique), storing not only the median values, but also the number of values strictly below the median. This results forms a pivot from which, calculate the median at the next-higher level of resolution.

For example, if the lowest-resolution median value for a pixel is 0x84, and there are n values below 0x84 in its histogram, then there will be n values below 0x8400 in the next-higher-resolution histogram, and the median will be in [0x8400 ... 0x84FF].

This scanning is bounded by a constant [256] number of steps per iteration, with each iteration adding eight bits of precision to the output. The final iteration is performed using the compound histogram, which yields the full-precision ordinal result. The entire process requires O(log r) levels of recursion, each taking O(log r) time for an overall computational complexity of O(log 2r).

d) DISCRETE WAVELET TRANSFORM

Wavelets are special functions which, in a form analogous to sine and cosines in Fourier analysis, are used as basal functions for representing signals. 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.

Due to its excellent spatial-frequency localization properties, the DWT is very suitable to identify the areas in the host image where a watermark can be embedded effectively. In particular, this property allows the exploitation of the masking effect of the human visual system such that if a DWT coefficient is modified, only the region to that coefficient will be modified.

In general, most of the image energy is concentrated at the lower frequency sub-bands LLx and therefore embedding watermarks in these sub-bands may degrade the image significantly. Embedding in the low frequency sub-bands however, could increase robustness significantly.

On the other hand, the high frequency sub-bands HHx include the edges and textures of the image and the human eye is not generally sensitive to changes in such sub-bands. This allows the watermark to be embedded without being perceived by the human eye.

Wavelet transform decomposes a signal into a set of basic functions. These basis functions are called wavelets. Wavelets are obtained from a single prototype wavelet y (t) called mother wavelet by dilations and shifting.
where, a is the scaling parameter and b is the shifting parameter. Wavelet transform is computed separately for different segments of the time-domain signal at different frequencies.

e) SINGULAR VALUE DECOMPOSITION

Singular Value Decomposition (SVD) can be looked at from three mutually compatible points of view. On the one hand, it is a method for transforming correlated variables into a set of uncorrelated ones that better expose the original data items. At the same time, SVD is a method for identifying and ordering the dimensions along which data points exhibit the most variation.

These ties into the third way of viewing SVD, which is that once to identify where the most variation is, it's possible to find the best approximation of the original data points using fewer dimensions. Hence, SVD can be seen as a method for data reduction.

SVD is a means of decomposing a matrix into a product of three simpler matrices. In this way it is related to other matrix decompositions such as eigen.

3. PERFORMANCE EVALUATION OF THE PROPOSED WORK

Steganography is characterized mainly by two aspects; imperceptibility and robustness. Imperceptibility means the embedded data must be imperceptible to the observer (perceptual invisibility) and computer analysis (statistical invisibility). Robustness means capacity (maximum payload is required) i.e., maximum amount of data that can be embedded into the cover image without losing fidelity of the original image [9].

The perceptual imperceptibility of the embedded image is indicated by comparing the original image or video to its stego counterpart so that their visual differences, if any, can be determined. Additionally, as an objective measure Peak Signal to Noise Ratio may be calculated. It is the ratio between a signal's maximum power and the power of the signal's noise.

4. EXPERIMENTAL RESULTS

Figure.1. AVI Format

Figure.1. shows the video sequences that are selected in AVI format. Figure.2. shows the conversion of frames from video sequence and Figure.3. Shows the selected frame which has low mean square error, in this frame we have embedded the secret image (Figure 4). Figure.5. shows the stego image (cover image with secret image) and Figure.6. Shows the extracted image.

5. CONCLUSION:

A novel approach of hiding image in selected video sequence based on their mean square error rate has been proposed in this paper, which works through the technique of hybrid image-hiding scheme based on Discrete Wavelet Transform (DWT) and Singular Value Decomposition (SVD). PSNR calculation shows that this technique provides the best quality of reconstructed image. The proposed model is more secured against attacks and satisfied both imperceptibility and robustness.

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