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An Integrated SVD and Visibility Restoration Digital Watermarking

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Abstract— This research work focuses on the securing the data transmission over internet by using the concept of the SVD based watermarking. Much important information is communicated over the internet every day. There are some hackers who are always available to hack this information. So securing the transmission is an important area of research. However by using the cryptography the encrypted message is converted into a meaning less form; which may alert the hackers to hack or crack the information. This research work focuses on securing the network transmission by embedding the information in the digital images. The overall goal of this work is to evaluate the performance of the proposed watermarking algorithm which integrates the visibility restoration technique with the SVD based watermarking different kind of attacks are also applied to the result of the proposed algorithm. The proposed algorithm is implemented in MATLAB using image processing toolbox. Experimental results have shown significant improvement of the proposed algorithm over the available techniques.

Keywords— SVD, Visibility restoration, Embedding and extraction.

I. INTRODUCTION

Digital technologies demonstration wonderful growth and advancements in the last years. The compensations offered by the digital technologies are major but the same digital technology opens the door for unlimited piracy and the problematic of protecting multimedia information becomes further significant. As a elucidation to this problem, digital watermark method is a new technique of protecting copyrights for digital data. Digital watermark is comprehended by implanting information data with an unresponsive form. It must be problematic for a hacker to remove watermark purposely. Watermarking is the procedure of implanting information named a watermark, into a multimedia object such that watermark can be discovered in future to make a proclamation about the object. The object can either be an image, audio, video or a text document .The watermark might contain additional information including the identity of purchaser of a particular copy of the object. Based on the purpose of the watermark, it is entrenched whichever visibly or invisibly.
Digital Watermarking delivers a technique to implant digital information into both digital and conventional media. Information limited within the digital watermark can be secondhand to augment value to a variety of techniques such as associated content, security, info protection, copy anticipation, authentication etc. A unique benefit of a digital watermark is that the information is guaranteed to innovative medium.

A. Attacks on Watermarks

In watermarking terminology, an attack is any dispensation that may damage discovery of the watermark or of the information transported by the watermark. Attacks can be classified as intentional or unintentional. Intentional attacks comprise elimination, cryptographic attack etc., here the aggressor deliberately uses an algorithm trying to eliminate or modify the watermark. While unintentional comprise image scaling, compression etc. The attack may or may not be fruitful but it always damages the watermarked info sometime to the extent of even disabling the discovery of watermark.

B. Watermarking Schemes to provide Robustness to attacks

SVD is very convenient tool for watermarking in the DWT domain. The scaling factor can be chosen from a fairly wide range of values for LL, and also for the other three bands. As the LL band contains the largest wavelet coefficients, the scaling factor is chosen accordingly i.e. upto 0.5 for LL and 0.01 for the other bands. For this pair of values there was no degradation in the watermarked image. When the scaling factor for LL was increased to an unreasonable value, the image become lighter while an increase in scaling factor for the other bands resulted in vertical and horizontal artifacts. Watermarks inserted in the lowest frequencies (LL subband) are resistant to one group of attacks, and watermarks embedded in highest frequencies (HH subband) are resistant to another group of attacks. If the same watermark is embedded in four blocks, it would be extremely difficult to remove or destroy the watermark from all frequencies. In some cases, embedding in the HL and LH subband is also resistant to certain attacks. Two examples of those attacks are

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histogram equalization and Gamma correction. After the cropping attack, singular value extraction in the HL subband does not allow proper construction of the watermark although the correlation is high.

II. LITERATURE REVIEW

A. Survey on Visibility restoration

Yu, Jing, Chuangbai Xiao, and Dapeng Li. (2010) [1] has proposed a novel fast defogging method from a single image of a scene based on a fast bilateral filtering approach. The complexity of our method is only a linear function of the number of input image pixels and this thus allows a very fast implementation. Results on a variety of outdoor foggy images demonstrate that our method achieves good restoration for contrast and color fidelity, resulting in a large improvement in image visibility.

He, Kaiming, Jian Sun, and Xiaoou Tang. (2009) [2] has proposed a simple but effective image prior - dark channel prior to remove haze from a single input image. The dark channel prior is a kind of statistics of the haze-free outdoor images. It is based on a key observation - most local patches in haze-free outdoor images contain some pixels which have very low intensities in at least one color channel. Using this prior with the haze imaging model, we can directly estimate the thickness of the haze and recover a high quality haze-free image.

Yu, Jing, and Qingmin Liao. (2011) [3] has proposed a novel fast defogging method from a single image of a scene based on the atmospheric scattering model. In the inference process of the atmospheric veil, the coarser estimate is refined using a fast edge-preserving smoothing approach. The complexity of the proposed method is only a linear function of the number of image pixels and this thus allows a very fast implementation.

He, Kaiming, Jian Sun, and Xiaoou Tang. (2011) [4] has proposed a simple but effective image prior-dark channel prior to remove haze from a single input image. The dark channel prior is a kind of statistics of outdoor haze-free images. It is based on a key observation-most local patches in outdoor haze-free images contain some pixels whose intensity is very low in at least one color channel.

Tarel et al. (2012) [5] has proposed to better handle road images by introducing an extra constraint taking into account that a large part of the image can be assumed to be a planar road. The advantages of the proposed local algorithm are the speed, the possibility to handle both color and gray-level images, and the small number of parameters. A new scheme is proposed for rating visibility enhancement algorithms based on the addition of several types of generated fog on synthetic and camera images.

V. Jayaraj et al. (2010) [6] has described the new method which introduces the concept of substitution of noisy pixels by linear prediction prior to estimation. A novel simplified linear predictor is developed for this purpose. The objective of the scheme and algorithm is the removal of high-density salt and pepper noise in images.

K. Aiswarya et al. (2010) [7] has described a new algorithm to remove high-density salt and pepper noise using modified sheer sorting method. The new algorithm has lower computation time when compared to other standard algorithms. Results of the algorithm are compared with various existing algorithms and it is proved that the new method has better visual appearance and quantitative measures at higher noise densities. The algorithm is based on a new concept of substitution prior to estimation in contrast to the standard switching-based nonlinear filters.

Gnanambal Ilango et al. (2011) [8] has introduced various hybrid filtering techniques for removal of Gaussian noise from medical images. The performance of Gaussian noise removing hybrid filtering techniques is measured using quantitative performance measures such as RMSE and PSNR. The experimental results indicate that the one of the proposed hybrid filter, Hybrid Max Filter performs significantly better than many other existing techniques and it gives the best results after successive iterations. The proposed method is simple and easy to implement.

P. E. Ng et al. (2006) [9] proposed a novel switching median filter incorporating with a powerful impulse noise detection method, called the boundary discriminative noise detection (BDND), for effectively denoising extremely corrupted images. To determine whether the current pixel is corrupted, the proposed BDND algorithm first classifies the pixels of a localized window, centering on the current pixel, into three groups-lower intensity impulse noise, uncorrupted pixels, and higher intensity impulse noise.

Zinat Afrose (2012) [10] has described a method to remove Salt & pepper, Gaussian and Speckle noise from compound images using median filter, relaxed median filter, wiener, centre weighted median and averaging filter . The performance of the different filters with the applied noises using compound images are compared and analyzed according to PSNR value. From the performance analyses the relaxed median filter gives better results for compound images.

S. Esakkirajan et al. (2011) [11] has described a new algorithm (MDBUTMF) which gives better performance in comparison with MF, AMF and other existing noise removal algorithms in terms of PSNR and IEF. The performance of the algorithm has been tested at different noise densities on both gray-scale and color images. Even at high noise density levels the MDBUTMF gives better results in comparison with other existing algorithms. Both visual and quantitative results are demonstrated.

Priyanka Kamboj et al. (2013) [12] has described that Enhancement of a noisy image is necessary task in digital image processing. Filters are used best for removing noise from the images. In this research workvarious type of noise models and filters techniques have been described. Filters techniques are divided into two parts linear and non-linear techniques. After studying linear and non-linear filter each of have limitations and advantages. In the hybrid filtering schemes, there are two or more filters are recommended to filter a corrupted location .The decision to apply a particular filter is based on the different noise level at the different test pixel location or performance of the filter scheme on a filtering mask.

Shanmugavadivu et al. (2012) [13] has proposed a filter which is more effective in restoring the images corrupted with fixed-value impulse noise. As the proposed filter is computationally simple, the restoration rate is faster. This filter finds

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application in eliminating noise from Scanning Electron Microscope (SEM) images, used in the study of surface morphology, because SEM images are invariably degraded by fixed value impulse noise.

Shanmugavadivu P et al. (2011) [14] has defined a newly devised noise filter namely, Adaptive Two-Stage Median Filter (ATSM) to denoise the images corrupted by fixed-value impulse noise. The performance of the proposed filter is proved to be better in terms of Peak Signal-to-Noise Ratio and human visual perception. This filter is effectual in denoising the highly corrupted image.

B. Survey on Watermarking

Sukumar, K. (2009) [15] has discussed that the pure SVD based watermarking scheme does not have high data payload and high security. A new robust multi image-watermarking scheme based on framelet and SVD technique has been proposed. It mainly addressed the multi-user problem in digital rights management. The framelet transform (first level) is applied to the gray scale cover image resulting in eight-detailed band (H1L, H2L, LH1, H1H1, H2H1, LH2, H1H2 and H2H2) and one coarse band (LL). To ensured security, watermark images are scrambled before embedding using secret key.

Makhloghi et al. (2011) [16] has proposed a robust blind digital image watermarking method for proof of ownership based on singular value decomposition in wavelet domain. The proposed method the embedding is done by modifying the specific bits of the singular values of the transformed host image with the bits of the watermark image's singular values. First, the DWT is applied to the host image. Then, the SVD transform is applied to each sub-band of the transformed image and the singular values of each sub-band and the singular values of the watermark image are converted to semi-binary arrays. Finally, the bits of the singular values of the watermark image are inserted into the selected bits of the singular values of decomposed host image's sub-bands.

Ghazy et al. (2007) [17] has presented a block based digital image watermarking that is dependent on the mathematical technique of singular value decomposition (SVD). The original image is divided into blocks, and then the watermark is embedded in the singular values (SVs) of each block separately. This segmentation process and watermarking on a block-by-block basis makes the watermark more robust to the attacks such as noise, compression, cropping and other attacks as the results reveal. Watermark detection is implemented by extracting the watermark from the SVs of the watermarked blocks. Extracting the watermark from one block at least is enough to ensure the existence of the watermark.

Makhloghi et al. (2011) [18] has proposed a robust blind digital image watermarking method for proof of ownership based on singular value decomposition in wavelet domain. IThe embedding is done by modifying the specific bits of the singular values of the transformed host image with the bits of the watermark image's singular values. First, the DWT is applied to the host image. Then, the SVD transform is applied to each sub-band of the transformed image and the singular values of each sub-band and the singular values of the watermark image are converted to semi-binary arrays. Finally, the bits of the singular values of the watermark image are inserted into the selected bits of the singular values of decomposed host image's sub-bands.

Mehta et al. (2013) [19] has worked to achieve good imperceptibility and robustness, a hybrid image watermarking algorithm based on discrete wavelet transform (DWT) and singular value decomposition (SVD) is proposed using the characteristics of human visual system model for copyright protection and authenticity. In the proposed watermarking algorithm, one level DWT is applied to selected image blocks to obtain four sub-bands of each block and then the U component of low frequency sub-band (LL) obtained after SVD transformation is explored under different threshold values for embedding and extracting the watermark.

III. PROBLEM DEFINATION

Digital watermarking is a technique which allows an individual to add hidden copyright notices or other verification messages to digital audio, video, or image signals and documents. The information which is embedded is called watermark. It can be text or an image. Two types of digital watermarks may be distinguished, depending upon whether the watermark appears visible or invisible to the casual viewer. Visible watermarks can be a logo or text on frames of videos either in all frames or in just a few selected frames. If it is present in selected frames then it passes off without being noticed, due to high frame rate. Invisible watermarks or Hidden watermarks on other hand are present in the file in such a way that they cannot be sighted but have to be extracted.

This research work focused on the digital watermarking using SVD based technique. The overall goal of this research work is to design and implement SVD based algorithm in MATLAB using image processing toolbox. The proposed algorithm seems to efficient as it reduces the effect of the fog and improve the quality of the cover image. The objective of this work is to prove ownership of copyrighted image and to solve the problem of piracy by embedding the watermark in the image. Also the same watermark can be extracted at the time of copyright issues. SVD based watermarking scheme is used to accomplish the watermarking process. To check the quality of the watermarked image parameters like Peak Signal to Noise Ratio (PSNR), Mean Squared Error (MSE) Bit Error Rate (BER) will also be measured.

IV. PROPOSED ALGORITHM

This section will explain the working of the proposed algorithm.

A. Embedding process

Step 1: First of all input cover image F and watermark image W.

Step 2: Now airlight map correction will come in action to reduce the fog from F image.

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Step 3: Now adaptive histogram stretching come in action to improve the visibility of the F image.
Step 4: Now perform SVD on F Image [U S V]=SVD(F);
Step 5: Add watermark W to SVs of Original Matrix of W by k=1 and D=S+k.*W;
Step 6: Perform SVD on new Modified Matrix i.e. [Uw Sw Vw]=SVD(D);
Step 7: Obtain the watermarked image using modified matrix (Sw) i.e. by using Fw=ISVD(U,Sw,V);
Step 8: Get watermarked image as Fw.

B. Extraction Technique

The extraction technique is exactly the reverse of the embedding technique.
Step 1: First of all input the watermarked image Fw1.
Step 2: Now perform SVD by [U1 S1w V1] = SVD (Fw1);
Step 3: Now apply inverse SVD D1=ISVD (Uw,S1w,Vw);
Step 4: Now extract the digital image by doing W1=(D1-S)/k; where k=1.
Step 5: W1 is final extracted image.

V. EXPERIMENTAL RESULT AND EVALUATION

This section consists the experimental results of the proposed algorithm. Two images are taken one will act as cover image and second as the watermark image.
Figure 1 is showing the input image which will act as cover image which will be communicated over the network.

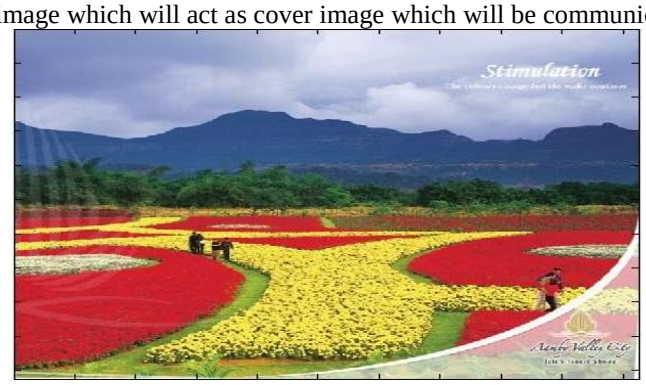

Figure 1 Input image

Figure 2 has shown the restored image. It is clearly shown that the output image has quite better visibility than input image. The image is also adjusted in such a way that it will not loss its contents much when we will embed an watermark image in it.

Figure 2 Restored image

Figure 3 is showing the image which will use as a watermark and will be embedded in the restored image.

Figure 3 Watermark image

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Figure 4 Image with embedded image

Figure 4 has shown the watermarked image. The image contains the image shown in figure 3. But it is clearly shown that the hidden image has not left any effect on the visibility of the image.

Figure 5 Extracted image without any attack

Figure 5 has shown the extracted watermarked image without the use of any attack. It is clearly shown that the extracted image is almost as it's because the correlation between watermark and watermarked image is 99.2.

Figure 6 Gaussian attacked image

Figure 6 has shown the extracted image using Gaussian filter based attack. The change between watermark image and extracted image is 88.9 so the change of the attack is there. Therefore it is clearly shown the modification on the secured image has been also done.

Figure 7 Median attacked image

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Figure 7 has shown the extracted image using Median filter based attack. The change between watermark image and extracted image is 78.9 so the change of the attack is there. Therefore it is clearly shown the modification on the secured image has been also done.

Figure 8 Histogram equalized image

Figure 8 has shown the extracted image using Histogram equalized based attack. The change between watermark image and extracted image is 73.1 so the change of the attack is there. Therefore it is clearly shown the modification on the secured image has been also done.

Figure 9 is showing the modification on the input image and watermarked image. The difference between the quality parameters are as MSE=.004, PSNR=71.63 and BER=.013

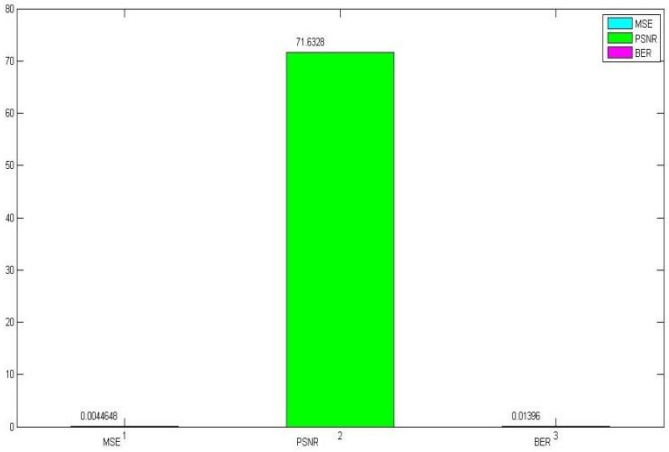

Figure 9 Final results

Table 1 is showing the correlation comparison when different kind of attack is done on the watermarked images. The correlation will be evaluated by comparing the input watermark image and extracted image.

Table 1 Correlation evaluation

Image	Without attack	Gaussian attack	Median filter	Histogram Eq.
1	98.22	88.2	79.2	72.1
2	97.88	89.4	78.5	72.3
3	99.2	86.3	79.1	71.6
4	97.2	85.8	81.9	69.8
5	98.1	87.7	82.1	74.3
6	98.22	88.2	79.2	72.1
7	97.88	89.4	78.5	72.3
8	99.2	86.3	79.1	71.6
9	97.2	85.8	81.9	69.8
10	98.1	87.7	82.1	74.3

VI. CONCLUSION

Digital watermarking is a multifaceted technique essentially concerning numerous conflicting necessities and tradeoffs thus subsequent in many real-world as well as technical tasks. Digital watermarking using SVD is a rapidly developing arena with heaps of potential in upcoming novel applications, also its present applications in the information security, manufacturing and information hiding areas.

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This work has focused on to prove the ownership of copyrighted image and to solve the problem of piracy by embedding the watermark in the image. Also the same watermark can be extracted at the time of copyright issues. SVD based watermarking scheme is used to accomplish the watermarking process. The design and implementation has been done in MATLAB using image processing toolbox. Different images are taken for experimental purpose. It has been found that after using the SVD based watermarking scheme there exist quite less effect on the output image than input image. To check the quality of the watermarked image parameters like Peak Signal to Noise Ratio (PSNR), Mean Squared Error (MSE) Bit Error Rate (BER) has been measured. The different kind of attacks are also done on watermarked image to validate the performance of the SVD based watermarking scheme.

In near future we will propose a modified SVD based watermarking to enhance the results further. And also we will use embedding ++ to enhance the security further. However further enhancement will also be done by implementing the proposed algorithm in real time environment. Also some more attack will be considered to evaluate the performance of the proposed algorithm further.

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