Abstract: This paper illustrates a unique approach for embedding binary image watermarks into the digital images, or the purpose of watermarking; we made use of three most influential transforms in the field of image processing i.e. Discrete Cosine Transform (DCT), Discrete Wavelet Transform (DWT) and Singular Value Decomposition (SVD). For the sake of estimation, comparison and calculation of our approach we calculated three image quality parameters specifically peak signal to noise ratio (PSNR), Mean square error (MSE) and Correlation.

Keywords: Watermarking, DWT, DCT, SVD, Attacks, PSNR, MSE

I. INTRODUCTION

This era is an era of ultimate connectivity which is connectivity & communication through internet and wireless networks spread all across the world. We have some of the most extraordinary innovations like digital camera, camcorders, MP3 players, PDA’s etc. for making, handling and using the multimedia information. These days, the expansion of internet has provided us some cherished gifts like electronically publishing of files, e-marketing, online newspaper, online magazine, online libraries, online videos, online audio, online commerce, online money transactions, real time data deliverance and much more. Because of all these things, containing, sharing and manipulating digital images over the internet have become a very simple task. So, authors of the images are afraid of sharing and giving their valuable piece of art, personal photographs, and important images through internet because of the problem of copyright protection [1, 2]. It becomes such a simple task to copy the digital information and then it is pasted somewhere else, it looks and works like the original data and thus it leads towards what is universally known as data piracy. The best case scenario to protect multimedia images or information against illegal usage is to implant a watermark, called digital watermark or copyright information into the cover data that authenticates the ownership of the data. This technique is called digital watermarking or in our case digital image watermarking which is a technique to hide an undisclosed signature, message or watermark inside the cover guess or make out the message with his naked eye and also he/she considers it as a normal image. The implanted message may be the creator name, emblem of his organization, or any sign which proves his or her ownership over the given image, data or information [3,4]. These days, both industrial individuals and research scholars are working hard to develop techniques that help us to provide evidence of proprietorship and to avoid illegal modification of the multimedia data. In our case, we try to focus on the digital images as our prime target. Various techniques and algorithms have been implemented in the field of digital image watermarking; few have been robust yet use too many resources and few that use little resources but does not pertain quality. Here we try to develop a sophisticated approach which may solve most of the problems experienced in the previously deployed techniques.

II. QUALITY ASSESSMENT PARAMETER

Mean Square Error (MSE), Peak Signal to Noise Ratio (PSNR), Correlation are the Images quality assessment parameters, used in this paper. The Correlation is calculated using the cover watermark and resultant image. Value of The correlation is always measured between 0 and 1. The three parameters have been selected the following image quality matrices [10]. For the purpose of evaluation for degradation after the watermark is included in the bitmap.

\[
MSE = \frac{1}{M \times N} \sum_{x=1}^{m} \sum_{y=1}^{n} \left( f(x, y) - f'(x, y) \right)^2 \tag{1}
\]

\[
PSNR = 10\log_{10} \frac{255^2}{MSE} \tag{2}
\]

\[
CC = \frac{\sum_i \sum_j W_c(i,j) W_t(i,j)}{\sum_i \sum_j W_c(i,j)^2} \tag{3}
\]

Here, Mean Square Error is denoted by MSE, while Peak Signal to Noise Ratio is denoted by PSNR, f(x, y) is the cover Image, f’(x, y) is Watermarked Image. MSE is defined as the average squared difference between a reference image and a distorted image presented by equation (1) and to calculate the similarity between the original image and watermarked image, PSNR is used which can be represented in mathematically expressed by above equation (2)[11,12]. Hence at the receiver end it is observed that we have extracted the watermark and computed the correlation for recovered watermark and original watermark for the purpose of assessing the robustness: [13, 14].

III. IMPLEMENTATION

In this algorithm, for the purpose of watermark embedding and extraction, Hybrid methods are used in a mixture of DWT, DCT and SVD this method shown in Fig.1 & Fig.2.
Image Watermarking – Hybrid Approach for Embedding Binary Watermark into the Digital Image

Fig. 1. Block Diagram for Hybrid Watermark Embedding

Fig. 1 describes the watermark embedding process done on a host image. First of all the original image is passed the colorspace conversion process for converting RGB to YcbCr. Then the 2-dimensional Discrete cosine transform [5,7,9] is applied on the converted image. After applying DCT, 2-dimensional Discrete wavelet transform [6,7] is applied. Then finally Singular value decomposition [8,15] if performed on the image. Meanwhile, the watermark is under passed SVD process. The then watermark is embedded on the image. After the embedding is done, Inverse DCT, DWT and SVD is applied to output image. Then colorspace conversion is done on the image and at last we get our watermarked image.

Fig. 2. Block Diagram for Hybrid Watermark Extraction

Fig. 2 describes the watermark extracting process done on a watermarked image. Firstly the watermarked image is passed through the colorspace conversion process. Then 2-Dimensional DCT is performed followed by a 2-Dimensional DWT. Then after, SVD is applied on the image. Then the extraction process is started. At the end of the process we get the watermark image which was previously embedded onto the image.

IV. RESULT & DISCUSSION

We have experimented the Mixture of DWT, DCT & SVD as the watermarking algorithm on different cover image and watermark. The performance is calculated by measuring PSNR and MSE. Simulation results show that hybrid technique is imperceptible and robust against variety of attacks.

A. Experimental result of custom images watermarked with binary message without attack

The Table I, as shown in a watermark has been implanted in an original image and parameters like PSNR, MSE & Correlation are also described. A common watermark is embedded in all custom images here the name of all watermarked images.

| Images | Parameter Value | Images | Parameter Value |
|--------|----------------|--------|----------------|
|        |                 |        |                 |
|        |                 |        |                 |
|        |                 |        |                 |
|        |                 |        |                 |
|        |                 |        |                 |
|        |                 |        |                 |
|        |                 |        |                 |

Table I. Result of hybrid based method with gain factor 100 & binary message

Table II. Recovered watermark images extracted from the custom watermarked images (a) bhai (b) niyu (c) camel (d) pari (e) crow (f) elephant (g) m (h) ladu (i) sea

![Recovered watermark images](image.png)

| Images | Parameter Value | Images | Parameter Value |
|--------|----------------|--------|----------------|
|        |                 |        |                 |
|        |                 |        |                 |
|        |                 |        |                 |

Table III. Result of hybrid based method on image niyu with different gain factor & binary message.

![Result of hybrid based method on image niyu with different gain factor & binary message](image.png)
The Table III shows the image niyu at various gain factors. Gain factors can be measured in an enormous range of alpha factors. Table 3 illustrates image niyu in alpha factors 1 to 10, 30, 50, 70, 90 & 100. Also parameters like PSNR, MSE & Correlation is recorded for same set of images and displayed in the table.

B. Experimental result of custom images watermarked with binary message with attack

Table IV. Average filtering with various masks sizes

| Image | Parameters | Extracted watermark |
|-------|------------|---------------------|
|       | Mask Size: 3x3 | PSNR: 35.0628 | Correlation: 0.8824 |
|       | Mask Size: 5x5 | PSNR: 33.8981 | Correlation: 0.8010 |
|       | Mask Size: 7x7 | PSNR: 33.1089 | Correlation: 0.7062 |
|       | Mask Size: 9x9 | PSNR: 32.4939 | Correlation: 0.6028 |

As illustrated in Table IV experimental results for average filtering attack done on the image niyu. It displays various mask size of the attack that was applied. Also the attacked image niyu with its PSNR reading & the extracted watermark with its correlation readings are displayed.

Table V. Compression with various quality values

| Image | Parameters | Extracted watermark |
|-------|------------|---------------------|
|       | Quality Value: 5 | PSNR: 32.4028 | Correlation: 0.8965 |
|       | Quality Value: 20 | PSNR: 34.6735 | Correlation: 0.9293 |

As illustrated in Table V experimental results for compression attack done on the image niyu. It displays various quality values of the attack that was applied. Also the attacked image niyu with its PSNR reading & the extracted watermark with its correlation readings are displayed.

Table VI. Cropping with various crop regions

| Image | Parameters | Extracted watermark |
|-------|------------|---------------------|
|       | Crop Regions: 25 | PSNR: 35.931 | Correlation: 0.9401 |
|       | Crop Regions: 50 | PSNR: 34.4163 | Correlation: 0.9373 |
|       | Crop Regions: 75 | PSNR: 32.6948 | Correlation: 0.9304 |
|       | Crop Regions: 100 | PSNR: 31.1532 | Correlation: 0.9138 |

As illustrated in Table VI experimental results for cropping attack done on the image niyu. It displays various crop regions of the attack that was applied. Also the attacked image niyu with its PSNR reading & the extracted watermark with its correlation readings are displayed. As illustrated in Table VII experimental results for Gaussian law pass filter attack done on the image niyu. It displays various deviations of the attack that was applied. Also the attacked image niyu with its PSNR reading & the extracted watermark with its correlation readings are displayed.

Table VII. Gaussian law pass filter with various standard deviations

| Image | Parameters | Extracted watermark |
|-------|------------|---------------------|
|       | Stand. Dev.: 0.5 | PSNR: 35.6105 | Correlation: 0.9292 |
|       | Stand. Dev.: 1.5 | PSNR: 35.1217 | Correlation: 0.8871 |
|       | Stand. Dev.: 2 | PSNR: 35.0955 | Correlation: 0.8848 |
|       | Stand. Dev.: 3 | PSNR: 35.0768 | Correlation: 0.8834 |
As illustrated in Table VII experimental results for Gaussian noise attack done on the image niyu. It displays various variances of the attack that was applied. Also the attacked image niyu with its PSNR reading & the extracted watermark with its correlation readings are displayed.

Table VIII. Gaussian noise with 0 mean and various variances

| Image | Parameters | Extracted watermark |
|-------|------------|---------------------|
|       | Variance: 0.0005  
      PSNR: 33.6843  
      Correlation: 0.9404 |                     |
|       | Variance: 0.01  
      PSNR: 28.6867  
      Correlation: 0.9327 |                     |
|       | Variance: 0.09  
      PSNR: 27.5954  
      Correlation: 0.852 |                     |
|       | Variance: 1.0  
      PSNR: 27.2364  
      Correlation: 0.6158 |                     |

As illustrated in Table IX experimental results for Median Filtering attack done on the image niyu. It displays the various mask size of the attack that was applied. Also the attacked image niyu with its PSNR reading & the extracted watermark with its correlation readings are displayed.

Table IX. Median filtering with various mask sizes

| Image | Parameters | Extracted watermark |
|-------|------------|---------------------|
|       | Mask Size: 3  
      PNSR: 36.4516  
      Correlation: 0.9067 |                     |
|       | Mask Size: 5  
      PNSR: 36.2008  
      Correlation: 0.8315 |                     |
|       | Mask Size: 7  
      PNSR: 36.0695  
      Correlation: 0.7495 |                     |
|       | Mask Size: 9  
      PNSR: 36.0647  
      Correlation: 0.6598 |                     |

As illustrated in Table X experimental results for Rotation attack done on the image niyu. It displays various rotation angles of the attack that was applied. Also the attacked image niyu with its PSNR reading & the extracted watermark with its correlation readings are displayed.

Table X. Rotation with various angles

| Image | Parameters | Extracted watermark |
|-------|------------|---------------------|
|       | Angle: 30  
      PNSR: 28.0956  
      Correlation: 0.5605 |                     |
|       | Angle: 90  
      PNSR: 28.0331  
      Correlation: 0.2709 |                     |

V. CONCLUSION

From the work we carried out, we can conclude that our proposed algorithm, The Mixture of DWT-DCT-SVD hybrid algorithm was found robust against various attacks like Compression, Cropping, Gaussian Law Pass Filter, Gaussian Noise, Median Filtering, and Rotation & Histogram Equalization. All the tests result show better and higher Peak Signal to Noise Ratio (PSNR) value, as well as minimal Mean Square Error (MSE) value. All these factors prove that proposed algorithm is a powerful approach that helps to embed and extract a watermark from an image which has gone through different attacks. Taking PSNR, MSE and Correlation to note, our proposed method holds its robustness and sheer visual clarity of the image even after attacked by various attacks which was not the case in other proposed techniques in the past like DWT, DCT, SVD and mixture of either of the techniques.

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