A Robust Embedding Algorithm for Digital Watermarking using 5-DWT-SVD Method

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Abstract— In this paper, we present a robust embedding algorithm for digital watermarking using 5-dimensional wavelet discrete transform (5-WDT) and singular value decomposition (SVD). First of all, we take two images cover color image and secret color image for embedding. On the cover color image, we apply image compression for reducing size and increasing time, then we apply 5-WDT and SVD. And repeat the same process for secret color image. We worked on both color and gray image for embedding. In this algorithm, we improve peak signal noise ratio (PSNR) and mean square error (MSE). In the experimental outcomes, we achieve PSNR value up to 70%.

Key words: Image Watermarking; Techniques; DWT; SVD; PSNR; MSE

I. INTRODUCTION

Today a large portion of the sound, feature, and picture can be spoken to in advanced structure. Fabrication of advanced media or records has turned into a critical issue for ID, verification and law implementation. These concerns activated numerous examines to discover approaches to shroud the copyright messages and serial number into the advanced media. Cryptography, Steganography, Watermarking is diverse information concealing methods. Among these systems watermarking is most suitable for interactive media applications. Uses of digital watermarking incorporate copyright insurance, fingerprinting, verification, duplicate control, alter recognition and information concealing applications, for example, show observing. Watermarking is the procedure that implants an information called a watermark, label or mark into a media question such that watermarks can be identified or extricated later to make an affirmation about the article. The article may be a picture, sound, feature, or content. In digital image watermarking article is included in advanced media. [1, 2] Robust picture watermarks will be watermarks intended to survive assaults, including sign preparing operations and spatial changes. To assess strong watermarks, we have to assess how assaults influence the watermark of a picture.

The attacks are isolated into mostly two sorts purposeful and accidental. The embedded watermarks accidentally impeded by such preparing like pressure and sign upgrade and so forth. The purposeful watermark connected to the unequivocal objective of impeding watermark. The mean square error (MSE) and peak signal noise ratio (PSNR) are the most prominent metric to gauge devotion [3, 4].

II. LITERATURE REVIEW

A. Seifeddine Naffouti

This paper proposes an added substance watermarking strategy by invoking Particle Swarm Optimization (PSO) method in wavelet space to enhance this plan of watermarking. To stay away from that the watermarking loses its power and imperceptibility and concentrate the watermark under the ideal execution, PSO is intertwined with the strategy proposed in [1] which used to embed the watermark in the rough guess sub-band LL3 and which did not matter any sort of picture handling so as to demonstrate its unwavering quality against different sorts of attacks, aside from that they demonstrate its PSNR subsequent to watermarking. In this paper, the fundamental concentrated on watermarking is that all coefficients are chosen for the LH3 sub-band of watermark to implant it in the same sub-band of the first picture. Result investigation demonstrates that the proposed calculation unquestionably beats the added substance technique which doesn't utilize PSO and the fitting deterioration level. [5]

B. Kazutake Uehira:

In this “optical watermarking” innovation, it utilized orthogonal changes, for example, a discrete cosine change (DCT) or a Walsh-Hadamard change (WHT), to deliver watermarked pictures; where 1-b twofold data were inserted into every pixel piece. In this paper, it proposed an ideal condition for a strategy of robust optical watermarking that changes the span of pixel squares by utilizing an exchange off in the productivity of embedding watermarking. It directed tests where 4*4, 8*8, and 16*16 pixels were utilized as a part of one piece. An identification exactness of 100% was gotten by utilizing a piece with 16*16 pixels when embedded watermarking was greatly powerless, despite the fact that the precision did not so much achieve 100% by utilizing pieces with 4*4 or 8*8 pixels under the same embedding conditions. [6]

C. Baiping Lei:

In this system, LWT→DWT is initially connected to disintegrate the host flag and get the relating estimated coefficients took after by DCT to exploit “vitality compaction” property. SVD is further performed to gain the particular values and improve the robustness of the plan. The versatile DM quantization is embraced to quantize the solitary values and implant the watermark. To withstand desynchronization assaults, synchronization code is embedded utilizing sound factual qualities. Besides, the clashing issue of strength and vagueness is viably determined by the DE enhancement. Recreation results exhibit that both the SVD-LWT-DWT and SVD-LWT-DWT techniques have great intangibility execution, and additionally oppose general sign handling, cross breed and desynchronization assaults. Contrasted and the past DWT-DCT, bolster vector relapse (SVR)-DWT-DCT and DWT-SVD systems, our strategy gets more strength against the chose assaults. [7]
D. Rajarathnam Nallusamy:
In this paper, it considered over the execution of three distinct watermarking calculations (DWT, SVD and DWT-SVD based watermarking calculations). They have made two unique watermarks with same watermark data, however, with diverse qualities - one is a QR Code as watermark picture which is fit for conveying extensive data in little space, while the other one is an ordinary content picture watermark and implanted inside medicinal pictures. They, then, have evaluated the nature of watermarked pictures got in the wake of implanting the watermarks utilizing both goal (PSNR) and additionally subjective (assessments from doctors, a radiologist and a medicinal physicist) routines and found that watermarking has not brought about loss of restoring data. Further, it has led a few examinations to assess the execution of these calculations regarding strength, limit, and embedding time. Exploratory results demonstrate that DWT based technique is suitable for therapeutic applications where installing time and vagueness are prime concerns while SVD based techniques are suitable for medicinal applications where heartiness and limit are the principle concerns. [8]

E. S. Manikandaprabhu:
In this paper, another watermarking methodology in view of wavelet coefficient quantization utilizing back propagation neural system as a part of discrete wavelet transform area is proposed. The host picture is deteriorated up to three levels utilizing discrete wavelet transform. The secreted picture is picked as a watermark. The back propagation neural system is utilized while inserting and separate the watermark. Peak signal noise ratio and normalized cross correlation coefficient are figured to quantify the picture nature of the proposed procedure. Trial results show that the proposed watermarking calculation has great intangibility and vigor against a few sorts of assaults, for example, salt and pepper, Gaussian and spot noise, compression and rotation. [9]

F. Nidhi Divecha:
Digital picture watermarking is one such innovation that has been produced to secure advanced substance (content, pictures, sound, and feature) from unlawful controls. In this paper, it proposed execution and performance examination of two distinctive watermarking plans taking into account DCT-DWT-SVD. Both are non-visually impaired systems. One is in view of the SVD of DC coefficients utilizing second level DWT disintegration and other is considered SVD of all DCT estimations of second level DWT creation of spread picture. To check the adequacy of both procedures for imperceptibility and security PSNR and NCC parameters is utilized. [10]

III. PROPOSED METHODOLOGY
In this work, we worked on image compression and image watermarking. First of all, we used two images: one is cover color image and the second is secret color image. We apply image compression using DWT on both images.

- Proposed Algorithm Using 5-DWT and SVD

A. Embedding Algorithm:
1) Using this formula, we compress the cover color image and secret color image:
\[ cr, bpp = \text{wcompress}(rgbimage) \]
Where rgbimage is cover color image
\[ cr, bpp = \text{wcompress}(secret) \]
Where secret is secret color image

2) Discrete Wavelet Transform (DWT)
DWT includes deterioration of the picture into frequency channel of steady data transmission. This causes the closeness of accessible disintegration at each level. DWT is executed as multistage change. Level wise deterioration is finished with multistage transformation.

   1) At 1-level DWT- Cover compressed image and secret color image is decomposed into four sub-bands: c_LL,s_LL,s_LH,s_HH and s_LL,s_LH,s_HL,s_HH

   2) At 2-level DWT is taken c_LL , s_LL and decomposed into c_LL1,c_LH1,c_HL1,c_HH1 and s_LL1,s_LH1,s_HL1,s_HH1

   3) At 3-level DWT is taken c_LL1, s_LL1 and decomposed into c_LL2,c_LH2,c_HL2,c_HH2 and s_LL2,s_LH2,s_HL2,s_HH2

   4) At 4-level DWT is taken c_LL2, s_LL2 and decomposed into c_LL3,c_LH3,c_HL3,c_HH3 and s_LL3,s_LH3,s_HL3,s_HH3

   5) At 5-level DWT is taken c_LL3, s_LL3 and decomposed into c_LL4,c_LH4,c_HL4,c_HH4 and s_LL4,s_LH4,s_HL4,s_HH4

3) Singular Value Decomposition (SVD):
A picture can be presented to as a network of positive scalar qualities. Formally, SVD for any picture say an of size \( m \times m \) is a factorization of the structure given by \( A=USVT \), where U and V are orthogonal grids in which sections of U are left singular vectors and segments of V are correct particular vectors of picture A. S is a corner to corner network of singular values in decreasing way. The essential thought behind SVD system of watermarking is to discover SVD of the picture and the modifying the singular quality to insert the watermark. In Digital watermarking plans, SVD is utilized because of its primary properties:

   1) A little unsettling included the picture, does not bring about the vast variety in its singular qualities.

   2) The singular quality represents to characteristic mathematical picture properties.

   3) Apply SVD to c_LL4 sub-band \( A_i = U_j \ast S_j \ast V_j^T \) \[ (3) \]
   Where \( A_i = c_LL4 \) (Cover)

   4) Apply SVD to s_LL4 sub-band \( A_i = U_j \ast S_j \ast V_j^T \) \[ (4) \]
   Where \( A_i = s_LL4 \) (Secret)

   5) Modify the singular value of \( A_i \) by embedding singular value of \( W \) such that \( S_j = S_j + \beta S_j \) \[ (5) \]
   Where \( S_j \) is modified singular matrix of \( A_j \) And \( \beta \) denotes the scaling factor, is used to control the strength of watermark signal

   6) Then apply SVD to this modified singular matrix \( S_pS_p = U_p \ast S_p \ast V_p^T \) \[ (6) \]
7) Take the modified 5-DWT coefficients, i.e., $A_{js} = U_{js} \times S_{js} \times V_{js}^T$.
8) Perform the protected image $A_{js}$ by applying 5-inverse DWT using one modified and other non-modified 5-DWT coefficients.

### B. Extraction Algorithm:
9) Apply five level DWT transform to decompose the protected image $A_{js}$ into four overlapping sub-bands (wm_LL4, wm_LH4, wm_HL4, wm_HH4).
10) Apply SVD to wm_LL4 sub-band i.e., $A_{js} = U_{js} \times S_{js} \times V_{js}^T$ (8) Where $A_{ijw} = \text{wm}_4$
11) Compute $S_{s} = (S_{js}-S_{ij})/\beta$, (9) where $S_s$ * singular matrix of extracted a secret image (possibly distorted).
12) Apply SVD to $S_{s}$ i.e., $S_{s} = U_{s} \times S_{s} \times V_{s}^T$ (10)
13) Now Compute extracted secret image $S*$ i.e., $S* = U_{s} \times S_{s} \times V_{s}^T$ (11)

### 1) Image Dataset:

#### Fig. 1:
Take 6 Gray Medical Image and 6 Color Image

#### Fig. 2:
Show Cover Compressed Image and Secret Color Image

### 3) Generate Protected Image:

#### Fig. 3: Show Protected Image

### 4) Apply Noise Attacks on Protected Image:

#### Fig. 4:
(a) Noise Attack with 0.001 (b) Show Recovered Image (c) Show Extracted Secret Color Image

### 5) Rotation Attack on Protected Image:

#### Fig. 5:
(a) Rotation Attack with 10° (b) Show Recovered Image (c) Show Extracted Secret Color Image

### 6) Read Cover Gray Image and Secret Gray Image:

#### Fig. 6:
Show Cover Gray and Secret Gray Image

### 7) Generated Protected Image:

#### Fig. 7:
Show Protected Image
8) Apply Attacks on Protected Image:

![Image showing noise and rotation attack]

Fig. 8: Show Noise and Rotation Attack

IV. PERFORMANCE EVALUATION

<table>
<thead>
<tr>
<th>Cover Gray Image</th>
<th>Base PSNR</th>
<th>Proposed PSNR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cover gray image</td>
<td>26.3841</td>
<td>28.5375</td>
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<tr>
<td>Cover gray image</td>
<td>27.2111</td>
<td>29.4414</td>
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<td>Cover gray image</td>
<td>44.5075</td>
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<td>Cover gray image</td>
<td>27.6153</td>
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<td>Cover gray image</td>
<td>20.9588</td>
<td>21.3085</td>
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<tr>
<td>Cover gray image</td>
<td>19.6795</td>
<td>21.1612</td>
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</table>

Table 1: PSNR Comparison between Base and Proposed Algorithm

<table>
<thead>
<tr>
<th>Cover Gray Image</th>
<th>Base NC</th>
<th>Proposed NC</th>
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<tbody>
<tr>
<td>Cover gray image</td>
<td>0.8710</td>
<td>0.8497</td>
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Table 2: NC Comparison between Base and Proposed Algorithm

<table>
<thead>
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<th>Cover Gray Image</th>
<th>Base MSE</th>
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<td>94.8946</td>
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Table 3: MSE Comparison between Base and Proposed Algorithm
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Table 4: Showing Results of Color Watermarking Image For Proposed Algorithm

<table>
<thead>
<tr>
<th>Cover Color Image</th>
<th>Red PSNR</th>
<th>Green PSNR</th>
<th>Blue PSNR</th>
<th>MSE</th>
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<tbody>
<tr>
<td></td>
<td>61.102</td>
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<td>63.073</td>
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</table>

Graph 1: NC Comparison between Base and Proposed Method

Graph 2: Proposed Algorithm Results on PSNR and MSE

V. CONCLUSION

In this paper, we show a powerful embedding calculation for digital watermarking utilizing 5-dimensional wavelet discrete transform (5-WDT) and singular value decomposition (SVD). From the observation, we can say that proposed estimation exhibits its proficiency against attacks. The trial results, evaluate the eventual outcome of the existing arrangement and proposed arrangement considering the parameters of PSNR, MSE, and Normalized Correlation. From the results we can say that the proposed arrangement works better than the present arrangement. We accomplished PSNR esteem up to 70%. The 5-DWT-SVD watermarking methodology can be striven for distinctive attacks like salt and pepper noise, rotation. The work can be extended out of equipment execution and performance examination in other change areas like wavelet discrete transform.

REFERENCES


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