Region Based Undetectable Multiple Image Watermarking

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Abstract—Today detectability of Intellectual Property in the digital world is a major issue. And a watermarking is one of them process to secure intellectual rights of digital assets. In our paper we propose a method to insert multiple watermark in spatial and frequency domain to make our assets secure and undetectable by dividing our host image into two regions, called region-A and region-B. In a region-A, an owner information is inserted with the help of LSB technique and in another, region-B, a circular watermarks are inserted with additive watermarking technique in DWT-DFT domain.

Index Terms: Intellectual Properties,Digital Rights Management(DRM),Discrete Fourier Transformation(DFT),Discrete Wavlet Transformation(DWT).

I. INTRODUCTION

Digital Watermarking has been used as a tool to protect the Intellectual Property Rights of Multimedia Documents. Through the watermarking we are able to prevent the unauthorized access, modification, and alteration of digital multimedia document[1].In today's era distribution of digital documents and e-commerce are widely used. Problems of Intellectual and copyright protection can be solved through multiple watermarking. In Multiple Watermarking we can insert more than one watermark into Multimedia content, to accomplish various goals of Digital Watermarking. A DRM Group preserving all the Intellectual Property Rights of multimedia documents. Digital watermarking is referred as to embedding information into a digital media in such a way that it is imperceptible to human eyes but can be easily detecting to embedded[1][2]. A watermark must be scattered into an image in such a way that its identification and modification should be preventive. Based on the domain, an insertion of watermarking can be divided into two parts.

A. Spatial Domain

Watermarking done through direct modifying the pixel values of the host image with having some correlation to it[1][3]. This technique is generally used because of its simplicity. This technique is fragile against attacks, and more perceptible[4]. Watermark insertion into host image can be in the Most Significant Bit (MSB) or in Least Significant Bit (LSB) bit of the host image's pixel.

B. Frequency Domain

Watermarking done through, transforming a host image into frequency domain using Discrete Fourier, Discrete Cosine, or Discrete Wavelet Transformation. After that watermark is inserted into transformed image . This technique improves security of watermark against attacks, and it also increases robustness.

1) **Discrete Fourier Transformation:** It is of fundamental important to image processing.It allows us to perform tasks which would be impossible to perform any other way; its efficiency allows us to perform other tasks more quickly[5]. The host image is transformed with the help of fast fourier transformation which, contains a unique feature, a symmetrical form after shifting the DFT coefficients of host image[6]. DFT coefficients contains positive and negative real and imaginary values. Fig.1 shows the transformed DFT image of Barbara, Lena and Tracy.

2) **Discrete Wavelet Transformation:** This transform concentrate on time and frequency. It transforms an image based on host image frequencies value into four sub-band called approximation, vertical, horizontal and diagonal, with the help by applying low pass and high pass filter on the host image. Low frequency information of the image is contain by approximation sub-band and high frequency contain by diagonal sub-band. Rest other two sub-band contains an average frequency of the host image. Fig.2 and Fig.3 shows wavelet transformation in general and on image Zelda respectively.

3) **Discrete Cosine Transformation:** It is a real part of fourier transformation. It doesn't contain any imaginary part when the host image is transforms by discrete cosine transformation. It divide host image into 8x8 block size and cosine transformation is applied on it. In this 8x8 block upper left corner contains the low frequencies, the middle part contains a mid-frequencies and the rest part contains the high frequencies of the transformed host image.

II. MULTIPLE WATERMARKING

Different watermarking techniques solve number of problems, who is source, creator, Originator etc. Multiple watermarking adds the advantages of different watermarking techniques into one, in the terms of robustness and security[7][8].

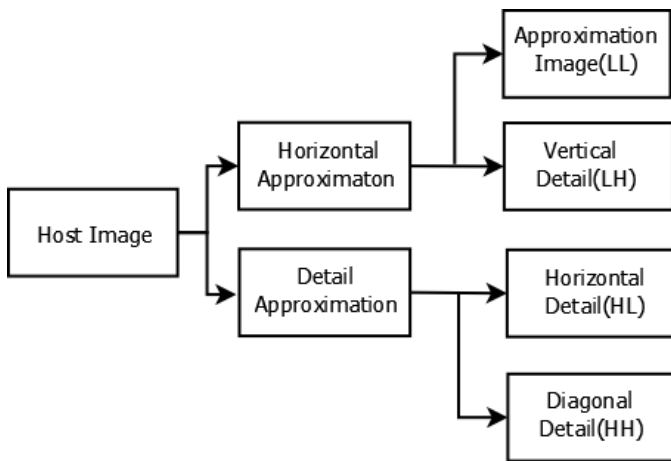Fig. 1. A standard image processing image with their respective Discrete Fourier Transformed image

(a).Barbara   (b).Lena   (c).Tracy

Fig. 2. A general idea of DWT to divide an image into sub-bands

Fig. 3. A DWT on image Zelda

All the features of a watermarking are also true for multiple watermarking. In the multiple watermarking, capacity of watermark is a foremost factor. Depending on the embedding methods available, we must take care that our watermark able to survive by embedding more than one watermark, and will not destroy or at least reduce itself[3][9].

III. **RELATED WORK**

Raval et. al.[9] Analysis the performance of multiple watermark in low and high frequency sub band of 2nd level of DWT by inserting two different binary watermarks using an additive scaling method. Taking strength factor of watermark as 0.10. Tao et al.[10] Securing multiple watermark image in DWT up to two level by inserting four same watermarks at 1st and 2nd level of DWT in all sub-bands and analyzing the performance of all watermarks. Ganic et. al.[6] Inserts multiple watermark into the coefficient of transformed DFT image by selecting high and low frequencies to make a watermarks undetectable from the watermarked image. Ranjan et. al.[11] Securing non-blind block based watermarking by inserting a
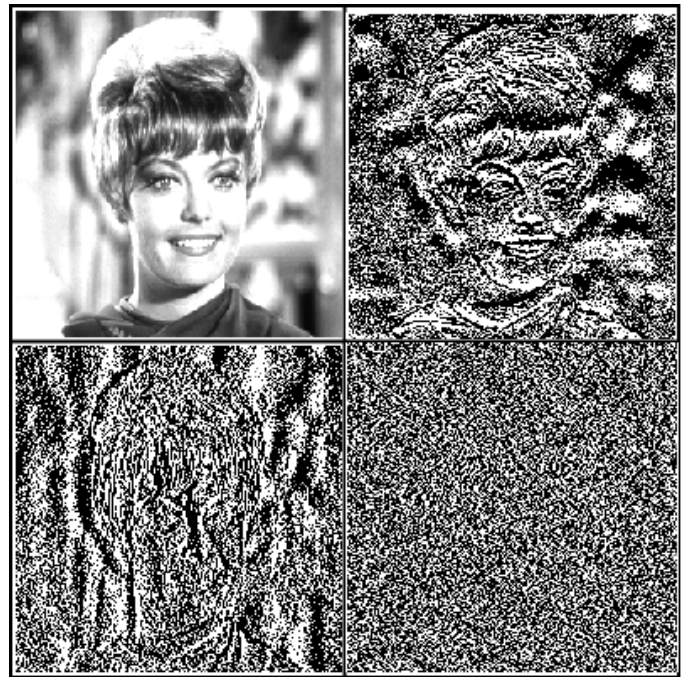
binary watermark into last pixel of each block after applying one level of DWT and DCT of block size 8*8. Baisa et. al.[12] Done insertion of watermark by scrambling watermark in middle frequency sub-band of DWT. To make it more secure they use pseudo random sequence to generate a periodic of watermark. Scrambling of watermark is done by Arnold Transform. Tao et. al.[13] Recovers the damaged watermark blocks with the help of host image's magnitudes coefficients of DFT. Hana et.al.[14] Creating their proposed technique more robust against attack by inserting same watermark at 1st and 2nd level of DWT in LL and HH sub-band. Sushila et. al.[15]Securing multiple watermark at 1st level by creating orthogonal projection vector of a size 8*8. By applying 1st level of DWT on Host Image and dividing LL sub-band into 8*8 blocks and inserting multiple watermarks in it.

IV. **PROPOSED METHOD**

We are proposing a multiple watermarking technique to insert more than one watermark into the host image with the features benefit of spatial and frequency domain. Which overcomes each others drawback. In our propose work we, insert three watermarks, one is by using any spatial domain technique which contains the information about the host image and owner. And other two watermarks are inserting in the DFT domain with the help of DWT. DFT having an undetectablity property and DWT have a robustness property. A host image is divided into two regions called A and B. In these two regions watermarks are inserted. Watermark inserted into region-A with the help of spatial domain and in Region-B with the help of frequency domain following with Parts-A, B and C. Figure
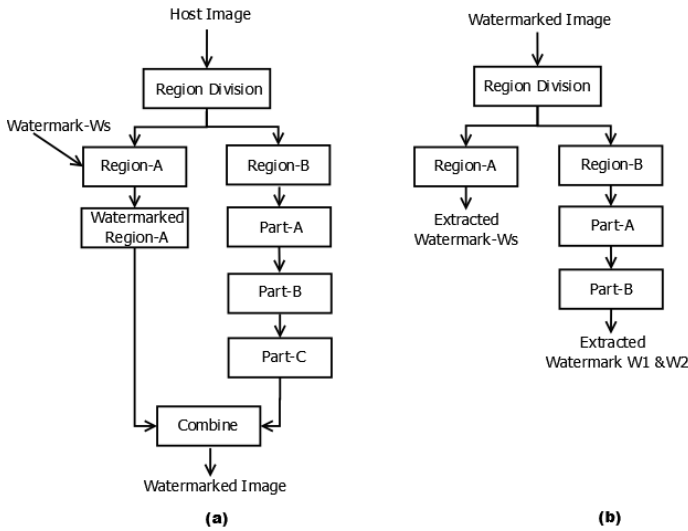
Fig. 4. (a)Watermark Embedding Process of our Propose Method; (b) Watermark Extraction Process from the Watermarked Image
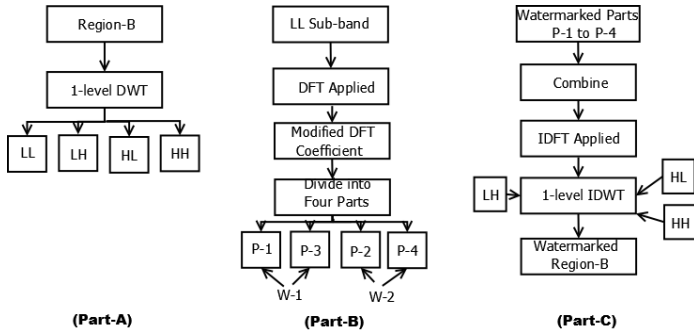

Fig. 5. shows parts which used in watermark embedding and extracting process
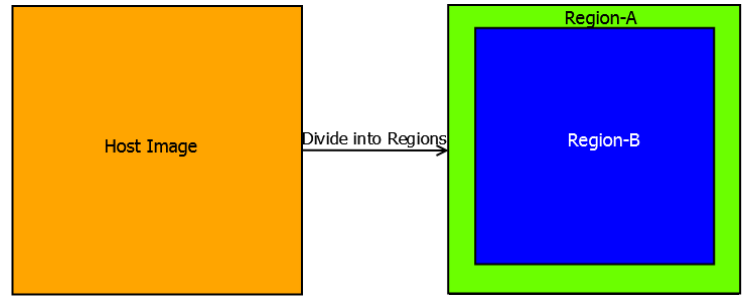

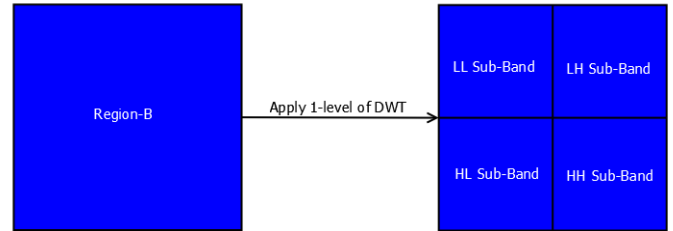Fig. 6. Division of Host Image into Region-A and Region-B.

Fig. 7. Division of Region-B into sub band using DWT

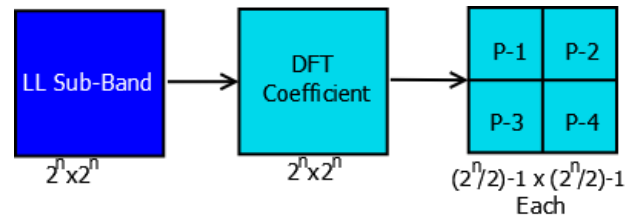

Fig. 8. Division of DFT coefficients into parts P-1 to P-4, where P-1 is symmetric to P-4 and P-2 is symmetric to P-3

4(a), 4(b), shows the embedding and Extracting process of our propose work.

A. Watermark Embedding Algorithm:

Insertion of watermarks are divided into three parts called Part-A, Part-B and Part-C.

- **Step 1:** A host image of size M x M divided into two regions called Region-A and Region-B. Division of regions must be in such a way that the size of Region-B is $2^{(n+1)}$ x $2^{(n+1)}$. Where, $2 <= n <= M$.
- **Step 2:** Watermark Insertion process into the regions A and B, shown in figure 4.
- **Step 3:** Watermark Insertion in Region-A:
  In this step a watermark's information Ws is inserting in a region-A using a spatial domain technique of Least Significant Bit, at 6th bit plane. It contains a least valuable information of host image and owner.
- **Step 4:** Watermark Insertion in Region-B:

  – **Step 4.1: Part A:**

    ∗ **i.** Apply one level of DWT on the Region-B.
    ∗ **ii.** We got four sub-bands LL, LH, HL and HH with four different frequencies called an approximation, vertical, horizontal and diagonal respectively. Details division of regions and bands shown in fig.6 and fig.7.

  – **Step 4.2: Part B:**

    ∗ **i.** Select LL sub-band whose size is 2^n x 2^n. Apply DFT on it. Through this we got a modified coefficients of LL whose size is same as LL sub-band. Shown in figure 5.
    ∗ **ii.** Coefficients of LL sub-bands divided into four parts of each size is $\frac{2^n}{2} - 1$ x $\frac{2^n}{2} - 1$.

  – **iii.** Watermark Insertion for P-1.

    ∗ **a.** Select a high and a low DFT coefficients of P-1.
    ∗ **b.** Select a block size 'b' and a pseudo random number (PRN-1) of length 'l', where b*l = size of P-1.
    ∗ **c. Creation of Watermark W-1:** Each frequency band is replaced by one component of PRN-1 in

every block. A replacement location is selected randomly.

* **d.** Select two scaling factor, ll and hh for low frequencies and high frequencies respectively. Where ll $>=$ hh.
* **e.** Add W-1 in P-1 by additive scaling method.

– **iv.** Copy P-1 into P-4 because of DFT symmetrical feature.
– **v.** Watermark Insertion in P-2.

* **a.** Select same frequencies bands for P-2, as selected in P-1.
* **b.** Select a block size 'b' and a different pseudo random number (PRN-2) of length 'l', where b*l = size of P-1.
* **c.** Watermark Insertion for P-2.
* **d. Creation of Watermark W-2:** Watermark W-2 is created same as step 4.2.iii.c with PRN-2.
* **e.** Use same scaling factor to insert W-2 in P-2 as in step 4.2.iii.e.

– **vi.** Copy P-2 into P-4 because of DFT symmetrical feature.
– **Step 4.2: Part C:**

* **i.** Combine all Watermarked parts P-1, P-2, P-3, P-4 and $\frac{2^n}{2}$ th row and col. And apply reverse DFT on Combined image.
* **ii.** Apply reverse DWT on watermarked LL and its respective sub-bands. This gives us a watermarked Region-B.

- **Step 5:** Combine Watermarked Region-A and Watermarked Region-B to get a Watermarked Image.

B. **Watermark Extraction Algorithm:**

To extract a Watermarks a reverse process of embedding is applied.

- **Step 1:** Divide Watermarked Image into Regions A and B.
- **Step 2:** Extract Watermark Ws from Region-A, by selecting LSB's values from 6th bit plane.
- **Step 3:** Apply part-A and part-B on Region-B, and extract Watermark W1 and W2 from it. For the detection of watermark from the watermarked image reference [6] is followed.

V. **CONCLUSION**

We propose a multiple watermarking technique with taking benefits of spatial and frequency domain. Our motto is to make our watermarks secure and undetectable with the help of inserting watermarks into different regions. Semi-fragile watermark inserted into region-A and a robust one into region-B, with the help of LSB and circular watermark insertion method respectively. Our propose method can we widely used in the field of medical to insert patients sensitive diseases information. It can also be used in covert channel for communication purpose where the insertion of watermark is undetectable.

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