Error-Resistant Image Watermarking Using DWT and Linear Modulation with LDPC Correction

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Abstract.

The DWT and linear modulation along with the LDPC code are employed to create a robust watermarking scheme that sends the information reliably and in a no distorted way. However, the watermarking technique intended for copyright and integrity verification of downloaded data often comes up against signal distortion, side errors, and transmission errors. This technique ensures the watermark remains hidden while preserving the image's visual quality.. The linear modulation scheme, combined with LDPC codes, is a strong error correction method which ensures that even if the watermark is subjected to noise, compression, or other image distortions, it can be correctly extracted.

Keywords: Watermarking, Discrete Wavelet transform, Linear modulation, LDPC.

1. INTRODUCTION

The digital era has resulted in a significant increase in the amount and various multimedia content, giving rise to critical problems in stopping intellectual real estate from being stolen. Rather than images, videos and sounds are most commonly stolen or shared online and this does cause an economic toll on creatives [1]. Therefore, watermarking has become a key weapon for hiding additional messages in the digital content which allows one detect ownership or give copyright specifics [2]. Epoch2 provides a large-scale dataset hosting 332,000 images that are resistant to various image attacks — such as compression, cropping and noise addition—when shared on different platforms. These challenges can result in degradation of the watermark's quality or even its detection, resulting in a need for methods Watermarking methods, which are designed to be highly resistant to errors, generally fall into two main categories: spatial domain techniques and frequency domain techniques.. The use of spatial domain techniques means one must print directly with the pixel values which are much easier to break compared a typical image processing [3].

2

2. METHODOLOGY

The steps of error-free image watermarking are image Acquisition and Preprocessing, First, we load the grey-scale host image that will hold the watermarked. A downsized version of this image to save memory. Next, the logo/watermark image is also loaded and converted to grayscale form for binary representation after thresholding[4]. The resulting binary watermark is then scaled to the size limit of an area within the host image[5].

After preparing the images, you need to visualize your input images. Images must be displayed using matplotlib so that we can again check the host image and binary watermark are correctly loaded as they prepared[6].

Then we use a 2D Discrete Wavelet Transform (DWT) with the Haar wavelet in it over the host image[7]. So if you apply wavelet transform to the image, it breaks down an image into LL,LH,HL and HH (low-low frequency component, low-high frequency component, highlow resonant component promise marsh) These components of DWT results are represented for observing their nature.

3. BLOCK DIAGRAMS

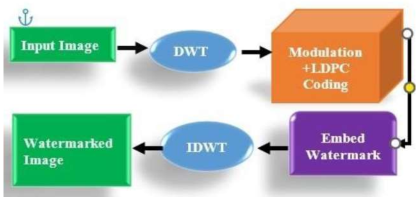

Figure 3.1: Block diagram of Watermark Extraction Embedding.

Figure 3.2: Block diagram of Watermark

3.1. Equations.

$$\text{PSNR} = 10 \log_{10} \left(\frac{MAX^{\wedge}2}{MSE}\right) \tag{2.1}$$

Where:

- MAX- Maximum possible pixel value of the image which can be e.g. 255 for 8-bit grayscale image.
- MSE- Mean Square Error which means it is defined as the mean of the squared difference between an original and a watermarked image pixel values.

Explanation of MSE Terms

$$\text{MSE} = \frac{1}{MN} \sum_{i=0}^{M-1} \sum_{j=0}^{N-1} [I(i,j) - K(i,j)]^2 \tag{2.2}$$

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- *M*, *N*: Dimensions of the image
  I(i, j): Pixel value at position *(i, j)* in the original image
- *K(i, j)*: Pixel value at the same position in the watermarked image

4. RESULT AND DISCUSSION

DWT, LDPC encoding, and BPSK modulation are used for watermark embedding to embed a binary logo in a grayscale host image, so the process of digital watermarking is performed using this code.Initially.The host image is broken down into four sub-bands—LL, LH, HL, and HH—using the Discrete Wavelet Transform (DWT).Because higher frequency components can embed a watermark with minimal visual impact, the HH sub-band is well-suited for preserving visual quality. The watermark is first encoded with LDPC encoding, modulated by BPSK, and embedded in the HH sub-band using an embedding strength at a level of alpha = 0.1. Further increases of this parameter make the watermark visible, but this does not work if it were very small as it would practically become almost invisible. Hence it supports integrity, with minimal disruption to visual humans. Further verification of this is conducted based on values obtained in terms of PSNR and SSIM values for water marking extraction as compared to that obtained in original images. PSNR stands for high pixel accuracy, and SSIM suggests that the structure and quality of the original image are preserved. A PSNR above 32 dB and an SSIM close to 1 confirm that the watermarked image maintains its structural integrity as well.

Figure 4.1. Host Image.

Figure 4.2. Final image.

Figure 4.3. DWT-LL

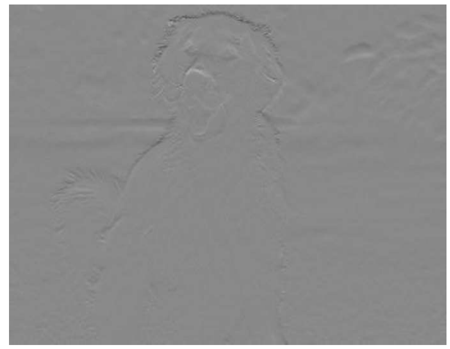

Figure 4.4. DWT-LH.

Figure 4.5. DWT-HH

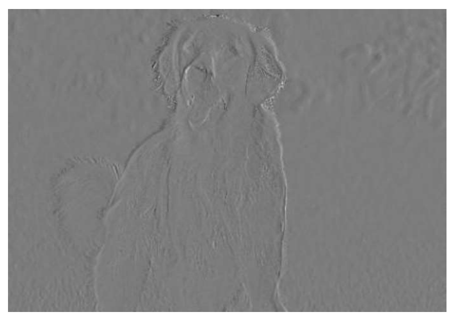

Figure 4.6. DWT-HL

TABLE I. MATRICS VALUES

Metrics	Value
PSNR	42.4500025628337
SSIM	0.9984911875494427

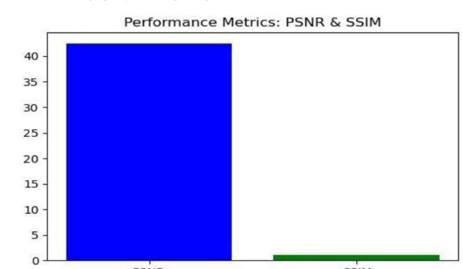

Figure 4.7: Graphical Analysis

5. REFERENCES

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Biographies

Amrutha Podipireddy received She completed her bachelor's degree in Electronics and Communication Engineering from JNTUK University in 2009. A few years later, in 2013, she earned her master's degree in Digital Electronics and Communication Engineering from the same university. Currently, she holds the position of Assistant Professor in the Department of Electronics and Communication Engineering at Dadi Institute of Engineering and Technology, Anakapalle.

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