# A Robust Image Watermarking Technique Using Luminance Based Area Selection and Block Pixel Value Differencing

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**Abstract :-***This work presents a digital image watermarking technique. It is a semi-blind process to insert invisible watermarks aimed towards strengthening the robustness, imperceptibility and security of watermark embedded in the watermarked image. In direction to achieve the mentioned objectives, this work luminance based area selection and block pixel value differencing. Watermark is embedded in blocks pixels of image based on the difference of two pixels. Calculated inter pixel differencing two pairs with highest difference values are selected for embedding .This highest values of difference is compared in range table and find the maximum number of bits of information . Thus, The Quality of image is maintained by using block pixel value differencing. This method improves the embedding capacity and makes the information undetectable. The proposed algorithm is quantitatively validated using three performance metrics namely peak signal to noise ratio, mean squared error and bit error rate. This approach is tested against variety of attacks and filter which shows a great ability to preserve the watermark against these attacks.*

***Keywords* -** Color image, PVD, log average luminance, MSE, PSNR, BER, watermarking techniques

## 1. INTRODUCTION

In recent years, unauthorized distribution of digital media such as audios, videos and images has become the most important challenge that faces media copyright protection. The digital communication technology, like internet technology confronts various troubles related to the privacy and security of the data. Security techniques are required because of illegal access of data without permission. Many techniques are used for providing the security of digital data like encryption, decryption, cryptography, steganography and digital watermarking. Authentication and information hiding and proof ownership have also become important issues. To accomplish these issues, watermarking technology is used. Digital watermarking[1] is a method for embedding some secret information and additional information in the cover image. . Digital watermarking addresses the growing concerns of theft and tampering through the use of advanced signal processing strategies to embed copyright and authentication information within multimedia content. Digital watermarking is use to authentication, owner identification, content protection and copyright protection. In other words, a watermark is a pattern of bits inserted into multimedia data such as digital image, audio or video file that helps to identify the file's copyright information. Watermark can provide information that serves as proof of ownership. Watermark may be a visible signature or logo placed over an image to determine the owner of that image.

## 2. LITERATURE REVIEW

Digital watermarking techniques are classified based on two working domain spatial domain and frequency domain. The spatial domain techniques works directly on pixels. It embeds the watermark by modifying the pixels value. Most commonly used spatial domain techniques are LSB and PVD. In LSB technique, these approaches use minor changes in the pixel value intensity. The watermark data is embedded into least significant bits of pixels. In PVD, method, it uses the difference value between two consecutive pixels in a block to determine how many secret bits should be embedded. It offers the advantage of conveying a large amount of message, while still maintaining the consistency of an image characteristic after data embedding. Most commonly used transform domain techniques are DCT, DWT and SVD [9]. All these techniques work on frequency components of image to embed watermark data. Transform domain techniques [2] embed the watermark by modifying the transform domain coefficients.

## 3. LUMINANCE BASED AREA SELECTION AND BLOCK PIXEL VALUE DIFFERENCING

We proposed a new technique for watermarking embedding in digital image. The area for embedding is selected using luminance based location method [2]. J. Hussein [6], in his work had developed a method for selecting the embedding area in cover image using

Luminance of image. The image of size 512X512 is divided into 8×8 blocks and the following operations are needed and must be performed to accomplish the embedding and extracting processes.RGB $YC_bC_r$ conversion

### 3.1 RGB to $YC_bC_r$ Conversion

The RGB color space is converted to YCbCr color space for each 8×8 block using the equations (1):

$$Y = 0.299 \times R + 0.587 \times G + 0.114 \times B$$
$$Cb = 0.596 \times R - 0.275 \times G - 0.321 \times B$$
$$Cr = 0.212 \times R - 0.523 \times G - 0.311 \times B \qquad (1)$$

where R, G, and B are red, green and blue components of RGB color space respectively.

### 3.2 Log-Average Luminance

The block selection criteria are dependent on log-average luminance for the entire image and log-average luminance for each block. The log-average luminance Yavg is calculated as shown in the equation (2)

$$L_{avg} = \exp(\sum \log(\delta + Y_{x,y})/N) \qquad (2)$$

$L_{avg}$ : Log-average luminance

$Y_{x,y}$: Luminance Y of the pixel at x,y

δ : A small value to avoid taking the log of a completely black pixel whose luminance is zero

N: The number of pixels in the image.

### 3.3 Block Selection Criterion

When 512×512 host image is divided into 8×8 blocks, 4096 blocks are produced. Since the watermark size is 32×32 pixels and if we consider minimum embedding capacity of 1 bit, each block can be used to embed 32 bits minimum and thus we require only 256 blocks to embed the entire watermark.

After finding the log-average luminance for the entire image and for each block; the best blocks are chosen from the blocks that have log-average luminance closer to the log-average luminance of the entire image [6]. To do that we select the blocks with log average luminance in the range [$Yavg$-$\beta$, $Yavg$+$\beta$,] where Yavg is the log average luminance of the image and β is the minimum floating-point value that is enough to determine adequate number of blocks.

### 3.4 Embedding process

Now in selected blocks separate RGB components of color image. We can embed our watermark using block pixel value differencing. In this method, from a selected block, we further divided the block into segments of 2X2 pixels (for each color plane). In each segment, we calculated inter pixel differences and two pairs with highest difference values are selected for embedding the information. This highest values of difference is compared in range table and we find the maximum number of bits of information (from secret message). This method not only improves the embedding capacity, but also makes the information undetectable. The complete embedding and extracting method is described in following section.

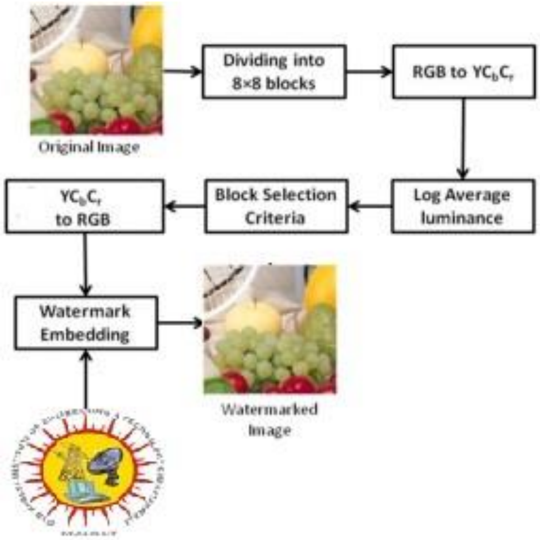



Figure 1 Watermarking Embedding

#### 3.4.1 Embedding Algorithm

i. Read this Cover –Image and separate its RGB components.

ii. Divide the selected block of size 8X8 into the segments of 2X2 pixels.

iii. Calculate the difference value $d_i$' for each segment of two consecutive non-overlapping pixels ***p(i)*** and ***p(i+1)*** and is given by $d_i = |p(i) - p(i+1)|$

iv. Now find the two highest difference value among four difference values of each colour plane which are not made by common pixel value.

v. Making the optimal range Table $R_i$ for the di such that

$$R_i = \min(u_i, d_i), \text{where } u_i \geq d_i$$

This is the optimum range where the difference lie.

vi. Compute the number of secret data ***bits't'*** to be embedded in selected pixel pair from the width $w_i$ of the optimum range, can be defined as

$$t = \log 2\, w_i.$$

vii. Read ***'t'*** bits from secret message and convert it into its decimal value b.

viii. Now finding the new difference value $d_i$' using m= $d_i$'=$l_i$ +b.

ix. Modify the values of $p_i$ and $P_{i+1}$ by the original PVD method as discussed in review section. (Where $p_i$ and $P_{i+1}$ are R and B components). Here only R and B components are selected because these two components add very little to Y value and uniformly distributing the difference does not alter their values to much extent and Y values remains almost same

x. Now repeat the steps for next segment in selected block and repeat the process for all selected blocks depending ipon the size of watermark.

Range table:-

| Range | Difference | Number of bits |
|---|---|---|
| 0-8 | 8 | $2^3$ |
| 9-16 | 8 | $2^3$ |
| 17-32 | 16 | $2^4$ |
| 33-64 | 32 | $2^5$ |
| 65-128 | 64 | $2^6$ |
| 129-256 | 128 | $2^7$ |

### 3.4.2 Quality measurement

The quality of the watermarked image is measured by finding Mean Square Error and peak signal to noise ratio (PSNR) values of the watermarked image and the original image. Lower MSE values and higher PSNR values imply good embedding results.

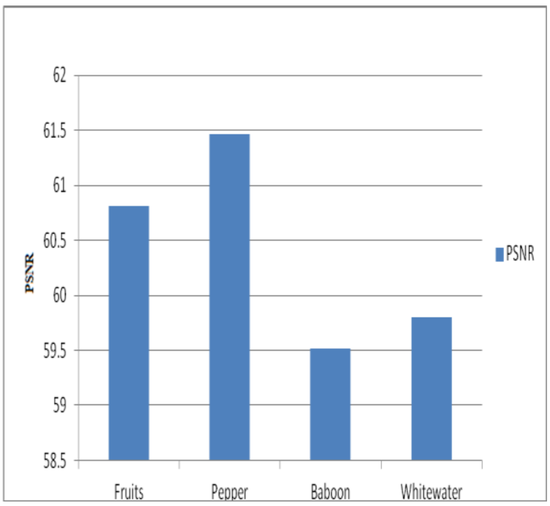



Figure 2 PSNR values of various images

### 3.4.3 Extraction Algorithm

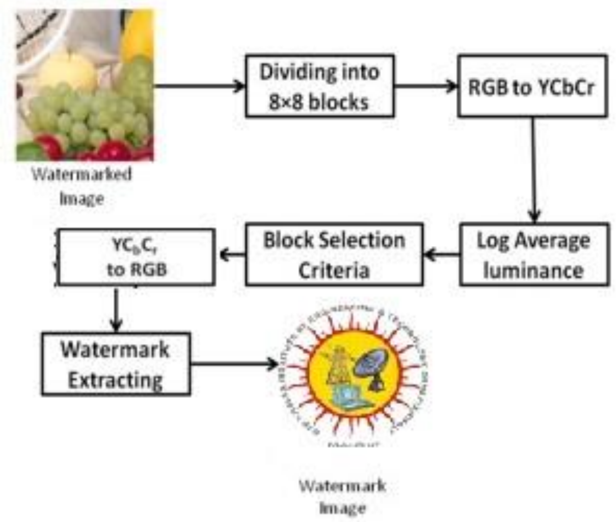



Figure 3 Extraction process

For the extraction process, the blocks are selected in the same manner as discussed in embedding procedure. While decoding the data from the watermarked-image, the range table, which is used at encoding, is required. The following steps used for extracting the hidden data:

i. Read this Cover –Image and separate its RGB components.

ii. Divide the selected block of size 8X8 into the segments of 2X2 pixels.

iii. Calculate the difference value ***$d_i$'*** for each segment of two consecutive non-overlapping pixels ***p(i)*** and ***p(i+1)*** and is given by

$$d_i=|p(i) - p(i+1)|$$

iv. Now find the two highest difference value among four difference values of each colour plane which are not made by common pixel value.

v. Compute the b' by b'= di'-li. Convert b' into binary of't' bits, where t=log2 $w_i$. These t bits are the hidden secret data.

Now repeat the process for other pixels by moving right to left and then to top for an image and extract the message bits before the previously extracted bits. After that these binary information is converted in to watermark image

## 4. Experimental Results

The imperceptibility and robustness of the proposed scheme demonstrated is using MATLAB, quality measures such as are used. The images used to calculate the PSNR (peak signal to noise ratio), BER (bit error ratio) and MSE (mean square error) are fruits, peppers, Baboon, whitewater images and the results of proposed method on these images have been described in Table 1 . The proposed method is tested with various attacks and the quality parameters like highpass, lowpass, Gaussian, median and JPEG compression are listed in Table 2. The result values of Table 1 clearly indicate the robustness and quality of the image is not degraded. The efficiency of the proposed method in this paper is compared against DCT method.

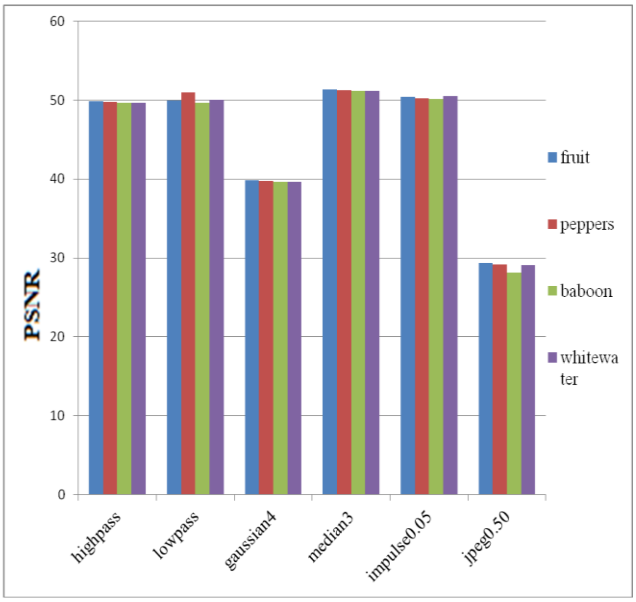



Figure 4 PSNR values after various attacks

**Table 1:** Comparison of Results of Hussein's and Proposed Method

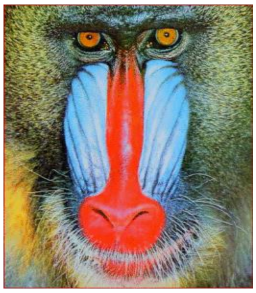
| Images | J.A.Hussein[6] method | Proposed Method | | |
|---|---|---|---|---|
| | PSNR | PSNR | MSE | BER |
| Fruits | 32.512 | 60.809 | 0.217 | 0.0164 |
| Peppers | 35.000 | 61.460 | 0.187 | 0.0163 |
| Baboon | 34.990 | 59.510 | 0.293 | 0.0168 |
| White Water | 32.650 | 59.797 | 0.274 | 0.0167 |

## 5. CONCLUSION

In this research paper, a new approach has been proposed. This approach achieves high imperceptibility and robustness of the embedded watermark. The blocks for embedding are selected using luminance of the image. The watermark is embedded using block pixel value differencing, which is more effective than DCT method. only the blocks with log-average luminance close to the log-average luminance of the entire image are used to embed the watermark. The test results show that these blocks do not degrade the image when the pixels' luminance value is increased or decreased. The experimental results show a high degree of robustness against a number of unintentional attacks such as highpass filter, lowpass filter, Gaussian, median, impulse and JPEG compression. The efficiency of the embedding process is measured by using PSNR value between the original and the watermarked image.

Fruits Image

pepper Image



Baboon Image

Whitewater Image

Watermark Image

**Table 2:** Values of Various Parameters after Attacks

| Images | | Attacks | | | | | |
|---|---|---|---|---|---|---|---|
| | | **Highpass** | **Lowpass** | **Gaussian4** | **Median 3** | **Impulse 0.5** | **Jpeg 0.50** |
| Fruits | MSE | 17.0518 | 19.7868 | 27.0390 | 15.4781 | 16.5282 | 37.5176 |
| | PSNR | 49.8845 | 49.9668 | 39.8655 | 51.3963 | 50.3883 | 29.3479 |
| | BER | 0.0200 | 0.0202 | 0.0251 | 0.0195 | 0.0198 | 0.0341 |
| Peppe rs | MSE | 17.8893 | 10.9906 | 27.9048 | 16.3753 | 17.4190 | 38.4130 |
| | PSNR | 49.7523 | 50.9845 | 39.7286 | 51.2545 | 50.2477 | 29.1999 |
| | BER | 0.0201 | 0.996 | 0.0252 | 0.0195 | 0.199 | 0.342 |
| Baboo n | MSE | 18.5009 | 18.4421 | 28.6055 | 16.9961 | 18.0203 | 39.0512 |
| | PSNR | 49.6582 | 49.6672 | 39.6209 | 51.1589 | 50.1552 | 28.1078 |
| | BER | 0.201 | 0.0201 | 0.0252 | 0.0195 | 0.0199 | 0.0344 |
| White Water | MSE | 18.5054 | 16.1416 | 28.6351 | 17.0277 | 18.0790 | 39.1310 |
| | PSNR | 49.6575 | 50.0329 | 39.6164 | 51.1541 | 50.5463 | 29.0956 |
| | BER | 0.0201 | 0.0200 | 0.0252 | 0.0195 | 0.0199 | 0.0344 |

**Table 3:** Watermark extract using median filter after adding Impulse noises

| **Images** | | **Impulse(0.10)** | **Median filter(3)** |
|---|---|---|---|
| Fruits | MSE | 39.6673 | 7.8026 |
| | PSNR | 20.8411 | 52.8480 |
| | BER | 0.0480 | 0.0189 |
| Peppers | MSE | 38.2848 | 7.0640 |
| | PSNR | 21.1668 | 53.0171 |
| | BER | 0.0472 | 0.0189 |
| Baboon | MSE | 38.7398 | 6.2177 |
| | PSNR | 21.0569 | 53.2194 |
| | BER | 0.0475 | 0.0188 |
| Whitewater | MSE | 38.8564 | 7.0485 |
| | PSNR | 21.1048 | 52.3472 |
| | BER | 0.476 | 0.0188 |

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