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# Hybrid Technique for Image Watermarking Using 3 Level LWT-Walsh Transform-SVD in YCbCr Color Space

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**Abstract**

Security is the prime concern in Industry Revolution 4.0. There are various techniques like watermarking, steganography and cryptography through which data can be secured so that unauthorized person unable to access prime data. This research paper is implemented using hybrid watermarking technique in YCbCr colour space to preserve the data secure from attacks. In this technique, both cover and host images are translated into YCbCr colour space from RGB image using specific command. After converting it into projected colour space three channels are generated and out of them one channel is selected for further processing. After selecting specific channel, three levels LWT (3-LWT) executed and images translated into four segments (HH, HL, LH, LL) as per frequency. After performing 3-LWT, WHT technique implemented followed by SVD to get projected output. The ultimate point of research is to get an appreciated PSNR value and its robustness against various attacks so that implemented integrated techniques do better with respect to other method. The experimental executed results from respective table depicts comparative analysis among proposed and existed method for parameter PSNR as well as processing time for embedding. It is clear from the above table III that the PSNR value of existing technique is 58.01 and proposed technique is 71.11. The value of processing time for extracting in existing technology is 0.766 second and proposed technique is 0.788 second. In term of PSNR from executed result it is clear indication that 3 Level LWT, Walsh Hadmard and SVD technique is superior than 2 Level LWT, Walsh Hadmard and SVD. Therefore, implemented method performs better in term of various parameters.

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## 1. Introduction

The latest developments in computer systems and computer networks, enormous quantity of digital information may be effortlessly sent out and stored up. Nevertheless, it can be noted that transferred data through any network and accumulated information in workstations can simply be altered or modified by rivals if information is not enciphered with various cryptography tools. Consequently, data protection is the most imperative issue in recent automated society [1].

Fig. 1. Data transfer process between M2M.

Transferred data through any network and accumulated information in workstations can simply be altered or modified by rivals if information is not enciphered with various cryptography tools. Due to advancement in area of communications it is becoming simpler to decrypt crypted text. Therefore, more refined techniques are intended for offering superior security than cryptography and steganography [2-4]. The technique utilized is called watermarking. In watermarking the data can be securely transferred from transmitter to the receiver side by utilization of watermarks. A digital watermark is message/data/information implanted in digital contents (audios, videos, images and text) which could be perceived and extracted later on the receiver side. The data for embedding in signals is digital watermarks, though in other circumstances axiom digital watermarks mean differences amid watermarked signal and host signal. A digital watermarking system typically involves three discrete steps, embed, attacks and detection.

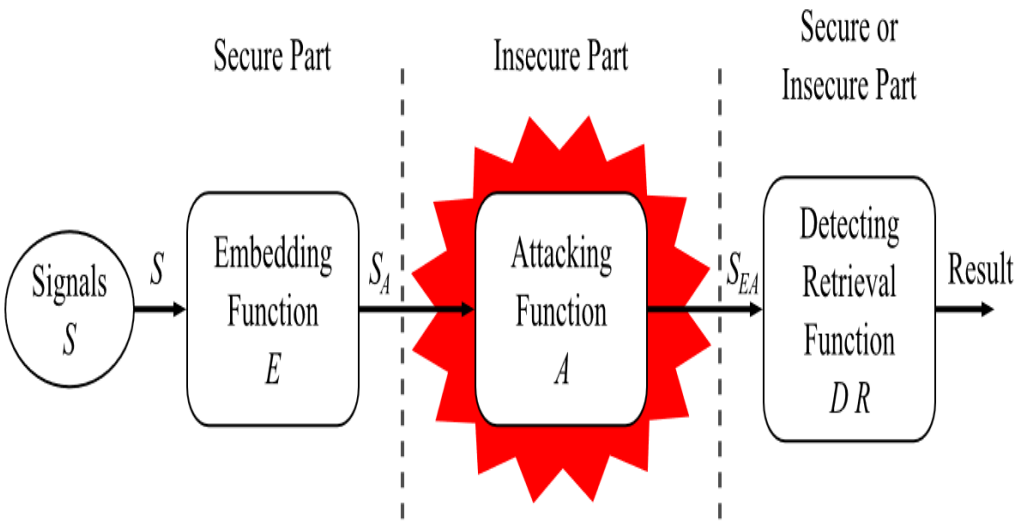


Fig.2. Digital watermarking life cycle phases.

Embedding is set of rules that accept host and data for embedding, and produce watermarked signals. Then watermarked digital signal is transferred and stored, typically transferred to another person. If any alteration is made by this person, it can be called attack [5]. If alteration is not malevolent, attacks arise from copyrighted protection applications, where unauthorized

person may try removing digital watermarks via modifications. These modifications can be done with any of the following methods:

- Loss compressing information (diminishing resolution),
- Cropping of images and videos or addition of noise deliberately.

Detection is set of rules utilized to attacked signal for extracting watermarks from it. In conditions signal was not modified throughout transmission phase, watermark will be there and signal can be dig out [7]. In tough digital watermarking applications, extractions algorithms must be capable for producing watermark accurately, even if alterations were sturdy.

## 2. Problem Formulation and Objectives

There are plenty of wavelet transform techniques which used to convert data from one domain to another domain for example lifting Wavelet Transform, Discrete Wavelet Transform and many more. Wavelet transform break down image into spatial domain and autonomous frequencies. DWT transformed image into four segments according to frequency content which are listed below:

- HH and HL
- LL and LH

One of the limitations of DWT is that it produces

- Blurring Noise near edges in images
- Ringing noise near edges in images

It happens due to big DWT fundamental. This limitation of earlier technique is conquering by LWT. Besides this LWT has fabulous computation time with respect to DWT. Existing technique is less secure against attacks therefore, hybrid techniques is proposed so that security issue can be resolved

**Objective:** In the research work, there are mainly four objectives which are listed below:

- To enhance the PSNR
- To make the system vigorous against a variety of attacks
- Execution time should be fast enough so that execution occurs instantly.
- To minimize the value of mean square error**.**

## 3. Methods

**3.1 Lifting Wavelet Transform:** Wavelet transform decomposes data into diverse spatial domain and autonomous frequencies and it is time domain analysis technique. When the image is DWT transformed, then image is segmented into four regions which are HH, HL, LH and LL. Out of these, LL is low frequency segment and rest are high frequency segments. Figure 1 shows the one level Discrete Wave Transforms decomposition process. In DWT method blurring effect is generated by wavelet filter and this is one of the major drawbacks of DWT

technique, along with some ringing noise produced at the edges of an images. LWT overcome this drawback of existed technique and besides this in proposed technique processing time also minimized which is also a milestone [8].

**3.2 Walsh Hadmard Transform:** Fourier transform can be executed on both real and complex numbers and Hadamard transform is a sample of a class of Fourier transforms. Hadamard transform execute various operation like linear, orthogonal and symmetric on $2^m$ real number. The Hadamard transform can be considered as being built of DFT. It decomposes a random input vector into a superposition of Walsh functions. Hadamard transform matrix consist only two types of elements either 1 or -1 and this matrix is an orthogonal square matrix. $H1$ is the smallest Hadamard matrix which is represented as [9]

$$H_1 = \frac{1}{\sqrt{2}}\begin{bmatrix}1 & 1\\ 1 & -1\end{bmatrix} \quad \text{.....Eq. No. (1)}$$

Superior size matrix computed with help of smallest Hadamard matrix as shown below:

$$H_2 = H_1 \times H_1 = \frac{1}{(\sqrt{2})^2}\begin{bmatrix}H_1 & H_1\\ H_1 & -H_1\end{bmatrix} \quad \text{.....Eq. No (2)}$$

In general formula for computing higher order matrix is depicted below:

$$H_n = H_{n-1} \times H_1 = \frac{1}{[\sqrt{2}]^n}\begin{bmatrix}H_{n-1} & H_{n-1}\\ H_{n-1} & -H_{n-1}\end{bmatrix} \quad \text{..... Eq. No (3)}$$

**3.3 Singular Value Decomposition:** SVD technique is very popular and used in various applications like matrix operation and data reduction in machine learning. Suppose there is a matrix M of order m×n and matrix may be real or complex does not matter and SVD technique segmented this matrix into three different matrixes as:

$M = USV^T$ ..... Eq. No (4)

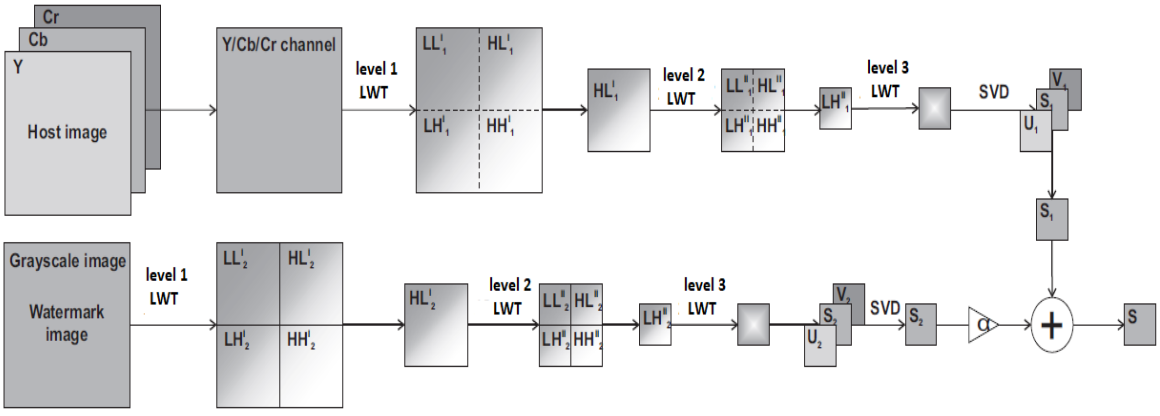


Fig.3. Procedure to combine S matrices of the Host Image and the Watermark Image.

Here V is known as a unitary matrix (real or complex) of order n × n. U is also a unitary matrix of order m×m (It can be complex or real). S is rectangular diagonal matrix which having non-negative real numbers on the diagonal of order m×n. One of the great edges of SVD technique is during utilization of singular matrix to insert watermark, minimum values of host images are changed due to which minimal changes take place in image and little changes can be discarded [10].

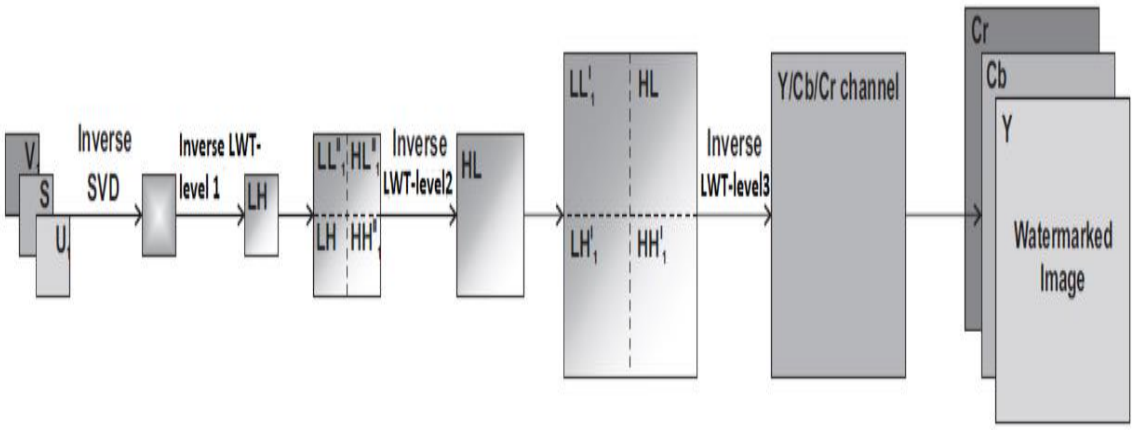


Fig.4. Procedure to get the watermarked image from the modified S matrix.

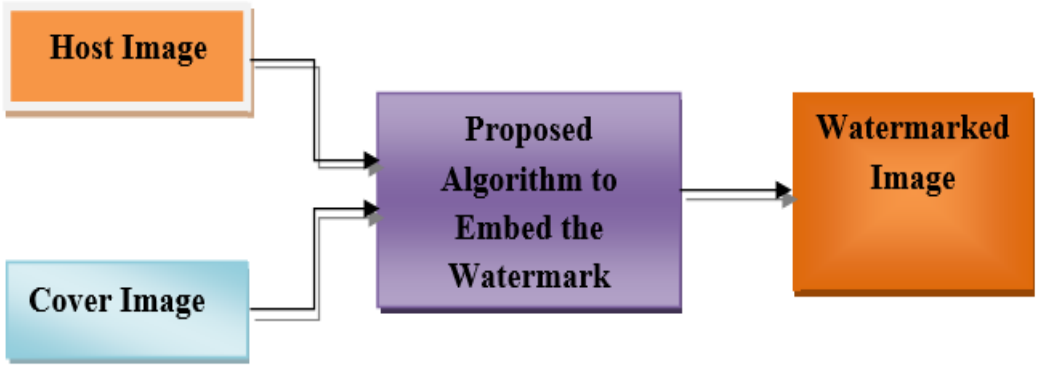


Fig.5. Representation of embedding of watermark image into the host image using proposed technique.

## 4. Results

In this section various result are listed which carried out in MATLAB 2021a environment. First of all, an appropriate benchmark dataset is selected from online repository for cover and watermark images.

**Table I: PSNR comparatively analysis among existing and proposed technique for watermarking**

| Sr. No | Cover Image | Watermark Image | Ref PSNR | 2 Level Proposed PSNR | 3 Level Proposed PSNR |
|---|---|---|---|---|---|
| **1** | Baboon | Pepper | 52.1232 | 55.2485 | 66.2982 |
| **2** | Bridge | Tulip | 52.2080 | 51.5613 | 67.8736 |
| **3** | Airplane | Lena | 42.1186 | 59.8033 | 71.7639 |
| **4** | Pepper | Bridge | 52.1812 | 65.4491 | 78.5393 |

The table I shows that there are two images one is cover image and other is watermark image.

- In case I, Baboon is a cover image and pepper is a watermarked image. Its existing PSNR value is 52.1232 where the proposed PSNR value for 3 Level is 66.2982.
- In II case Bridge as a cover image and Tulip is a watermarked image. Its Existing PSNR value is 52.2080 where the proposed PSNR value for 3 Level is 67.8736.
- In III Airplane as a cover image and Lena is a watermarked image. Its Existing PSNR value is 42.1186 where the proposed PSNR value for 3 Level is 71.7639.
- In IV case Pepper as a cover image and Bridge is a watermarked image. Its Existing PSNR value is 52.1812 where the proposed PSNR value for 3 Level is 78.5393

Hence, it shows that proposed method having more value of PSNR than existed method.

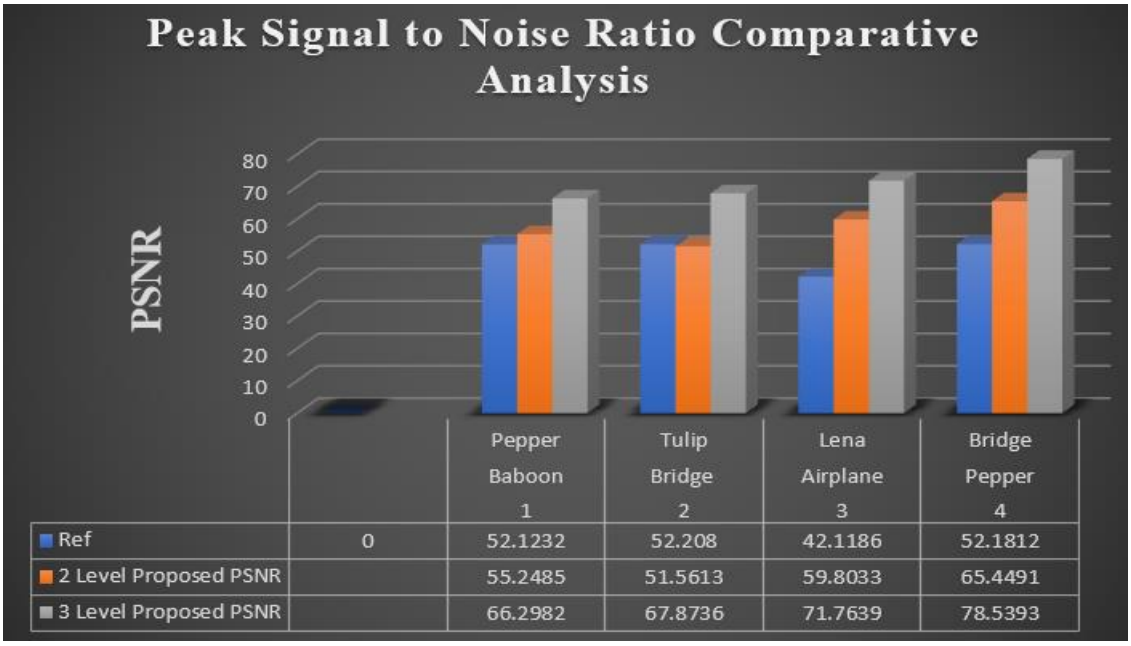


Fig.6. PSNR Comparative analysis among Ref, 2 Level LWT and 3 Level LWT

**Table II: Time comparatively analysis among existing and proposed technique for watermarking**

| Sr. No | Watermarked Image | Ref Embedding Time | 1 Level Proposed Embedding Time | 2 Level Proposed Extraction Time | 3 Level Proposed Extraction Time |
|---|---|---|---|---|---|
| **1** | Baboon | 0.5474 | 0.4704 | 0.7681 | 0.7966 |
| **2** | Bridge | 0.5175 | 0.4755 | 0.7535 | 0.7623 |
| **3** | Airplane | 0.5407 | 0.4815 | 0.7569 | 0.7884 |
| **4** | Pepper | 0.4251 | 0.4630 | 0.7857 | 0.8057 |

Table II depicted the extraction time for Baboon 2 level is 0.7681 and proposed extraction time for 3 level is 0.7966. Extraction time for Bridge 2 level is 0.7535 and proposed extraction time for 3 level is 0.7623. Extraction time for Airplane 2 level is 0.7569 and proposed extraction time for 3 level is 0.7884 and extraction time for Pepper 2 level is 0.7857 and proposed extraction time for 3 level is 0.8057.

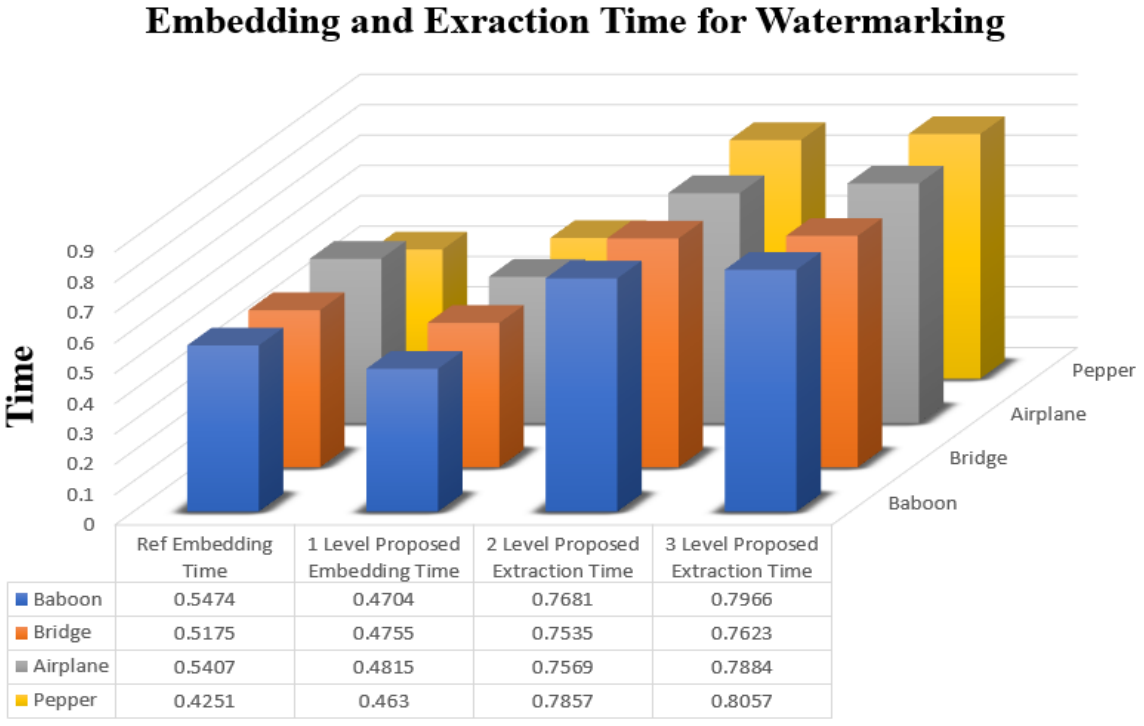


Fig.7. Embedding and Exraction Time for Watermarking

**TABLE III: Parameter Analysis Among Existed (2 Level) and Proposed Technique (3 Level)**

| S.NO. | PARAMETERS | 2 Level Proposed Extraction Time for | 3 Level Proposed Extraction Time for |
|---|---|---|---|
| 1 | PSNR | 58.01 | 71.11 |
| 2 | Extraction Time for Watermarking | 0.766 | 0.788 |

From table III it is clear from that the PSNR value of existing technique is 58.01 and proposed technique is 71.11. The value of processing time for extracting in existing technology is 0.766 second and proposed technique is 0.788 second. In term of PSNR from the table III it is clear indication that 3 Level LWT Walsh Hadmard SVD technique is superior than 2 Level LWT Walsh Hadmard SVD.

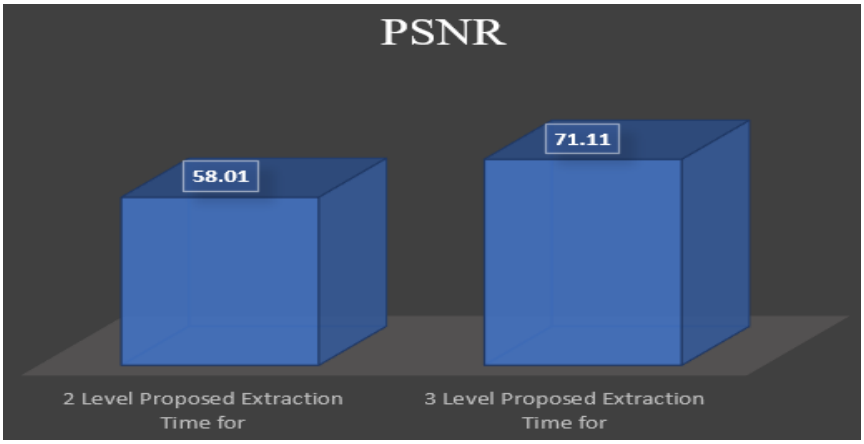


Fig.8. PSNR Comparative analysis for existed and proposed technique.

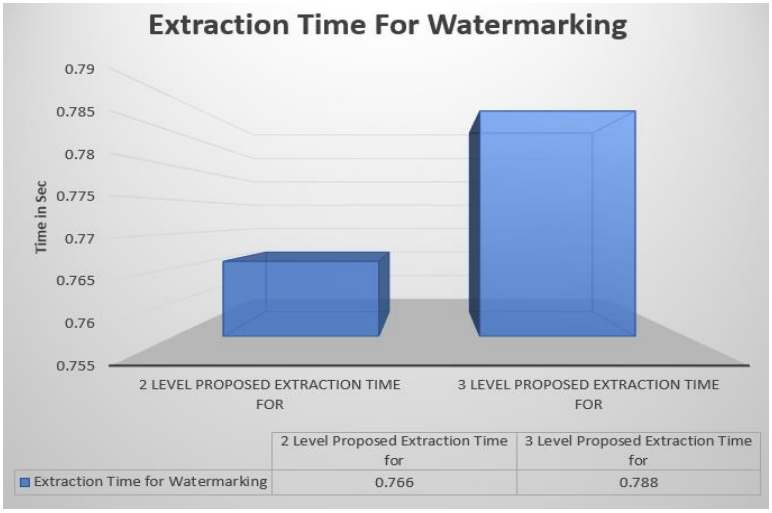


Fig.9. Extraction time Comparative analysis for existed and proposed technique.

## 5. Discussion

The research work implemented in YCbCr colour space using hybrid technique for watermarking. In this research work in first phase both cover and host images are translated into YCbCr colour space from RGB images. After converting it into projected colour space three channels are generated and out of them one channel is selected for further processing. Out of these channels any channel can be selected. After selecting Y channel, three levels LWT (3-LWT) processed and images converted into four segments or bands (HH, HL, LH, LL) as per frequency. After performing 3-LWT, Walsh Hadmard Transform technique and followed by SVD implemented to get projected output. Our ultimate point is to get an appreciated PSNR value and its robustness against various attacks so that implemented integrated techniques do better with respect to other method. This implemented method performs better in term of various parameters. The experimental executed results from respective table depicts comparative analysis among proposed and existed method for parameter PSNR as well as processing time for embedding. It is clear from the above table III that the PSNR value of existing technique is 58.01 and proposed technique is 71.11. The value of processing time for extracting in existing technology is 0.766 second and proposed technique is 0.788 second. In term of PSNR from executed result it is clear indication that 3 Level LWT, Walsh Hadmard and SVD technique is superior than 2 Level LWT, Walsh Hadmard and SVD.

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