Methodology

In this chapter, with advancement of technology it is difficult to protect creative content and intellectual property. It is very easy to copy and modify digital media resulting in great loss in business. So the viable solution for this problem is digital watermarking. Digital watermarking is a technique by which we embed copyright mark into digital content which is used to identify the original creator and owner of digital media. It is prominently used for tracing copyright infringements. In this paper technique based on 1-level discrete wavelet transform is used for insertion and extraction of watermark in original image.

Digital image is a representation of two dimensional image using ones and zeros (binary).

Digital image in the computer is an array of numbers that represent light intensities at various points (pixels).

- **A binary image** is a digital image that has only two possible values for each pixel. Typically, the two colors used for a binary image are black and white (0, 1).
- **Grayscale image** is an image in which the value of each pixel represent also as black-and-white, are composed exclusively of shades of gray, varying from black and white.
- **Color images** are stored in either 24-bit (true color images) or 8-bit per pixel files. A common image size is 640 × 480 pixels and 256 colors (or 8 bits per pixel) Represent colors RGB.

3.4 Watermarking techniques:

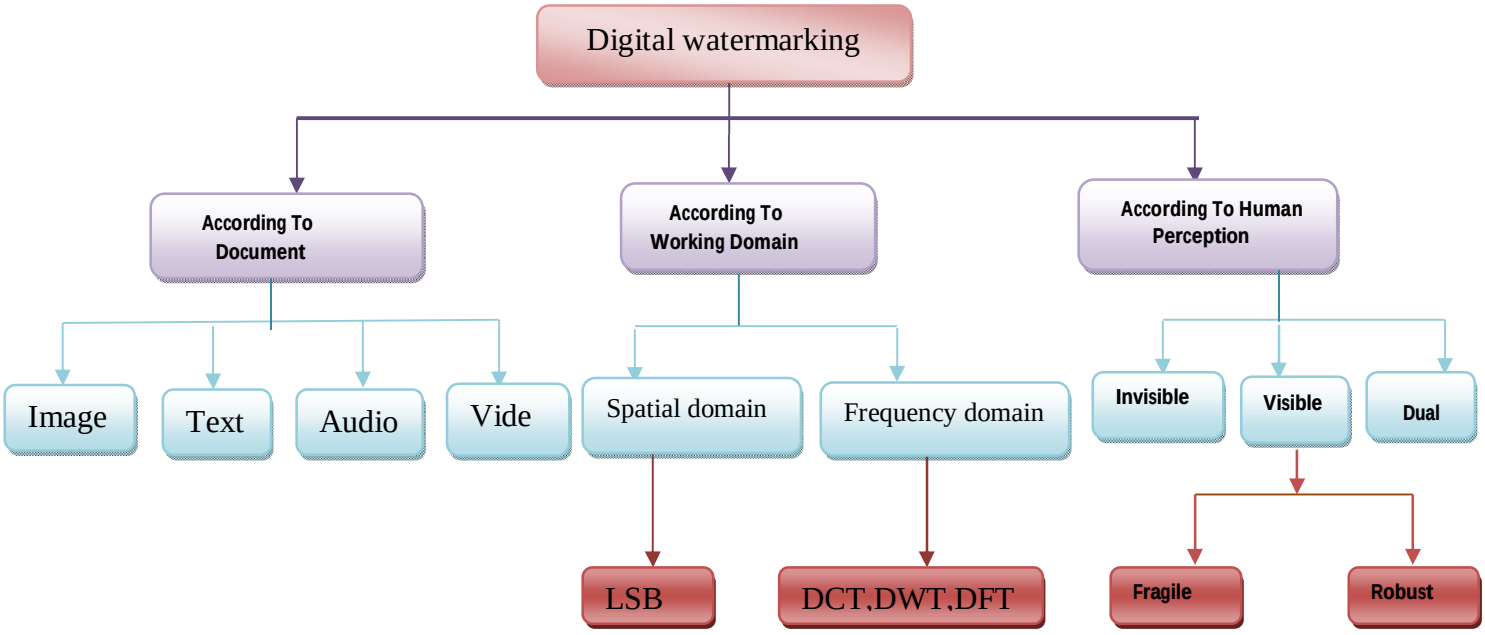


Figure 3.1: Classification of watermarking *techniques*

3.5 Proposal method (Frequency domain (Discrete wavelet transforms)):

Wavelet Transform is a modern technique frequently used in digital image processing, compression, watermarking etc.

The wavelet transform decomposes the image into three spatial directions, horizontal, vertical and diagonal, we have split the image into four bands denoted by LL, HL, LH and HH and one level decomposition and figure Shows one level.

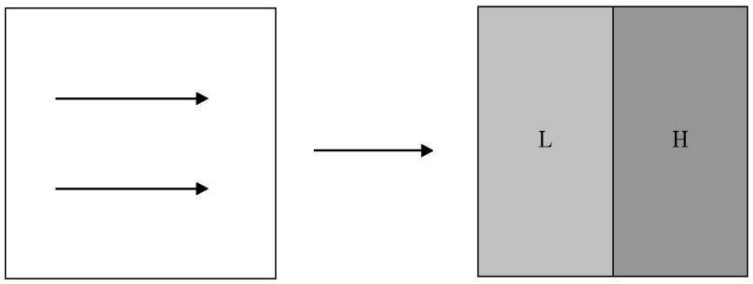


Fig 3.2: Horizontal Transform-2 sub bands

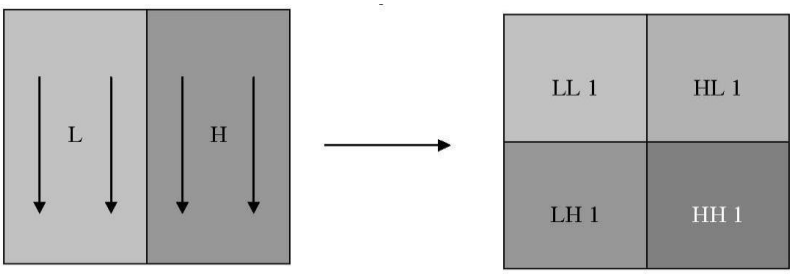


Fig 3.3:Vertical Transform-4 sub bands

3.6 Watermark process:

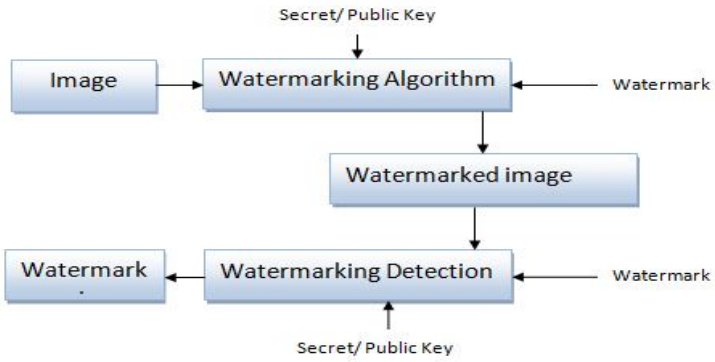
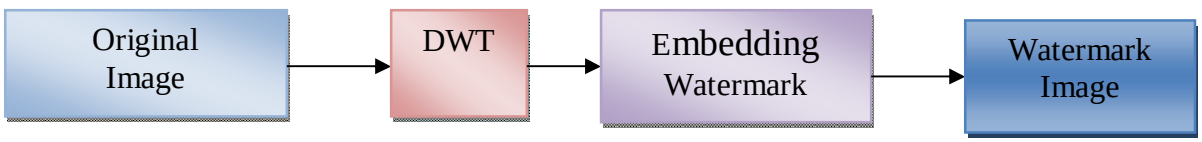


Figure 3.4: Watermark embedding process and extraction process

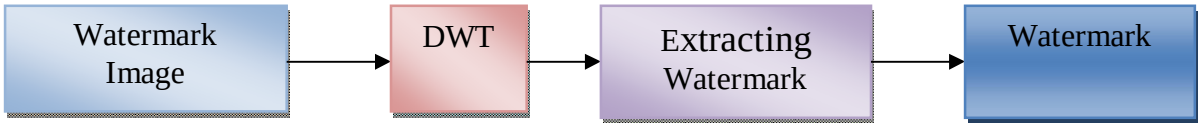
3.6.1 Watermark Embedding Process:

The proposed model for DWT based image watermark embedding is shown in figure (3. 5).



3.6.2 Watermark Extracting Process:

The proposed model for DWT based image watermarking extracting is shown in figure (3. 6).



3.7 Algorithm Performance:

Performance evaluation is very important part in the any algorithmic design in watermarking.

To measure efficiency the system (project) performance we calculate the following parameters:

3.7.1 Mean Square Error (MSE):

The mean squared error (MSE) in an image watermarking is to estimate or measures the average of the squares of the "errors", between host image and watermark image.

MSE is then calculated as follow:

$$MSE = \frac{1}{N*N} \sum_{i}^{N} \sum_{j}^{N} (wIJ - HIJ)^2 \qquad [19]$$

Where:

N: size of an image.

Wij= Pixel value in Watermarked Image.

Hij= Pixel value in Host Image.

3.7.2 Peak signal to Noise ratio (PSNR):

Peak Signal to Noise Ratio (PSNR) is used to determine the Efficiency of Watermarking with respect to the noise.

The noise will degrade the quality of image. The visual quality of watermarked and attacked images is measured using the Peak Signal to Noise Ratio [14].

The **PSNR** is then calculated As follows:

$$PSNR = 10 \log \left(\frac{p^2}{MSE} \right) \qquad [19]$$

Where:

P= maximum value in host image.

4.1 Simulation Environments:

MATLAB is widely used in all areas of applied mathematics, in education and research at universities, and in the industry. MATLAB stands for Matrix Laboratory and the software is built up around vectors and matrices. This makes the software particularly useful for linear algebra but MATLAB is also a great tool for solving algebraic and differential equations and for numerical integration. MATLAB has powerful graphic tools and can produce nice pictures in both 2D and 3D. It is also a programming language, and is one of the easiest programming languages for writing mathematical programs. MATLAB also has some tool boxes useful for signal processing, image processing, optimization, etc.

MATLAB used Because of matrix and vector computation and manipulation algorithms, the software is primarily used for:

- Producing solutions to complex systems of equations
- Modeling, simulation, and prototyping
- Data analysis, exploration, and Image processing.

A digital image can be considered as a large array of discrete dots, each of which has a brightness associated with it. These dots are called picture elements, or more simply pixels.

4.2 Typical uses include:

- Math and computation.
- Algorithm development.
- Image processing.
- Modeling, simulation, and prototyping.
- Data analysis, exploration, and visualization.
- Scientific and engineering graphics.
- Application development, including Graphical User Interface building.

4.3 Significant Language Features:

MATLAB is a mathematical scripting language that looks very much like C++.

Some features of the language are:

- Efficient matrix and vector computations.
- Easy creation of scientific and engineering graphics.
- Application development, including graphical user interface building.
- Object-oriented programming.
- Extensibility (Tool Boxes).
- File I/O functions.

4.4 Image formats supported by Matlab:

The following image formats are supported by Matlab:

- BMP
- HDF
- JPEG
- PCX
- TIFF
- XWB

4.5 Flow chart for this system:

Simulation model consist of two models: embedding model and extracting model Described as follows:

Flow chart of embedding/ extracting:

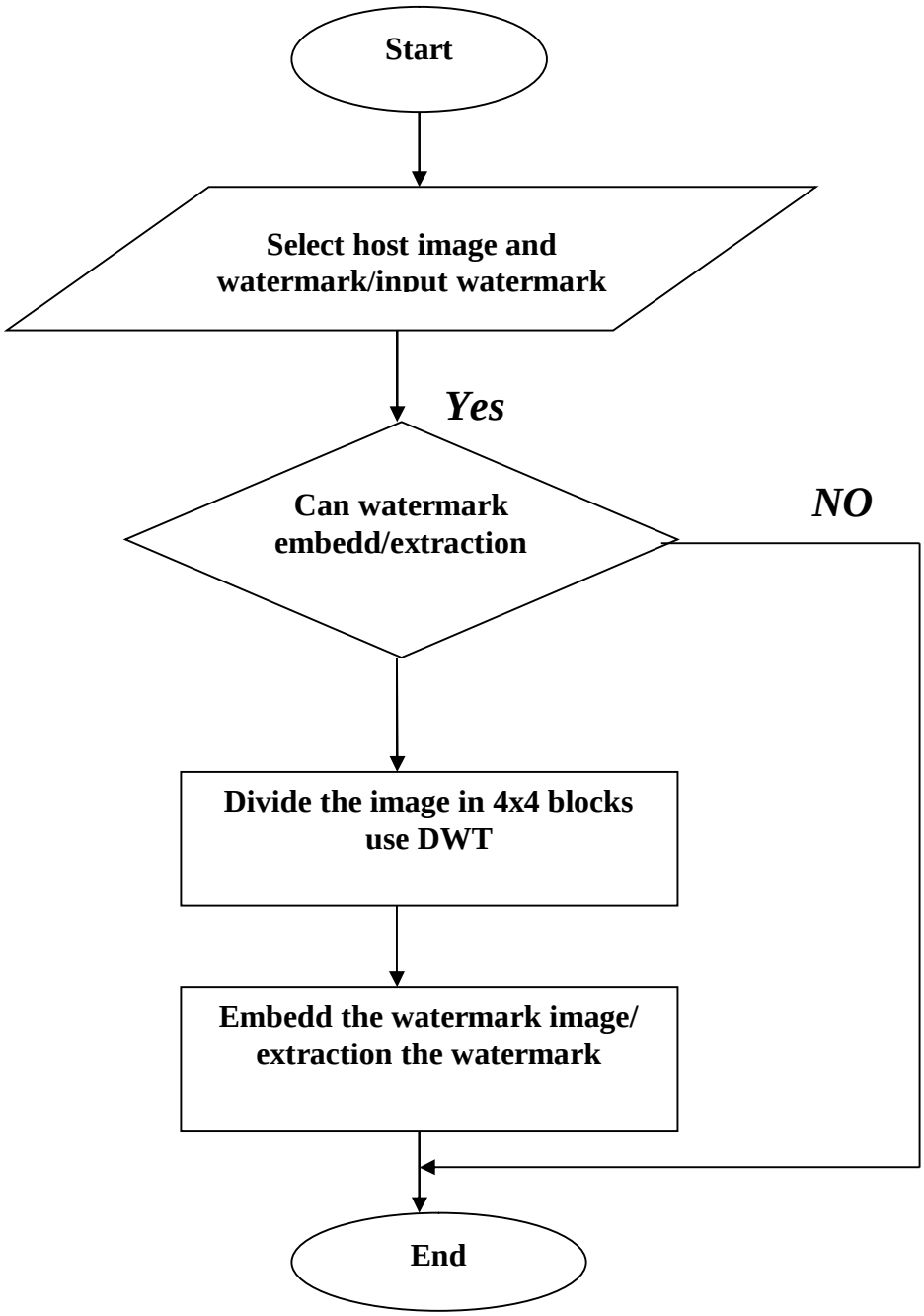


Fig 4.1: Flow chart of embedding/ extracting

4.6 DWT Domain Watermarking:

Wavelet transform is a time domain localized analysis method with the window's size fixed and forms convertible. There is quite good time differentiated rate in high frequency part of signals DWT transformed. Also there is quite good frequency differentiated rate in its low frequency part. It can distill the information from signal effectively. The basic idea of discrete wavelet transform (DWT) in image process is to multi-differentiated decompose the image into sub-image of different spatial domain and independent frequency district .Then transform the coefficient of sub-image. After the original image has been DWT transformed, it is decomposed into 4 frequency districts which is one low frequency district (LL) and three high-frequency districts(LH,HL,HH). If the information of low-frequency district is DWT transformed, the sub-level frequency district information will be obtained. The following figure represents the watermarking system in DWT [8]:

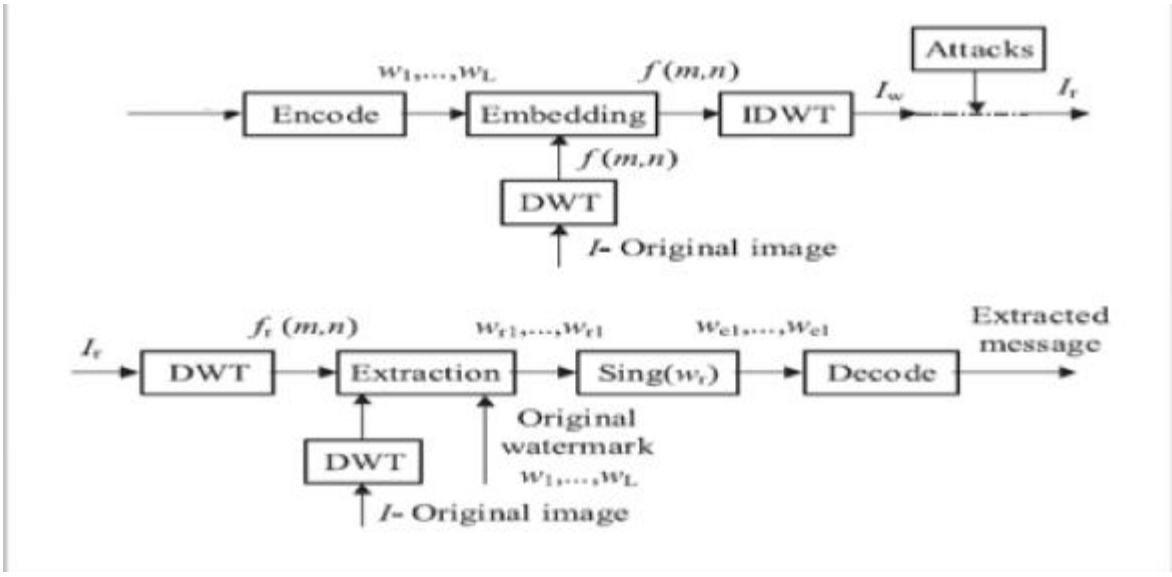


Figure 4.2: Watermark system in DWT

In two-dimensional separable dyadic DWT, each level of decomposition produces four bands of data, one corresponding to the low pass band (LL), and three other corresponding to horizontal (HL), vertical (LH), and diagonal (HH) high pass bands. The decomposed image shows a coarse approximation image in the lowest resolution low pass band, and three detail images in higher bands. The low pass band can further be decomposed to obtain another level of decomposition. This process is continued until the desired number of levels determined by the application is reached [2].

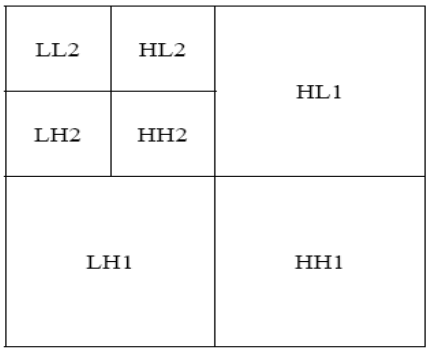


Figure 1.3: DWT decomposition with two levels

4.7Proposed method:

The proposed watermarking system is given in the following process:

Embedding watermarking

Input: original image, watermark image.

Process:

1. Using two-dimensional DWT, obtain the first level decomposition of the original image and watermark image.

2. Modify the DWT coefficients in the LL band:

$$newhost\_LL = (F * h\_LL) + (F * w\_LL) \qquad [20]$$

3. Apply DWT to obtain the watermarked Image.

Output: Watermarked image.

Extracting watermarking

Input: Watermarked image.

Process:

1. using two-dimensional DWT, obtain the first level decomposition of the watermark image

2. Extract the visual watermark from the LL band:

$$newwatermark\_LL = (F\_LL - F * h\_LL)/F \qquad [20]$$

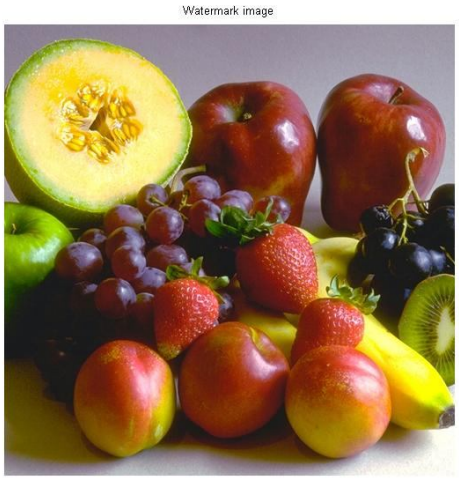
Output: original image.

4.8 Simulation results:

Since the magnitudes of DWT coefficients are larger in the lowest band at each level of decomposition, it is possible to use a larger scaling factor for watermark embedding. For the other 3 bands, the DWT coefficients are smaller, allowing a smaller scaling factor to be used. The resulting watermarked image does not have any degradation leading to a loss in its commercial value. in the below experiments, we measured the visual quality of watermarked and attacked images using the Peak Signal To-Noise Ratio (PSNR), PSNR measures are estimates of the quality of the reconstructed image compared with an original image. The fundamental idea is to compute the value which reflects the quality of the reconstructed image. Reconstructed image with higher metric are judged as having better quality.

For first levels of decomposition, the proposed watermarking the following data calculated from run matlab for DWT watermarking for different value of quality factor.

First Level Decomposition Figure 4.4 shows the 512x512 Original Image and 512x512 watermark images.



Original Image Watermarked

Watermark embedding technique:-

Alpha blending:-

Alpha blending is the process of combining an image with a background to create the appearance of partial or full transparency. The formula of alpha blending used for watermarking embedding is:

Watermarked image= A*(LL1) + B*(WM1)

A, B= scaling factors for cover and watermark image respectively.

LL1=low frequency approximation of cover image.

WM1= watermark image.

Watermark extraction technique:-

Alpha blending:-

The alpha blending formula used for watermark extraction is:

Recovered watermark = (WM - A*LL1)

WM=Watermarked image.

A= scaling factor for cover image.

LL1= Low frequency approximation component of cover image.

To generate the final watermark extracted image, inverse discrete transform is applied to watermark image coefficient [20].

Example different image:-

Fig 4.4: Original Image

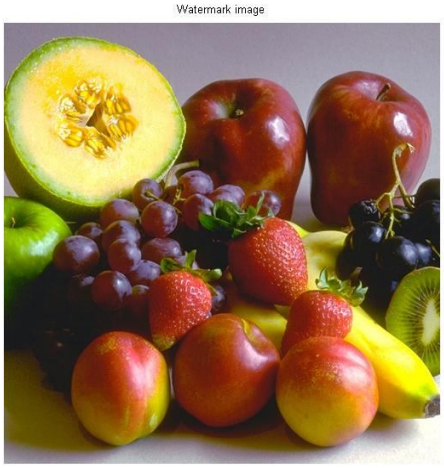


Fig 4.5: Watermarked

Fig 4.6: Image with embedded watermark

Fig 4.7: Original Image

Fig 4.8: Watermarked

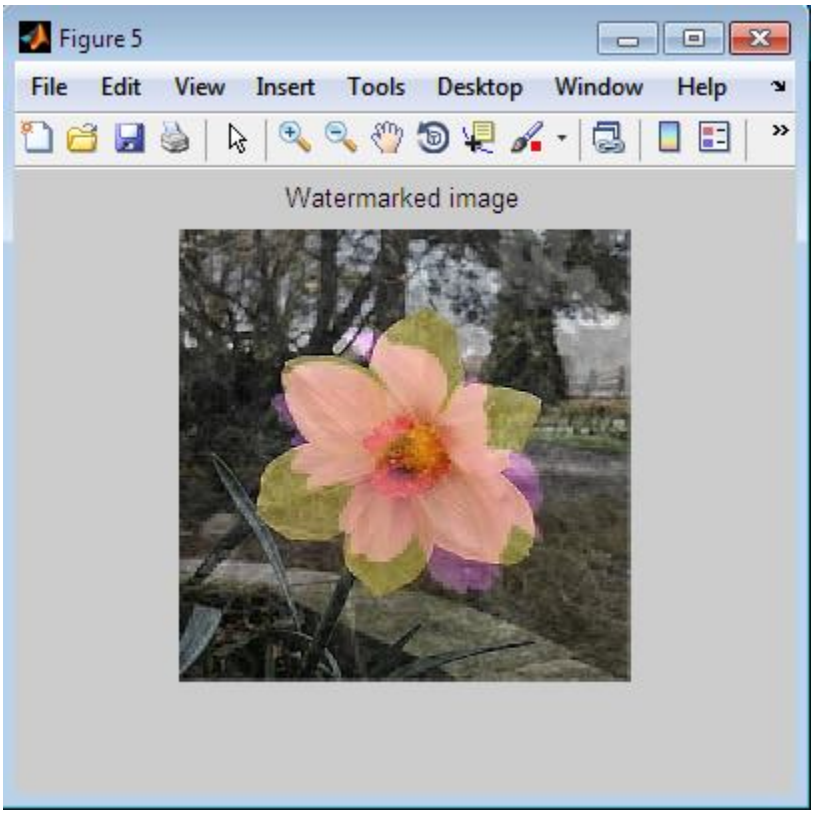


Fig 4.9: Image with embedded watermark

Experimental Results:-

Two color images are used for performing watermarking process. One image is taken as cover image and other is taken as watermark image. In this low frequency contents of both images are taken. This technique is called alpha blending. Both images are of equal size i.e. of 512*512.The watermark image is embedded into cover image by varying the value of A and B based on different values of scaling factor.

Factor	MSE	PSNR	Different image
0.30	0	Inf	
0.30	0	Inf	
0.30	0	Inf	

0.30	0	Inf	

4.9 Results and Histogram:

The effect of the watermarking algorithms on the image is determined by calculates the MSE and PSNR.

MSE Calculate the difference between the two images was small if the result is better.

Understood that PSNR is the ratio of signal power to the noise power. In terms of images, how the original image is affected by the added noise. In PSNR, we take the square of the peak value in the image (in case of an 8 bit image, the peak value is 255) and divide it by the mean square error. The PSNR are used to measure the quality of an image after the reconstruction. I understand that higher the SNR or PSNR, the reconstruction is good.

Histogram is a representation of the distribution of colors in an image. For digital images, a color histogram represents the number of pixels that have colors in each of a fixed list of color ranges that span the image's color space, the set of all possible colors.

In the histogram form image properties tested three colors (RGB).

Fig 4.10: watermark

Fig 4.11: Extract watermark

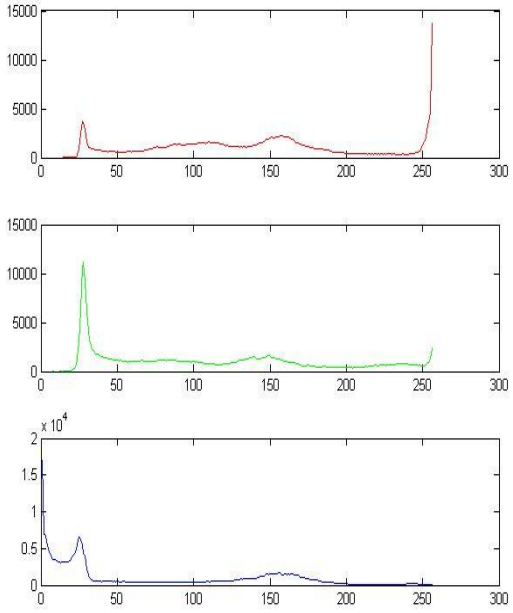


Fig 4.12: Histogram watermark

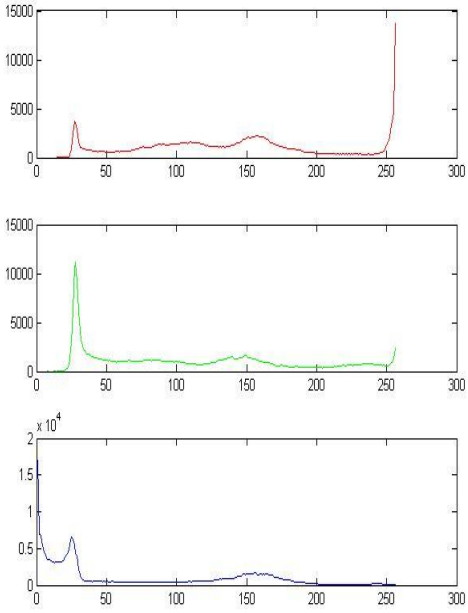


Fig 4.13: Histogram Extract watermark

Fig 4.14: watermark

Fig 4.15: Extract watermark

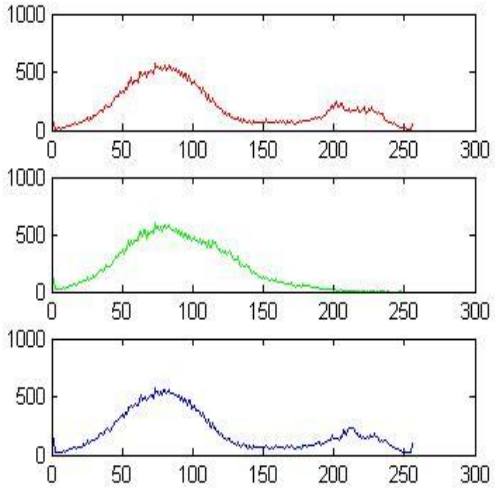


Fig 4.16: Histogram watermark

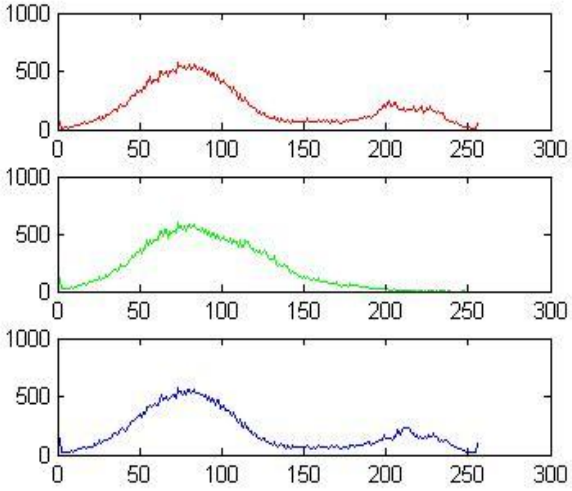


Fig 4.17: Histogram Extract watermark