A PROJECT REPORT

ON

"IMAGE FUSION USING DWT FOR MEDICAL APPLICATIONS"

Submitted in partial fulfillment of the requirements

of the degree of

Bachelor of Engineering

in

Electronics and Telecommunication

by

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This is to certify that the project entitled **" Image Fusion Using Dwt For Medical Applications"** is a bonafide work of **Magar Mohini (15ET04), Sayyed Alisha (15ET06), Shah Shama (15ET07), Phadatare Rohini (14ET05)** submitted to the University of Mumbai in partial fulfillment of the requirement for the award of the degree of Bachelor of Engineering in Department of Electronics and Telecommunication Engineering.

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This project entitled **"Image Fusion Using Dwt For Medical Applications"** by **Magar Mohini (15ET04), Sayyed Alisha (15ET06),Shah Shama (15ET07),Phadatare Rohini (14ET05)** is approved for the degree of **Bachelor of Engineering in Electronics and Telecommunication** .

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Abstract

Medical image fusion is the process of registering and combining multiple images from single or multiple imaging modalities to improve the imaging quality and reduce randomness and redundancy in order to increase the clinical applicability of medical images for diagnosis and assessment of medical problems. Multimodal medical image fusion algorithms and devices have shown notable achievements in improving clinical accuracy of decisions based on medical images. The domain where image fusion is readily used nowadays is in medical diagnostics to fuse medical images such as CT(Computed Tomography),MRI(Magnetic Resonance Imaging). This project aims to present a new algorithm to improve the quality of multimodality medical image fusion using Discrete Wavelet Transform (DWT) approach Discrete Wavelet transform has been implemented using different fusion techniques including pixel averaging, maximum, minimum methods for medical image fusiontion technique is applied in detecting the type of leaf disease. The experimental results show that the proposed algorithms give watermarked images with good visual quality and survival to number of image attacks such as salt and pepper noise, Gaussian noise, speckle noise, median filtering, cropping, rotation, translation.

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List Of Abbreviation

- CT = Computed Tomography
- DSA = Digital subtraction angiography
- DWT = Discrete Wavelet Transform
- FMRI = Functional magnetic resonance imaging
- JPEG = Joint Photographic Experts Group
- MRI = Magnetic Resonance Image
- MSE = Mean Square Error
- PET = Positron emission tomography
- PSNR = Peak Signal to Noise Ratio
- PCA = Principal Component Analysis
- RMSE = Root Mean Square Error
- SPECT = Single Photon Emission Computed Tomography
- UVW = Ultra-Wideband

Chapter 1

INTRODUCTION

The term fusion means in general an approach to extraction of information acquired in several domains. The objective of Image fusion is to combine information from multiple images of the same scene in to a single image retaining the important and required features from each of the original image. The main task of image fusion is integrating complementary information from multiple images in to single image. The resultant fused image will be more informative and complete than any of the input image and is more suitable for human visual and machine perception. Image fusion is the process that combines information from multiple images of the same scene. Medical image fusion is the technology that could compound two mutual images in to one according to certain rules to achieve clear visual effect. By observing medical fusion image, doctor could easily confirm the position of illness. Medical imaging provides a variety of modes of image information for clinical diagnosis, such as CT, X-ray, DSA, MRI, PET, SPECT etc. Different medical images have different characteristics, which can provide structural information of different organs. For example, CT (Computed tomography) and MRI (Magnetic resonance image) with high spatial resolution can provide anatomical structure information of organs. In this project, a novel approach for the fusion of computed tomography (CT) and magnetic resonance images (MRI) images based on wavelet transform has been presented. Different fusion rules are then performed on the wavelet coefficients of low and high frequency portions. The registered computer tomography (CT) and magnetic resonance imaging (MRI) images of the same people and same spatial parts have been used for the analysis. The following image fusion techniques are explained in this project.

- Simple Average Method
- Select Maximum Method.
- Select Minimum Method.
- Discrete Wavelet Transform (DWT) method.

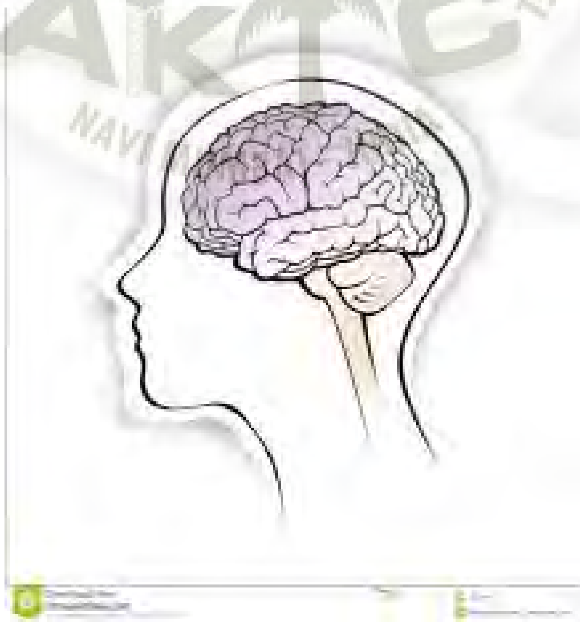

Figure 1.1: block Diagram

1.1 Need of Image Fusion

This method helps to study human tissue at the same time allows doctors to see multiple aspects of the same area. The goal of multi-modal imaging is to provide a complete picture of a specific tissue in the human body. The image should allow doctors to see anything present in that specific tissue: its size, its exact location and its metabolic activity. It should also allow doctors to analyse the metabolic activity of surrounding tissues. Thus, doctors can evaluate any abnormalities or changes in the function of those tissues as a result of a condition or a tumour or any other medical complication. Multi-modal imaging techniques allow scientists to view high-definition images of the virus starting from the point of infection and continuing through the process through which the virus uses a human body to replicate itself and destroy immune cells. Doctors can be hopeful that multimodal imaging may detect disease in human tissue before it develops too far. Detecting cancer by this method, they hope, will be possible through the study of just a small number of abnormal cells, rather than the millions required by other methods.Doctors can be hopeful that Multi-modal imaging may detect disease in human tissue before it develops too far. Detecting cancer by this method, they hope, will be possible through the study of just a small number of abnormal cells, rather than the millions required by other methods.

Figure 1.2: CT

1.2 Why Image Fusion

Multi sensor data fusion has become a discipline which demands more general formal solutions to a number of application cases. Several situations in image processing require both high spatial and high spectral information in a single image. This is important in remote sensing. However, the instruments are not capable of providing such information either by design or because of observational constraints. One possible solution for this is data fusion.

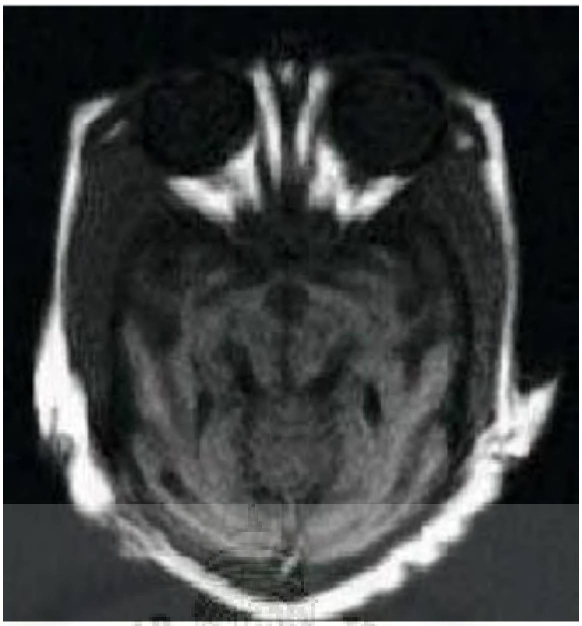

Figure 1.3: MRI

1.3 Standard Image Fusion Methods

Image fusion methods can be broadly classified into two groups - spatial domain fusion and transform domain fusion.The fusion methods such as averaging, Brovey method, principal component analysis (PCA) and IHS based methods fall under spatial domain approaches. Another important spatial domain fusion method is the high pass filtering based technique. Here the high frequency details are injected into upsampled version of MS images. The disadvantage of spatial domain approaches is that they produce spatial distortion in the fused image. Spectral distortion becomes a negative factor while we go for further processing, such as classification problem. Spatial distortion can be very well handled by frequency domain approaches on image fusion. The multiresolution analysis has become a very useful tool for analysing remote sensing images. The discrete wavelet transform has become a very useful tool for fusion. Some other fusion methods are also there, such as Laplacian pyramid based, curvelet transform based etc. These methods show a better performance in spatial and spectral quality of the fused image compared to other spatial methods of fusion.The images used in image fusion should already be registered. Misregistration is a major source of error in image fusion. Some well-known image fusion methods are:

- High pass filtering technique
- IHS transform based image fusion
- PCA based image fusion
- Wavelet transform image fusion
- Pair-wise spatial frequency matching

1.4 Image Filtering and Enhancement

Contrast adjustment, morphological filtering, deblurring, ROI-based processing Image enhancement is the process of adjusting images so that the results are more suitable for display or further image analysis. For example, you can remove noise, sharpen, or adjust the contrast of an image, making it easier to identify key features.

- Image Filtering

  Convolution and correlation, predefined and custom filters, nonlinear filtering, edge-preserving filters

- Contrast Adjustment

  Contrast adjustment, histogram equalization, decorrelation stretching

- Morphological Operations

  Dilate, erode, reconstruct, and perform other morphological operations

- Deblurring

  Deconvolution for deblurring

- ROI-Based Processing

  Define and operate on regions of interest (ROI)

- Neighborhood and Block Processing

  Define neighborhoods and blocks for filtering and I/O operations

- Image Arithmetic

  Add, subtract, multiply, and divide images

Chapter 2

LITERATURE SURVEY

Agarwal Ruchi Sanjay,Rajkumar Soundrapandiyan, Marimuthu Karuppiah, Rajasekaran Ganapathy they have performed a In the proposed method, source images are decomposed into low-level sub-band, high-level Sub-bands using DWT. Next, low-level sub-images are fused using type-2 fuzzy fusion rule and high-level sub-images are fused using average fusion rule. Finally, inverse DWT is applied on the fused components to obtain the fused image.[1]

Pramit Parekh, Nehal Patel, Priteshkumar Prajapati , Sarita Visavalia they have presented Medical image fusion is the only emerging technique which has attracted researchers to assist the doctors in fusing images and retrieving relevant information from multiple modalities such as CT, MRI, FMRI, SPECT, PET.[2]

Anjali A. Pure, Neelesh Gupta, Meha Shrivastava they proposed When sensitive organs like brain are scanned, both magnetic resonance imaging and computed tomography scans are preferred. CT provides best information about denser tissue and MRI offers better information on soft tissue .These complementarities have led to idea that combining images acquired with different medical devices will generate an image that can offer more information than individual image. So, it is expected that fusion of MRI and CT images of the same organ would result in an integrated image of much more details.[3]

Mamta Sharma have proposed Image fusion techniques are important as it improves the performance of object recognition systems by integrating many sources of satellite, airborne and ground based imaging systems with other related data sets. Further, it also helps in sharpening the images, improve geometric corrections, enhance certain features that are not visible in either of the images, replace the defective data, complement the data sets for better decision making.[4]

Medha Balachandra Mule, Padmavathi N.B they presented In this paper image fusion methods such as Simple Average, Select maximum, Select Minimum, Principal Component Analysis (PCA), and Discrete Wavelet Transform (DWT) are explained and are compared using the quality metrics Peak Signal to Noise Ratio (PSNR) and Root Mean Square Error (RMSE).[5]

Raushan Kumar, Gunjan Sharma, Varun Sanduja has proposed various attacks on A Real Time Approach to Compare PSNR and MSE Value of Different Original Images and Noise (Salt and Pepper, Speckle, Gaussian) Added Images and work on PSNR, MSE, Real Time, Digital Image Processing, Image Quality, Noise.[6]

Asma Ahmad, Nikita Kashyap , G.R.Sinha They presented 3-Level DWT Image Watermarking Against Frequency and Geometrical Attacks such as Image watermarking, 3-level DWT, PSNR,MSE[7]

Raushan Kumar, Gunjan Sharma, Varun Sanduja has proposed A Real Time Approach to Compare PSNR and MSE Value of Different Original Images and Noise (Salt and Pepper, Speckle, Gaussian) Added Images.[8]

Neha Chauhan,Akhilesh.A.Waoo,P.S.Patheja worked on Attack Detection in Watermarked Images with PSNR and RGB Intensity.The paper described a method for embedding and detecting chaotic watermarks in large images.An adaptive clustering technique is employed in order to derive a robust region representation of the original image.[9]

C. Saranya,S. Shoba"Comparison of Image Fusion Technique by Various Transform based Methods. A transform based image fusion technique is employed in order to improve efficiency in an effective manner. By this method better PSNR (peak signal to noise ratio) value with less MSE (mean square error) can be obtained.[10]

Chapter 3

WAVELET TRANSFORM

The most common form of transform type image fusion algorithms is the wavelet fusion algorithm due to its simplicity and its ability to preserve the time and frequency details of the images to be fused. Wavelet transform fusion is more formally defined by considering the wavelet transforms of the two registered input images together with the fusion rule .Then, the inverse wavelet transform is computed, and the fused image is reconstructed. 2-D DWT is very useful for image processing because the image data are discrete and the spatial and spectral resolution is dependent on the frequency. The DWT has the property that the spatial resolution is small in low-frequency bands but large in high frequency bands.The wavelet transform (WT) has been extensively studied in last decade. Many applications of the wavelet transform, such as compression, signal analysis and signal processing have been found. There are many good tutorial books and papers on this topic. Here, we just introduce the necessary concepts of the Discrete Wavelet Transform (DWT) for the purpose of this paper.The basic idea of the DWT for a one-dimensional signal is the following. A signal is split into two parts, usually high and low frequencies. The edge components of the signal are largely confined in the high frequency part. The low frequency part is split again into two parts of high and low frequency. This process is continued until the signal has been entirely decomposed or stopped before by the application at hand. For compression and water-

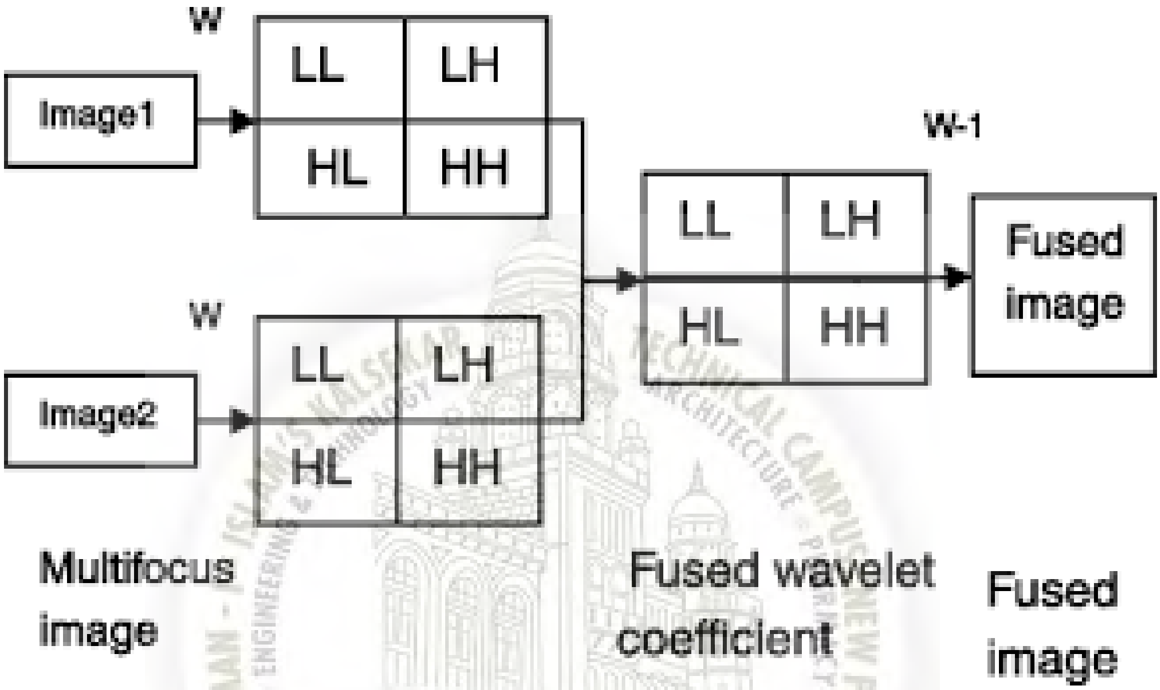

Figure 3.1: block Diagram

marking application, generally no more than five decomposition steps are computed. Furthermore, from the DWT coefficients, the original signal can be reconstructed.The wavelet transform decomposes an image into three spatial directions, ie the horizontal HL, the vertical LH and the diagonal HH. At each level of decomposition, the magnitude of the DWT coefficients is larger in the lowest subbands (approximation LL subband), and smaller for other subbands (detail subbands: HL, LH and HH).The most significant coefficients in a subband are those with large magnitudes. The high resolution subbands help in locating the edge and texture patterns for an arbitrary image.Watermarking in the DWT domain has a number of advantages over other transforms, particularly the Discrete Cosine Transform (DCT) [8]: Wavelet coded image is a multi-resolution description of an image. Hence, an image can be shown at different level of resolution and can be sequentially processed from low to high resolution. DWT is closer to the properties of the human visual system than the DCT, since it splits the signal into individual bands, which can be processed independently. The distortions introduced by wavelet domain coding with high compression ratio are less annoying than those introduced at the same bit rate by the DCT. In the JPEG case, block-shaped distortions are clearly visible, since image coding based on the DCT usually operates on independent 8 8 blocks. Watermarking schemes put more watermark energy into the large DWT coefficients, thus affecting mostly regions like lines and texture on which the human visual system is not sensitive, too. DWT has spatial frequency locality, which means if the watermark is embedded into the DWT coefficients, it will affect the image locally. Hence, the wavelet transform provides both frequency and spatial description for an image

3.1 Applications

- The discrete wavelet transform has a huge number of applications in science, engineering, mathematics and computer science. Most notably, it is used for signal coding, to represent a discrete signal in a more redundant form, often as a preconditioning for data compression. Practical applications can also be found in signal processing of accelerations for gait analysis, image processing,in digital communications and many others.
- It is shown that discrete wavelet transform (discrete in scale and shift, and continuous in time) is successfully implemented as analog filter bank in biomedical signal processing for design of low-power pacemakers and also in ultra-wideband (UWB) wireless communications.

Chapter 4

GEOMETRIC ATTACKS

4.1 Introduction

Image watermarking is an efficient solution for authentication and copyright protection of images in popular communication environments like Internet, which is susceptible to illegal usages. The basic procedure of image watermarking is to hide some data along with the cover image. Thus, the ownership or copyright of the multimedia can be provided by using the watermarked image.The most important properties of an efficient watermarking algorithm are imperceptibility (i.e., no visual difference between original and watermarked image) and robustness against various image manipulations called attack. The main attacks can be categorized as: (1) signal processing like JPEG compression, various types of noise, filtering, and blurring, etc; and (2) geometric attacks like rotation, scaling, cropping, translation ,and affine transformation, etc. In case, if image watermarking is performed in spatial or signal domains it can be done by watermarking by directly altering pixels ,leads to easy and low-cost implementation.These attacks are also called as de-synchronization attacks Geometric attacks are geometric distortions to an image and include operations such as rotation,

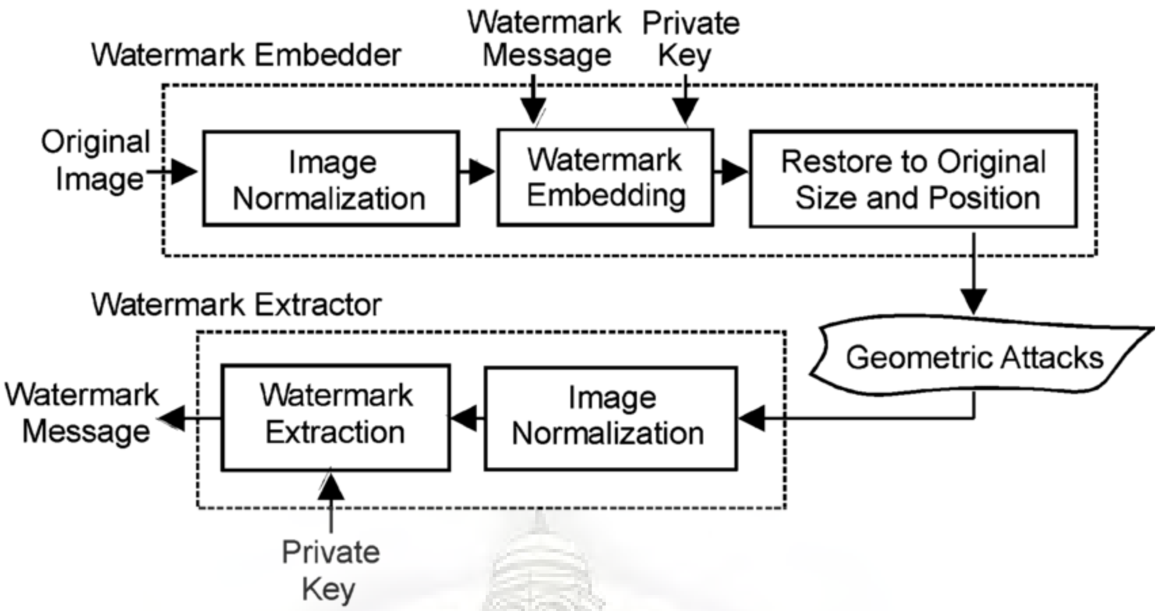

Figure 4.1: watermark system

translation, scaling and cropping etc. Geometric attacks attempt to destroy synchronization of detection thus making detection process difficult and sometimes even impossible. The distortion due to geometric attack is clearly visible. Geometric attacks are classified basically into two types as global geometric and local geometric attacks. Global geometric attacks affect all the pixels of an image in similar manner. The examples include rotation, scaling, translation etc. Local geometric attacks affect different portions of an image in different ways. These attacks include cropping, row-column blanking, warping etc. Rotation, translation and scaling attacks are examples of affine transform.

4.2 Attacks on watermarked Image

Watermark channel introduces distortion in watermarked image and hence in embedded watermark. The watermarked image is also likely to be subjected to certain manipulations, some unintentional such as compression and transmission noise and some intentional such as cropping, filtering etc. Such distortion or manipulation is defined as attack on watermarked image. Performance of distorted images in image watermarking is tested and judged for robustness evaluation. Robustness indicates survival of watermark in the watermarked image even if image is subjected to any distortion or manipulation.watermark attacks have three classes while ignoring the cryptographic and system-based attacks (e.g.Oracle, counterfeit original, averaging).The possible attacks are broadly classified as shown in Fig

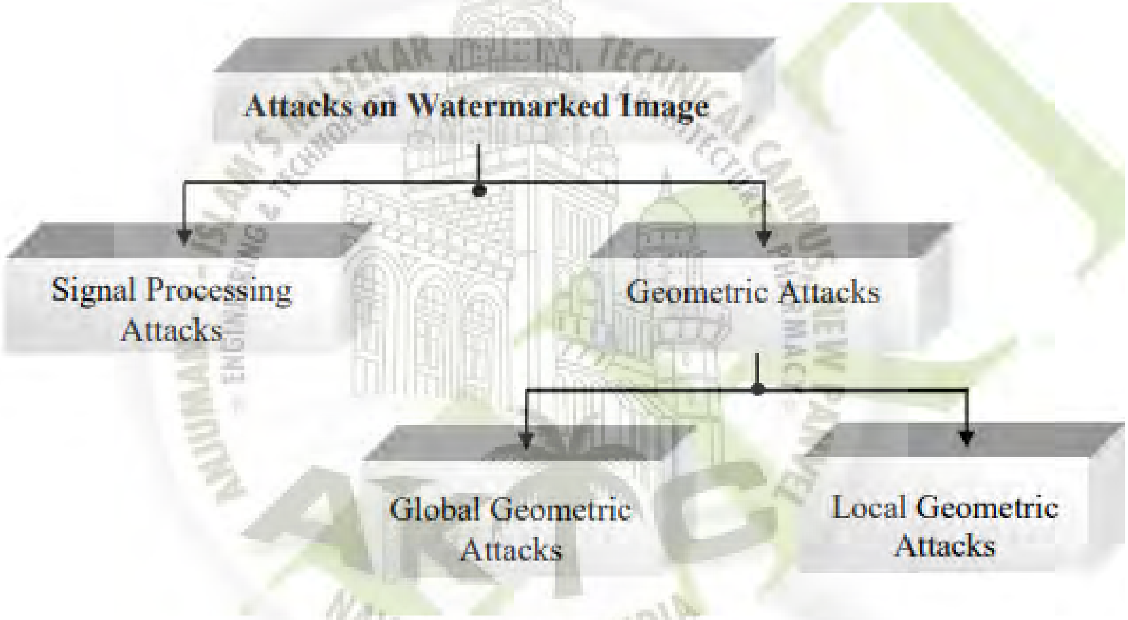

Figure 4.2: classification

- Geometric attacks
  (desynchronization) e.g. random local distortion.
- Signal processing attacks
  e.g. noise addition,dithering, and stochastic attacks
- Specialized attacks
  based of knowledge of the

- Robustness attacks

  These attacks aim to diminish or remove the presence of a watermark in marked data without harming the image. Generally such attacks modify the pixel values of the image.

- presentation attacks

  This attack does not necessarily remove the watermark from the content; instead it manipulates the content so the detector cannot find it. A good example is the Mosaic attack, which posses the initially remarkable property that the marks from an image can be removed and still have it rendered exactly the same, pixel for pixel, as the marked image by a standard browser.

- Interpretation

  In some watermarking schemes, the marks detected presence can cause multiple interpretations of the derived analytic or scientific data, and an attacker can engineer a situation that neutralize the strength of any evidence of ownership presented. These attacks seek to forge invalid or multiple interpretations from watermark evidence. For instance, and attacker can attempt to make another watermark in the same watermarked image with strength equal to the first one in order to make it difficult to say which mark has been made first.

- Legal attacks

  This attack may involve existing and future legislation on copyright laws and digital information ownership, the different interpretations of the laws in various jurisdictions, etc. An attacker can cast doubt on the watermarking scheme in the courtroom in order to cause problem to decide who the owner is.

- Simple attacks
  (other possible names include waveform attacks and noise attacks). These are conceptually simple attacks that attempt to impair the embedded watermark by manipulation of the whole watermarked data (host data plus watermark) without any attempt to identify and isolate the watermark, like linear and general non-linear filtering.

- Detection-disabling attacks
  (other possible names can be synchronization attacks and Jitter attack). The main characteristics of this category is that an attacker does not attempt to remove the watermark from the watermarked data, but to remove the synchronization of the watermark so that it cannot be detected properly by the watermark detector. So the watermark itself may (and usually) still be physically present in the data. One example is Mosaic attack.

- Removal attacks
  attacks, which aim to remove or seriously degrade the watermark, embedded in the watermarked data so that the detector can no longer positively detect it. It is further divided into simple and analysis attacks to show the different strategies taken to reach this common goal. Examples of these sub categories are lossy compression and non-linear filtering respectively.

- Ambiguity attacks

  An attacker tries to embed another watermark into a watermarked data and thus making it difficult to determine the first embedded watermark. Authors believe that the transitions between the groups are sometimes fuzzy, and some attacks do not clearly belong to one single group. Cropping for example can be regarded as either simple attacks or detection-disabling attacks. There is a table of classification in this article for proposed attacks that could be useful.

Chapter 5

PROBLEM STATEMENT

5.1 Problem Statement

Combination of two images to obtain a single image is the Medical image fusion. In medical applications, the fusion of images can frequently contribute to added clinical information that cannot be clear in a separate image. The image fusion was used to enhance image to visualize the coronary artery blood vessels clearly.Though there are lots of signal processing and geometric attacks such as mean attack, median attack, noise attack, cropping, scaling, rotation, reflection, shearing and translation,the existing system is robust only against translation, shearing, rotation

The fused image of decomposed sub bands are obtained by applying inverse transforms. A transform based image fusion technique is employed in order to improve efficiency in an effective manner. By this method better PSNR (peak signal to noise ratio) value with less MSE (mean square error) can be obtained.The image fusion process can be performed with various levels of image representation are feature level, pixel level, decision level and data level. In pixel level image fusion technique, the fused image can be obtained in which each pixel determines a set of pixels in various source images. The advantage of the fused images are more informative than input image and it also comprises original information. While the pixel level fusion is compared in the decision level fusion and feature level fusion, it is more efficient and easy to implement.

Inshort:

- How to design a dedicated system that will perform the task of image fusion?
- How to calculate the PSNR of the image?
- How to make the system more reliable under various attacks?

Chapter 6

EXPECTED OUTCOME

- New algorithm to improve the quality of multimodality medical image fusion using Discrete Wavelet Transform (DWT) approach Discrete Wavelet transform has been implemented using different fusion techniques including pixel averaging, maximum, minimum methods for medical image fusion.
- Image fusion indices try to figure out some or the combination of the various factors that determine the quality of the image which include sharpness, contrast, distortion.
- Algorithm to calculate for salt and pepper,rotation attack.Then we will extract the attacked image and watermarked image separately, and finally we are going to verify those observed values with our experimental results.

Chapter 7

TECHNICAL DETAILS

7.1 Methodology

1. Input two images. One CT image and another MRI image.
2. Decompose both the images using discrete wavelet transformation.
3. Four images will be obtained;approximate sub-image,Horizontal frequency sub band,Vertical frequency sub band and Diagonal frequency sub band.
4. Apply inverse discrete wavelet transform on the images to obtain a reconstructed fuse

- This entire thing will be implemented in MATLAB.

chart.png

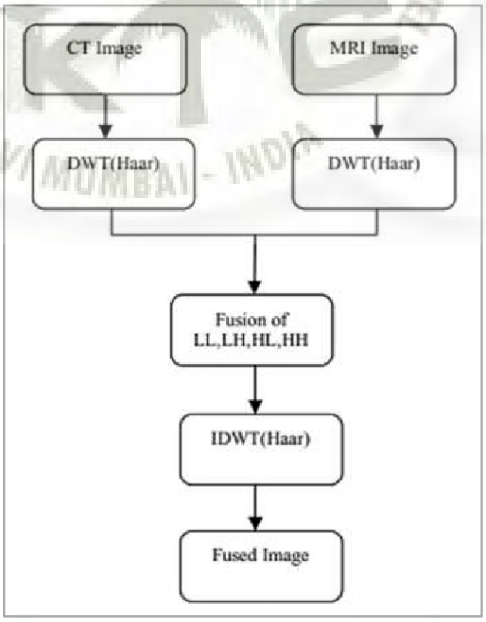

Figure 7.1: flow chart

7.2 Methodology of Attacks

.png

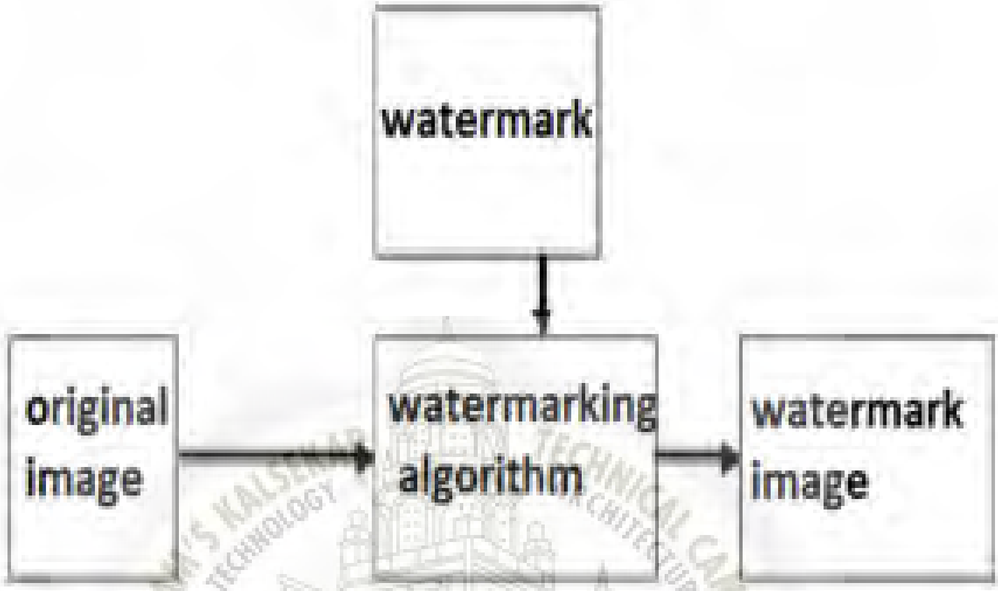

Figure 7.2: block diagram

The original image is embedded with another image is using DWT where it is divided into 4 sub blocks, and then watermarking algorithm is applied where we will obtain the watermarked image .Then we will check for the various kinds of attacks with the already taken cover and watermarked image. In the existing system they calculated for Rotation. In addition to that, we are going to calculate for mean, median, noise. Then we will extract the attacked image and watermarked image separately, and finally we are going to verify those observed values with our experimental results.

7.3 Performance Analysis

PSNR is calculated between host image and attacked watermarked image. It is measured in units of dB.The larger the PSNR value, higher is the quality of the resulting image. This is widely used parameter for quality assessment of degraded watermarked image.

$$PSNR = 10log_{10}\left(\frac{MAX_I^2}{MSE}\right)$$

$$MSE = \frac{1}{mn}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i,j) - K(i,j)]^2$$

Figure 7.3: Formula

Chapter 8

RESULT and DISCUSSION

To demonstrate the efficiency of the proposed scheme, we selected some earlier geometrically robust works and the result shave been compared in terms of the robustness and imperceptibility. For each related work, we used its case study with similar specifications to establish a fair comparison. The experiments were coded by MATLAB R2107 and implemented on a PC with CPU Intel Pentium 3.Then the image is verified against different kinds of geometric attacks such as rotation, shearing, cropping, mean, median, noise attacks. To evaluate imperceptibly, we use the Peak-Signal-to-Noise-Ratio (PSNR), which is defined as follow. With higher PSNR value, the watermarked image is more invisible.There are 3 methods of Image fusion.

8.1 Maximum Method

Every pixel of the fused image will be the pixel with maximum intensity of the corresponding position pixels in the input image. One advantage of this method over averaging method is that there is no compromise made over the good information available in the input images. A straight forward selection of the better pixel intensity is made here. But of course, it is combined with the disadvantage that higher pixel intensity does not always mean better information. It depends on the type of image under consideration. Thus, you either take the whole of the information or totally avoid the same.

8.1.1 Result

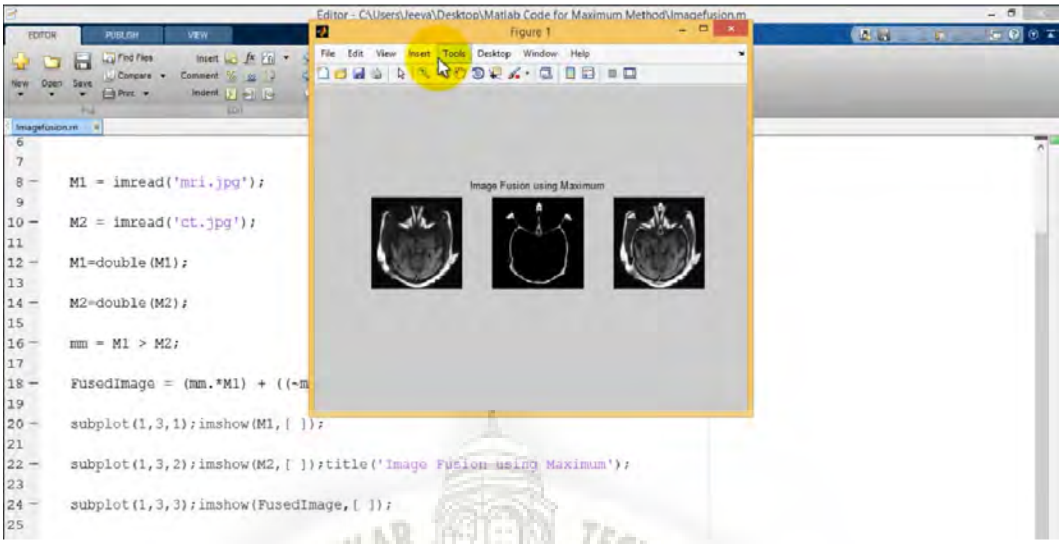

Figure 8.1: maximum

8.2 Minimum Method

Similar to the Maximum Selection method, this method to either completely considers the information from an input image or discards it fully. No averaging or any operation of the like is performed here. The quality of the fusion is specific to the type of image we are dealing with. In certain cases, say, images with dark shades would generate a good fusion image with this method.

8.2.1 Result

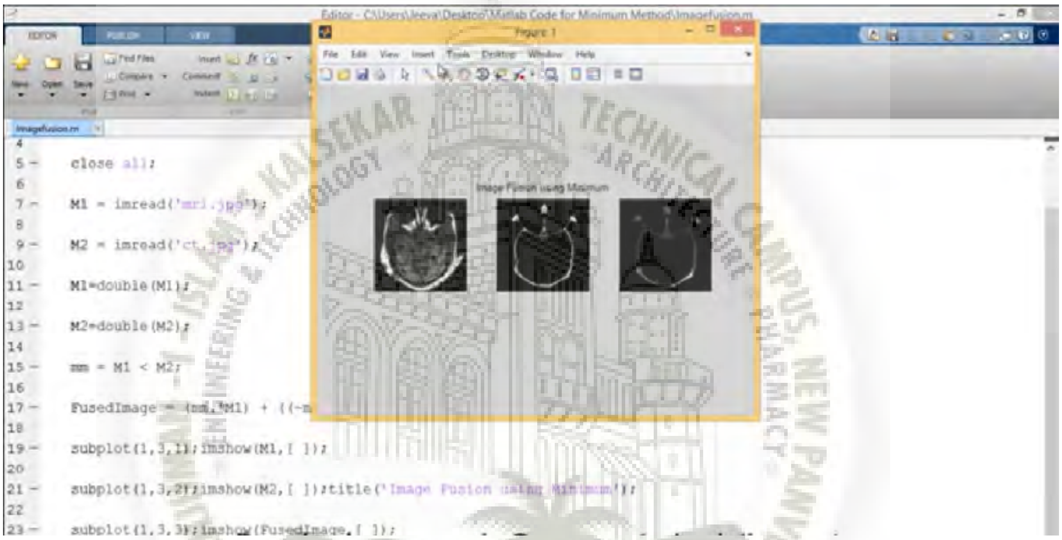

Figure 8.2: minimum

8.3 Average Method

Due to the averaging operation, both the good and the bad information are minimized arriving at an averaged image. Thus the algorithm does not actually fuse the images perfectly

8.3.1 Result

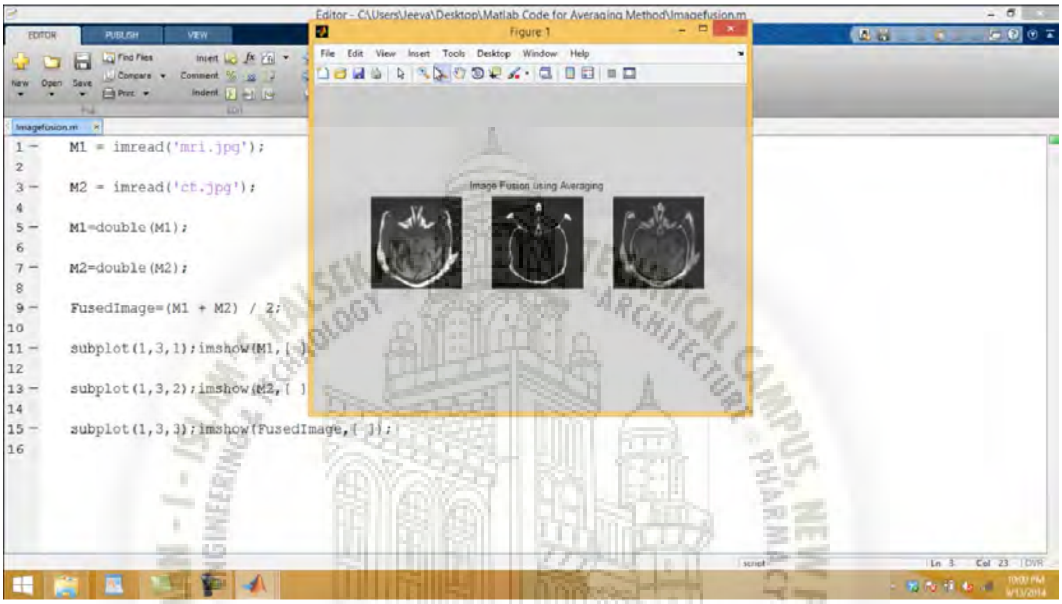

Figure 8.3: averaging

result.png

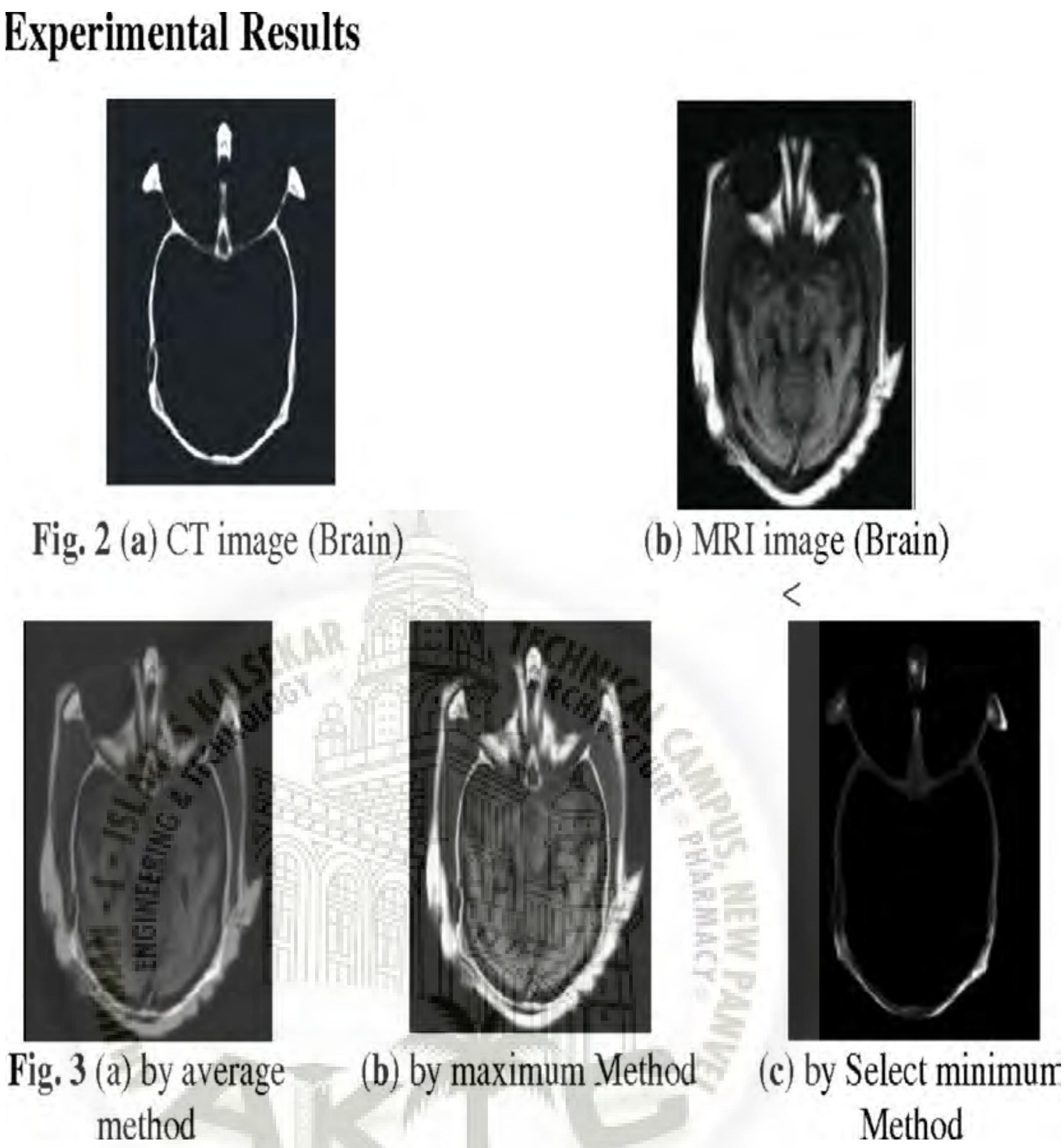

Figure 8.4: result

8.4 Image fusion result

image2 (2).png

Figure 8.5: Fused image 1

8.5 Rotation Attack

The watermarked image is rotated by different angles and still watermark can be extracted. Image rotation makes co-ordinate axes changed. Without synchronization to orthogonal axes, one cannot extract watermark correctly. The question of geometrically distorted axis recovery is to be considered. It is assumed that the distorted axes have been recovered before watermark is detected.

image1 rotate.png

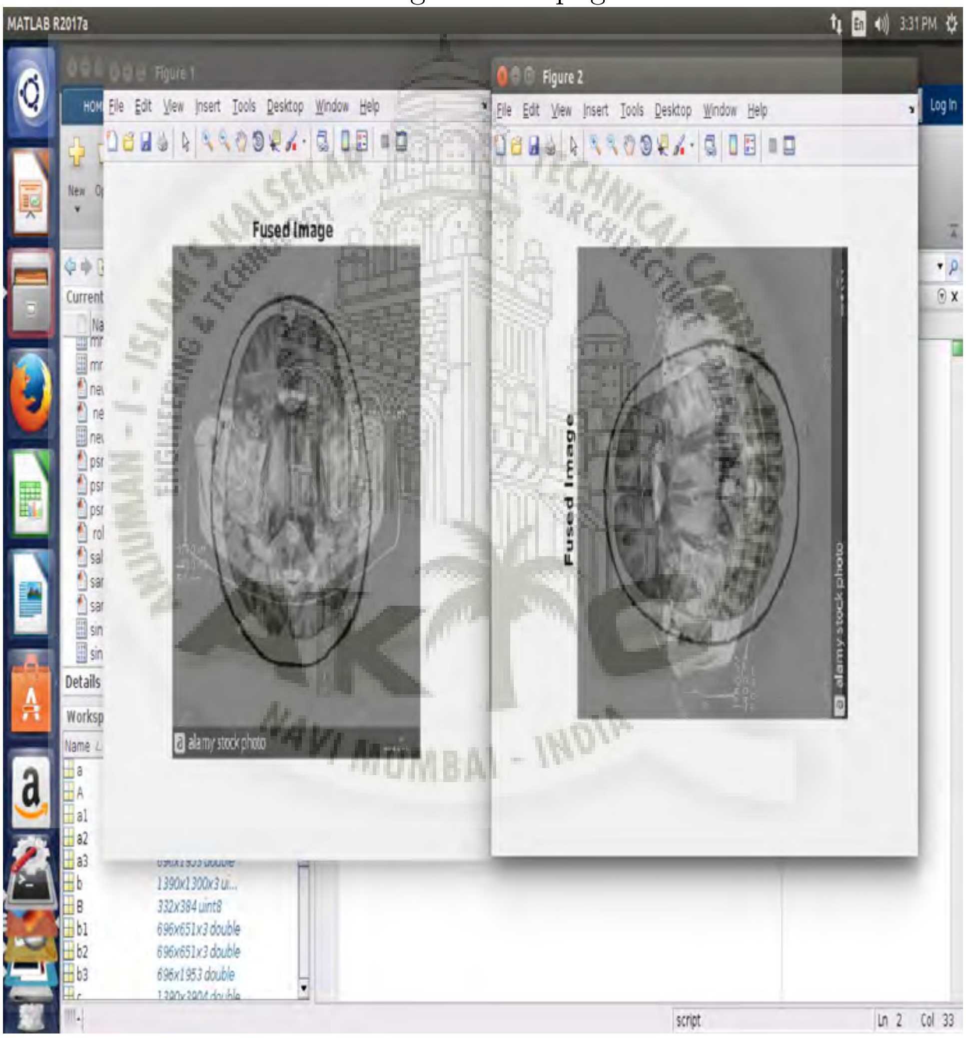

Figure 8.6: rotation

8.6 Salt and Pepper Noise Attack

This noise not fully degrades the original image rather only some pixel values are changed.Mainly this noise is present in data transmission.Syntax to use 'imnoise' is, X = imnoise(Image,'salt and pepper', 0.02).Above function adds "salt and pepper" noise to an image named Image, where percentage distortion is the noise density. The default for percentage distortion is 0.1

image2 noised.png

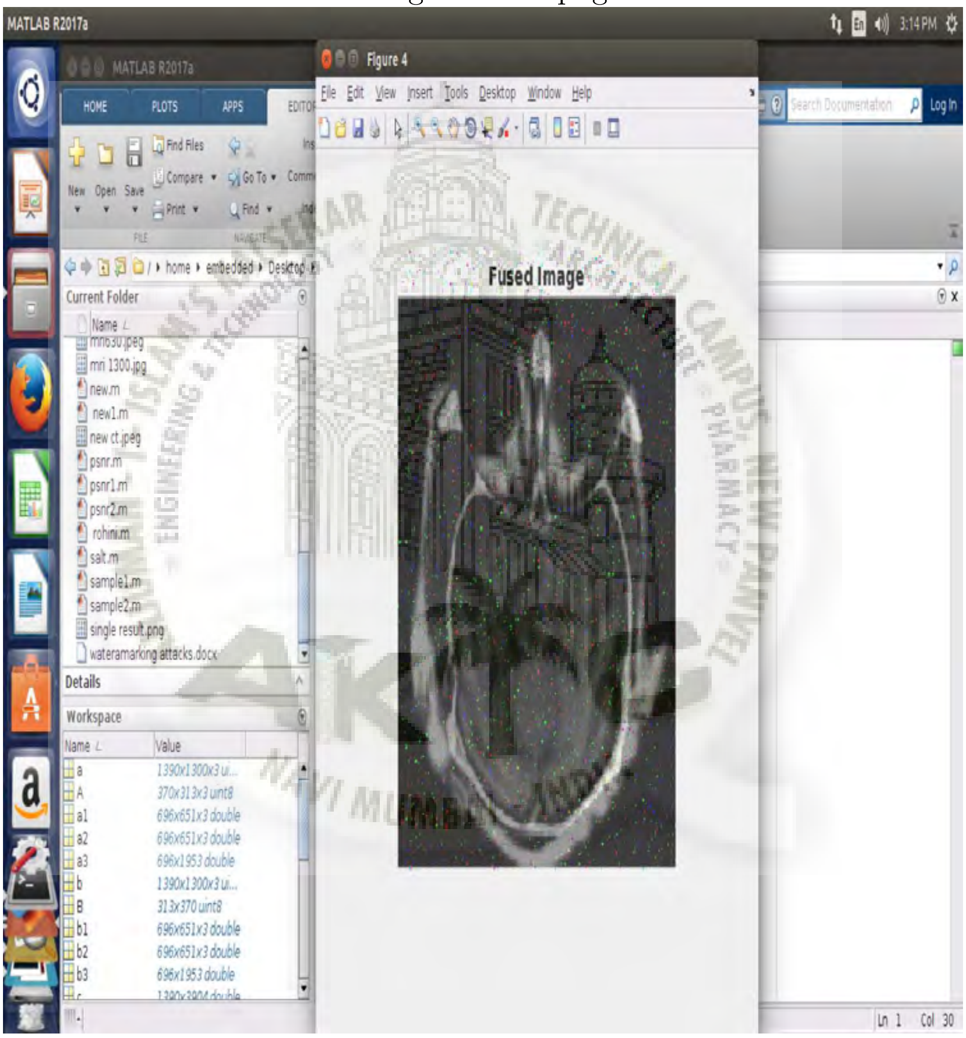

Figure 8.7: Salt pepper

8.7 PSNR Result

value.png

VALUES	CT	MRI	FUSED	NOISE	ROTATE
MSE	92	72.6	62.21	64.37	88.83
PSNR	28	29.1	31.98	30.21	28.67

Figure 8.8: psnr and mse

- Peak Signal to Noise Ratio (PSNR) and Mean Square Error (MSE) are used to comparing the squared error between the original image and the reconstructed image.There is an inverse relationship between PSNR and MSE. So ahigher PSNR value indicates the higher quality of the image (better).

- MSE can be calculated as the square difference between reference image and reconstructed/restored image. Thus a higher value of PSNR indicates that the image is of higher quality and vice-versa. A 20 dB or higher PSNR indicates that the image is of good quality.

Chapter 9

CONCLUSION and FUTURE SCOPE

9.1 conclusion

In this method, first, watermark and host images were taken to discrete wavelet transform domain and then HH and LL sub-bands of the host image were blocked. Afterward, LL sub-band blocks of the watermark image were embedded in the singular values of the blocks of the host image and a different SF was used for each block. It can be observed that higher the value of PSNR and lower value of MSE are desired results.From the above obtained results, it can be concluded that image quality assessment is a difficult task as the value of PSNR and MSE for different test images are not satisfactory as desired and this field still needs lot of hard work for development of accurate image quality metrics.

9.2 Future Scope

The PSNR and MSE are good metrics for image quality assessment but not accurate as desired. Still there is need for better technique for getting improved value of PSNR and MSE and also other image quality assessment metrics for digital image processing.As Watermarking becomes more widely used in computing there are issues that need to be resolved. There are a wide variety of different techniques with their own advantages and disadvantages.

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CERTIFICATE

- We presented our project "Image Fusion Using Dwt For Medical Applications"at A.C.Patil College of Engineering,Navi Mumbai,Maharashtra.Sector 4, Kharghar, Navi Mumbai, Maharashtra 410210.
- Which held in vectors (Project Presentation) event on 28th march 2019.
- **Certificate is awaited.**

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