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Research Paper

Medical Image Fusion using Matlab

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Abstract:-*The objective of Image fusion is to combine information from multiple images of the same scene into a single image retaining the important and required features from each of the original images. Nowadays, with the rapid development of high-technology and modern instrumentations, medical imaging has become a vital component of a large number of applications, including diagnosis, research, and treatment. Medical image fusion is the idea to improve the image content by fusing images taken from different imaging tools like Computed Tomography (CT), and Magnetic Resonance Imaging (MRI). For medical diagnosis, Computed Tomography (CT) provides the best information on denser tissue with less distortion. Magnetic Resonance Image (MRI) provides better information on soft tissue with more distortion [1]. The fusion performance is evaluated based on the mean square error (MSE) and peak signal-to-noise ratio (PSNR).*

Keywords: -*CT scan, MRI scan, DWT, MSE, PSNR*

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I. 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 into a single image retaining the important and required features from each of the original images. The main task of image fusion is integrating complementary information from multiple images into a single image. The resultant fused image will be more informative and complete than any input image and more suitable for human vision and machine perception. Image fusion is the process that combines information from multiple images of the same scene. 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 into one according to certain rules to achieve a clear visual effect. By observing medical fusion images, doctors could easily confirm the position of illness. Medical imaging provides a variety of modes of image information for clinical diagnoses, such as CT, X-ray, DSA, MRI, PET, SPECT, etc.

Different medical images have different characteristics, which can provide structural information on different organs. For example, CT (Computed tomography) and MRI (Magnetic resonance image) with high spatial resolution can provide anatomical structureinformation of organs. And PET (Positive electron tomography) and SPECT (Emission computed tomography) with relatively poor spatial resolution, but provide information on organ metabolism. Thus, a variety of imaging for the same organ, are contradictory but complementary and interconnected. Therefore, the appropriate image fusion of different features becomes an urgent requirement for clinical diagnosis. This paper presents a novel approach for the fusion of computed tomography (CT) and magnetic resonance (MR) images based on wavelet transform. Different fusion rules are then performed on the wavelet coefficients of low and high-frequency portions.

II. IMAGE FUSION TECHNIQUES

In the process of image fusion, the good information from each of the given images is fused to form a resultant image whose quality is greater than any of the input images. Image fusion method can be broadly classified into two groups 1. Spatial domain fusion method. 2. Transform domain fusion method. In spatial domain techniques, we directly deal with the image pixels.[1] The pixel values are manipulated to achieve the desired result.[1]In frequency domain methods the image is first transferred into the frequency domain. It means that the Fourier Transform of the image is computed first. All the Fusion operations are performed on the

Fourier transform of the image and then the Inverse Fourier transform is performed to get the resultant image. Image Fusion applied in every field where images are ought to be analyzed[8]. Numerous methods have been developed to perform image fusion. Some well-known image fusion methods are listed below

Image fusion using wavelet Transform
2. Image fusion by using stationary wavelet transform
3. Image fusion by using discrete wavelet transform.
4. Principal component analysis (PCA) based fusion

1. Image fusion based on wavelet transform

Wavelet transform is a time-frequency analysis technique that decomposes a signal or image into different frequency components. It provides a multi-resolution representation by dividing the signal into approximate (low-frequency) and detailed (high-frequency) components at various scales. Wavelet transform allows analysis of both local and global image features, making it suitable for image fusion tasks.They transform the signal under investigation into another representation which presents the signal in a more useful form. Mathematically, we denote a wavelet as

$$\psi_{a,b}(t) = \frac{1}{\sqrt{|a|}}\psi((t-b)/a)$$

;

Where b=is location parameter a=is scaling parameter for a given scaling parameter a, we translate the wavelet by varying the parameter b. we define the wavelet transform as

$$w(a,b) = \int_t f(t)\frac{1}{\sqrt{|a|}}\psi((t-b)/a)$$

According to the equation, for every(a, b), we have a ocean transfigure measure, representing how much the gauged ocean is similar to the function at a position, t = b/ a " If scale and position are varied truly fluently, also transform is called continuous ocean transfigure. " " If scale and position are changed in separate way, the transfigure is called separate ocean transfigure. " The image conflation system can be generally grouped into three orders. In this route, the information will witness this phase until finishing the demanded number of duplications which may be commanded as stated by the span of the employed way. This AES stage Might be best with an encryptor or an encryptor with a decryptor. What's further, it incorporates the outfit used for the four AES way movement Rows Step, byte concession exercising those concession boxes(S BOX), blend Columns, and include round magic. For high- haste vittles which will be executed also to a full 128 odds information path, the increment might have a chance to bemulti- plied ideally n times Toward applying those circles unrolled structural engineering. In this architecture, replicates of the AES phases need aid formed for series, the place n number from claiming phases may be employed. Over AES 128- odds way measure architecture, n may be 10, Likewise, 10 AES duplications are demanded to complete the encryption/ decryption forms.

2. Image fusion by using stationary wavelet transform

The Discrete Wavelet Transform isn't a time- steady transfigure. The way to restore the restatement invariance is to total some slightly different DWT, calledun-decimated DWT, to define the stationary sea transfigure(SWT). In biomedical signal processing. separate Wavelet Transform(DWT) is considered one of the most popular styles because of its capability to characterize contemporaneously a signal in the time and frequence disciplines. In practice, the DWT of a signal r(n) with N figures of samples is calculated by passing it through a series of separate pollutants bank. First the original signal is passed through a low pass sludge with an impulse response G(n) which gives a low- frequence element A called' Approximations Portions' with N/ 2 samples, and through a high pass sludge with an impulse response H() which gives a high- frequence factors CD called Details Portions' with N/ 2 samples, and the process is repeated over thedetail portions by adding the position of corruption. It does so by suppressing the down- slice step of the devastated algorithm and rather over- testing the pollutants by fitting bottoms between the sludge portions. Algorithms in which the sludge is over- tried are called " àtrous ", meaning " with holes ". As with the devastated algorithm, the pollutants are applied first to the rows and also to the columns. still, the main debit of DWT isn't restated in- variant property due to the operation of extermination which removes every other of the portions of the current position. To overcome this limitation, the Stationary Wavelet Transform(SWT) is proposed. Unlike Discrete Wavelet Transform(DWT), SWT does not incorporate down- slice operations. therefore, the ap- proximation portions(

SWA) and detail portions(SWD) at each position have the same length as the original signal. The multiresolution in the SWT is achieved by upsampling by a factor of two the portions of the low pass and high pass pollutants at each position of corruption. The SWT is also called by a variety of names in the literature including restatement steady(TI) sea transfigure, Shifted steady(SI) sea transfigure, etc. In terms of redundancy, SWT is more spare than DWT, a property that can be more suitable for numerous operations similar as signal denoising and surge discovery(13). The process of SWT corruption at position 2 of a signal (n) with Nsamples is illustrated inFig. 1. still, the main debit of DWT isn't restated in- variant property due to the operation of extermination which removes every other of the portions of the current position. To overcome this limitation, the Stationary Wavelet Transform(SWT) is proposed. Unlike Discrete Wavelet Transform(DWT), SWT does not incorporate down- slice operations. therefore, the ap- proximation portions(SWA) and detail portions(SWD) at each position have the same length as the original signal. The multiresolution in the SWT is achieved by upsampling by a factor of two the portions of the low pass and high pass pollutants at each position of corruption. The SWT is also called by a variety of names in the literature including restatement steady(TI) sea transfigure, Shifted steady(SI) sea transfigure, etc. In terms of redundancy, SWT is more spare than DWT, a property that can be more suitable for numerous operations similar as signal denoising and surge discovery(13). The process of SWT corruption at position 2 of a signal (n) with Nsamples is illustrated inFig. 1. still, the main debit of DWT isn't restated in- variant property due to the operation of extermination which removes every other of the portions of the current position. still, the main debit of DWT isn't restated in- variant property due to the operation of extermination which removes every other of the portions of the current position. still, the main debit of DWT isn't restatement in- variant property due to the operation of extermination which removes every other of the portions of the current position. To overcome this limitation, the Stationary Wavelet Transform(SWT) is proposed. Unlike Discrete Wavelet Transform(DWT), SWT doesn't incorporate down- slice operations. The multiresolution in the SWT is achieved by upsampling by a factor of two the portions of the low pass and high pass pollutants at each position of corruption. The SWT is also called by a variety of names in the literature including restatement steady(TI) sea transfigure. Shifted steady(SI) sea transfigure, etc In terms of redundancy. SWT is more spare than DWT, a property that can be more suitable for numerous operations similar as signal denoising and surge discovery(13). The process of SWT corruption at position 2 of a signal(with A samples is illustrated in fig. 1

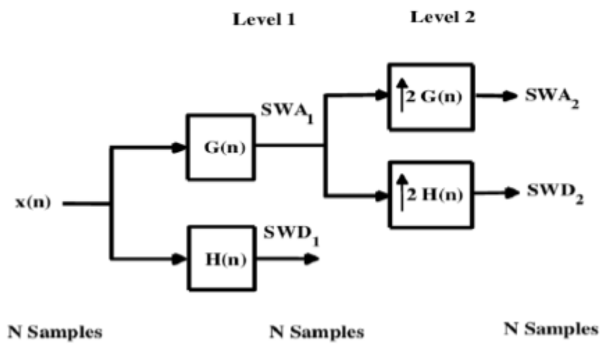

Fig. 1. Stationary Wavelet Transform

The 2D Stationary Wavelet Transform(SWT) is grounded on the idea of no extermination. It applies the Discrete Wavelet Transform(DWT) and omits both down- slice in the forward and up- slice in the antipode transfigure. More precisely, it applies the transfigure at each point of the image and saves the detail portions, and uses the low- frequence information at each position. The Stationary Wavelet transfigure corruption scheme is illustrated in Figure 5 where Gi and Hi are a source image, low- pass sludge, and high- pass sludge, independently. Figure 5 shows the detailed results after applying SWT to an image using SWT at 1 to 4 situations(14). The information inflow illustration in the image emulsion scheme employing SWT is as below(1)

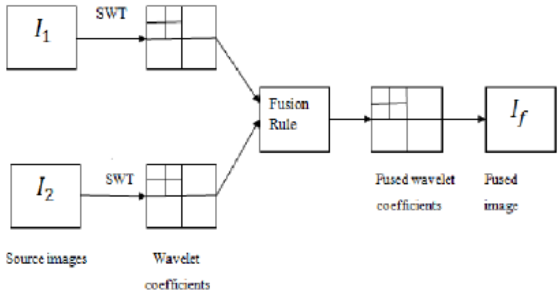

Fig 6. The information flow diagram in the image fusion scheme employing SWT[1]

The processing way of SWT are as follows(14).
- putrefy the two source images using SWT at one position performing in three details subbands and one approximation subband(HL, LH, HH, and LL bands).
- Also take the normal approximate corridor of images. - Take the absolute values of vertical details of the image and abate the alternate part of the image from the first. D = (abs(H1L2)- abs(H2L2))> = 0
- For the fused vertical part make element-wise addition of D and the vertical detail of the first image and also abate another vertical detail of the alternate image multiplied by a logical note of D from the first.
- Find D for perpendicular and slant corridor and gain the fused perpendicular and details of the image. - The same process is repeated for emulsion at the first position.
- Fused image is attained by taking inverse stationary sea transfigure.

3. Image fusion by using discrete wavelet transform

Wavelet transforms aremulti-resolution image corruption tools that give variability of channels representing the image point by different frequence subbands atmulti-scale. It's a notorious fashion for assaying signals. When corruption is performed, the approximation and detail element can be separated 2- D Discrete Wavelet Transformation(DWT) converts the image from the spatial sphere to the frequence sphere. The image is divided by perpendicular and vertical lines and represents the first order of DWT and the image can be separated into four corridor which are LL1, LH1, HL1 and HH1.(12).

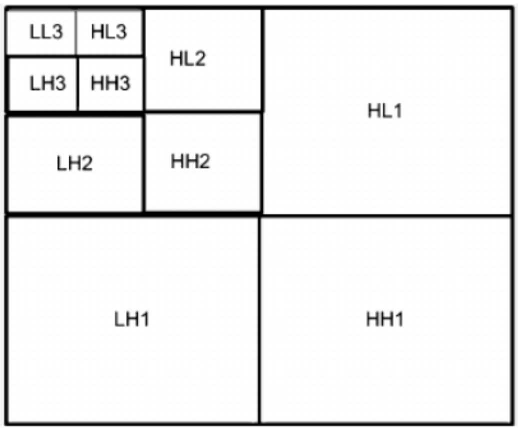

Fig 2. Wavelet decomposition[12]

In separate sea transfigure(DWT) corruption, the pollutants are especially designed so that consecutive layers of the aggregate only include details that aren't formerly available at the antedating levels.

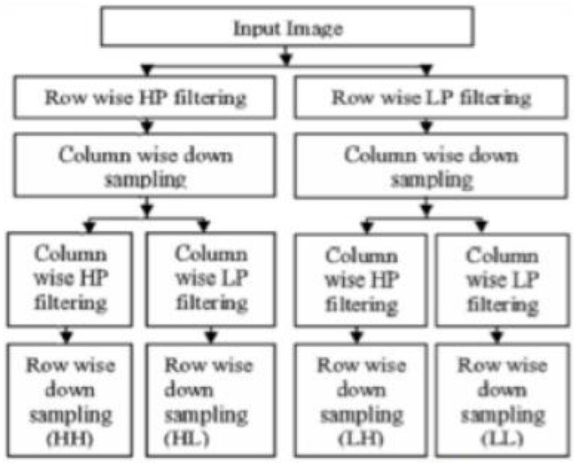

Fig 3. DWT decomposition[1]

The DWT corruption(13) uses a waterfall of special lowpass and high- pass pollutants and asub-sampling operation. The labors from 2D- DWT are four images having a size equal to half the size of the original image. So from the first input image, we will get HHa, HLa, LHa, and LLa images and from the alternate input image, we will get HHb, HLb, LHb, and LLb images. LH means that a low- pass sludge is applied along x and followed by a high- pass sludge along y. The LL image contains the approximation portions. LH image contains the vertical detail portions. HL image contains the perpendicular detail portions, HH contains the slant detail portions. The sea transfigure can be performed for multiple situations. The coming position of corruption is performed using only the LL image. The result is foursub-images each of size equal to half the LL image size.(1) The image emulsion process using DWT is described below

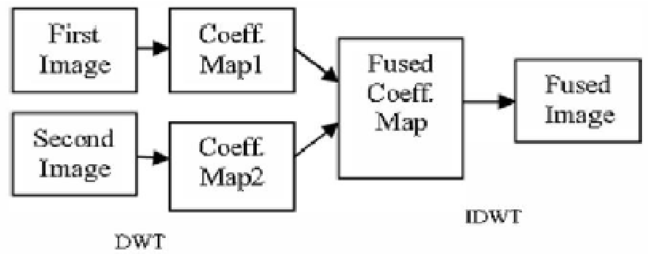

Fig 4. Image fusion process using DWT[1]

Wavelet transfigure is first performed on each source image to induce a emulsion decision chart grounded on a set of emulsion rules. The fused sea measure chart can be constructed from the sea portions of the source images according to the emulsion decision chart. Eventually, the fused image is attained by performing the inverse sea transfigure. The process way can be given below(13)
Accept the two images.
- Perform DWT on both images A andB.
- Perform position 2 DWT on both images A andB.
- Let the DWT measure of image A will be(HHa HLa LHa LLa).
- Let the DWT measure of image B will be(HHb HLb LHb LLb)
- Take the normal of pixels of the two bands from HHa and HHb and store them to HHn.
- Take the normal of pixels of the two bands from HLa and HLb and store to HLn.
- Take the normal of pixels of the two bands from LHa and LHb and store to LHn.
- Take the normal of pixels of the two bands from LLa and LLb and store to LLn.
- Now we've new HHn, HLn, LHn, LLn DWT portions.
- Take Inverse DWT on the HHn, HLn, LHn, and LLn portions.
- Gain the fused image and display.

4. Principal component analysis (PCA) based fusion

Principal component analysis(PCA) is a vector space transfigure frequently used to reduce multidimensional data sets to lower confines for analysis. PCA is the simplest and most useful of the true eigenvector-grounded multivariate analyses because its operation is to reveal the internal structure of data in an unprejudiced way. The algorithm can be epitomized as the following(12):

1. Inducing the column vectors, independently, from the input image matrices.
2. Calculate the covariance matrix of the two- column vectors formed in 1
3. The slant rudiments of the 2x2 covariance vector would contain the friction of each column vector with itself, independently.
4. Calculate the Eigenvalues and the Eigenvectors of the covariance matrix .
5. homogenize the column vector corresponding to the larger Eigenvalue by dividing each element by the mean of the Eigenvector.
6. The values of the regularized Eigenvector act as the weight values which are independently multiplied with each pixel of the input images.
7. Sum of the two gauged matrices calculated in 6 will be the fused image matrix.

Still, PCA supplies the stoner with a 2D picture, a shadow of this object when viewed from its most instructional standpoint, If a multivariate dataset is imaged as a set of equals in a high- dimensional data space(1 axis per variable). This dimensionally- reduced image of the data is the ordination illustration of the 1st two top axes of the data, which when combined with metadata(similar as gender, position etc) can fleetly reveal the main factors underpinning the structure of data(10). The top element analysis is a system in which several identified variables are converted into several uncorrelated variables called top factors. A compressed and ideal description of datasets is reckoned with by PCA. The first top element accounts for as much important of the revision in the data as possible and each succeeding element accounts for as importance of the remaining revision as possible. The first top element is taken to be along the direction with a maximum revision. The alternate top element is constrained to lie in the subspace vertical to the first within this subspace, this element points to the direction of maximum revision. The third star element is taken in the direction of maximum friction in the subspace vertical to the first two and so on. The PCA is also called as Karhunen- Loève transfigure or the Hotelling transfigure. The PCA doesn't have a fixed set of base vectors like FFT, DCT, sea, etc. and its base vectors depend on the data set(1)(11). The image emulsion process using PCA is described below The information inflow illustration of the PCA- grounded image emulsion algorithm is shown in Fig. and 2) x, y) are the two input images which are to be fused[11].

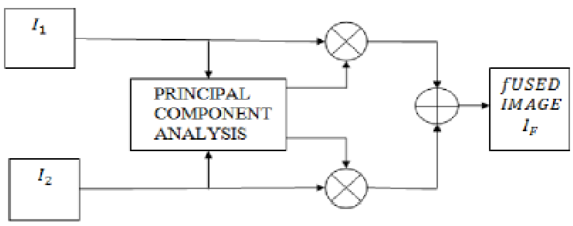

Fig1.The information flow diagram in image fusion scheme employing PCA[1].

III. IMAGE FUSION PARAMETERS

The general requirements of an image fusing process are that it should preserve all valid and useful pattern information from the source images, while at the same time, it should not introduce artifacts that could interfere with subsequent analyses. The performance measures used in this paper provide some quantitative comparison among different fusion schemes, mainly aiming at measuring the definition of an image[8].

3.1 PEAK SIGNAL TO NOISE RATIO (PSNR)

PSNR is the ratio between the

PSNR is the ratio between the maximum possible power of a signal and the power of corrupting noise that affects the fidelity of its representation [8][15]

The PSNR measure is given by:-

$$PSNR = 10 \cdot \log_{10}\left(\frac{MAX_I^2}{MSE}\right)$$
$$= 20 \cdot \log_{10}\left(\frac{MAX_I}{\sqrt{MSE}}\right)$$
$$= 20 \cdot \log_{10}(MAX_I) - 10 \cdot \log_{10}(MSE)$$

3.2 MEAN SQUARED ERROR (MSE)

The mathematical equation of MSE is given by the following equation

$$\mathrm{MSE} = \frac{1}{n}\sum_{i=1}^{n}(y_i - \tilde{y}_i)^2$$

Where A – is the perfect image, B – is the fused image to be assessed, i – is the pixel row index, j – pixel column index, m, n-No. of row and column

IV. RESULT

4.1 Input Images:

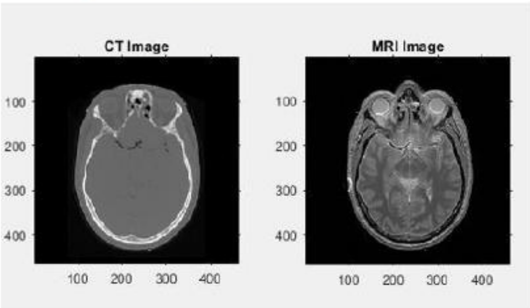

Fig.7 Input Images

4.2 Output Images:

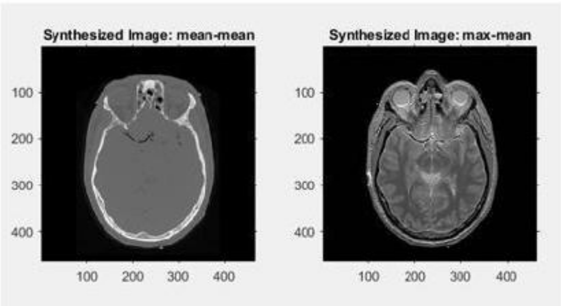

Fig.8 Image fusion using wavelet Transform

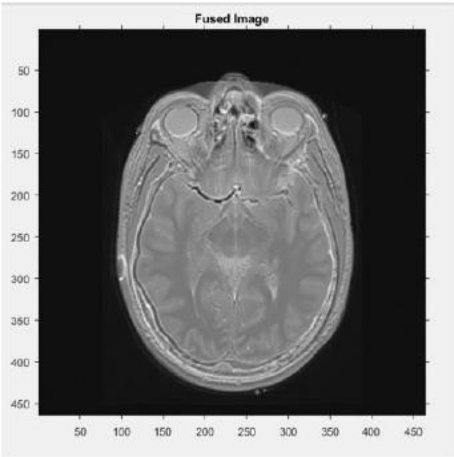

Fig.9 Image fusion by using stationary wavelet transform

Fig.10 Image fusion by using discrete wavelettransform.

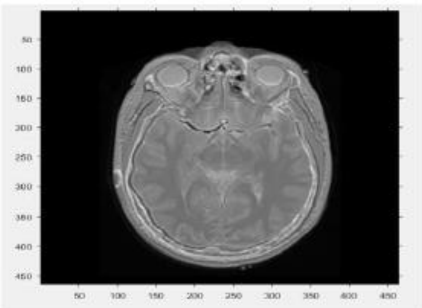

Fig. 11 Principal component analysis (PCA) basedfusion

V. CONCLUSION

In this paper, a method of image fusion is proposed. It is based on the use of Stationary Wavelet Transform, Discrete Wavelet transform, and Principal Component Analysis. By surveying all the techniques with their parameters, it is concluded that spatial domain techniques have a blurring problem and are overcome by transform domain techniques out of two techniques of transform domain that is SWT and DWT concluded that SWT gives less PSNR ratio and high MSE and gives better result compared to DWT. In addition, our proposed method is to combine the two techniques SWT and DWT of two same domains that is transform domain and will improve the image quality.

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