CT AND MRI IMAGE ENHANCEMENT BASED ON IMAGE FUSION TECHNIQUES

Medisetti Kasi Annapurna[1], Ch.Srinivasa Rao [2]

1 PG scholar, JNTUK-UCEV, Vizianagaram, 535003, India

2 Professor, JNTUK-UCEV, Vizianagaram, 535003, India

Abstract:

Medical image analysis is a recent upcoming research area This research work is about Magnetic Resonance Imaging MRI and Computer Tomography CT. This analysis involves three major image processing applications. They are Image Fusion, Image Denoising and Imageenhancement. Each application works with the following transforms namely DiscreetWavelet Transform. The final output image provides more information than any of the single images Medical image fusion tries to solve the issue of where there is no single modality which provides both anatomical and functional information. Further more information provided by different modalities may be in agreement or in complementary nature the main objective of medical image fusion is to obtain a high-resolution image with as much details as possible in a single image for the purpose of diagnosis. And image contrast enhancement carried out by the via component decomposition and tissue attenuation, a parametric adjustment model was deduced to generate many enhanced images at once. Finally, an ensemble framework was reposed for fusing these enhanced images and producing a high-contrast output in both bright and dark regions. To evaluate the performance a classical tool such as correlation, SSIM map is used, which provides accurate result when compared to other signal fidelity metrics.

Keywords: Medical images, DCT, Component enhancement, parametric adjustment, SSIM

I. Introduction

Image fusion is the process of combining multiple input images into a single hybrid fused image. The purpose of image fusion is to provide an output image from the collection of input images which is having more information of the scene than the one individual input image. The output image should be more useful for human visual perception. Image fusion has been used in many application areas. In remote sensing, multimodality fusion is used to achieve high spatial and spectral resolutions by combining images from two different types of sensors, one of which has high spatial resolution and the other one high spectral resolution. Many fusion applications have appeared in medical imaging like simultaneous evaluation of CT, MRI, and/or PET images [1]. Visible and infrared image fusion has appeared in military, and surveillance areas. In multiview fusion, multiple images of the same scene are taken by the same sensor but from different viewpoints is fused to get a image with higher resolution than the sensor normally provides or to recover the 3D representation of the scene. Images of the same scene are obtained at different times either to find and evaluate changes in the scene or to obtain a less degraded image of the scene. The list of applications illustrates the different types of problems we face when fusing images. It is difficult to design a universal technique that is applicable to all image fusion tasks. Every technique should take into account not only the fusion goal and the characteristics of individual sensors, but also particular imaging conditions, imaging geometry, required accuracy, noise corruption, and application-dependent data properties. Motivation for image fusion is the result of recent advancements in the field of image Scanners or sensors. As the new image scanners are of high resolution and are available at low cost, multiple sensors are used in a wide range of imaging applications. These sensors are of high spatial and spectral resolution and offer faster scan rates. The images taken by these sensors are more reliable, informative and contain complete picture of the scanned environment. Thus, they help in improved performance of dedicated imaging systems. As the number of sensors increase in an medical application, the more proportionate amount of sensors is permitted by a corresponding increase in die processing power of the system. A sensor grabs multiple images of a location and one of them will be considered for analysis. However, the considered image may not have good spatial and spectral resolution. To overcome this and to generate a fused image with high spatial and spectral resolution, this thesis identifies the need for image fusion by developing new techniques to improve the performance of existing fusion techniques. There is need to provide the technique of image fusion more effectively through analytical study of medical images using wavelet transforms. A new tool for medical diagnosis is obtained in an effective manner, dependent on the integration of two or more images, from the same scene or the same section, and then incorporating good features of each image and injecting it into a newimage to form a more accurate picture and clearer input images. This process is called image fusion. Image fusion technique within short time is able to overcome many obstacles that face the subject of image enhancement compared to traditional techniques used in various fields like remote sensing, military surveillance, and medical field. Therefore, more research is needed in this field to develop medical technology and so this is what this study is going to try to do by combining most of the images features in one image using image fusion technique. This technique has an important role in providing information required by medical doctors in providing better medical diagnostics services.

II. Literature survey

An extensive number of techniques available to fuse visual image information from last few decades. These techniques vary in their nature, robustness, complexity and sophistication. Medical image fusion is one of the important fields with large number of dedicated publication. The purpose of literature review is to give background information on the issues related to image fusion. Medical image fusion techniques are evaluated by quantitative and qualitative measures .Fused images under evaluation; if helps to improve the efficiency of arriving at a particular decision with respect to the reference problem in a short span of time [1][2][3] image fusion technique is good. Image fusion objective is to combine information from several images (sensors) taken from the same scene in order to achieve a new fused image, which contains the best information coming from the original images. So fused image is better quality than any of the original images.Authors in [4][5] stated that although vast development has been noticed in the field of medical imaging in the last 50 years but further improvements are still required to be made in the field of MRI, ultrasound and molecular imaging. The infrastructure of picture archiving and communication system is likely to be improved further in terms of its reliability speed and accuracy so that we get much better information. Authors in [6][7]further stated that medical imaging systems is evaluated on the basis of everything from the hardware and software that is used for storage, transmission and presentation of images to the interpreting clinician. Evaluation methodologies cover a broad range, from receiver operating characteristic; receiver based operating techniques that measure diagnostic accuracy to timing studies that measure image-interpretation workflow efficiency. There has been a considerable amount of methodological development and innovation to carry out statistical analysis in the evaluation of medical imaging systems. Through continuing medical imaging system development and system evaluation, diagnostic accuracy by both humans and computers will continue to improve and positively impact patient care. Authors in [8][9][10] Medical image fusion is the process of registering and combining multiple images from single or multiple imaging modalities for improving the imaging quality and reduce redundancy. Medical image fusion increases the clinical applicability of medical images for diagnosis and treatment of medical problems. Multi-modal medical image fusion has shown that clinical accuracy of decisions based on medical images is increasing. The ability of image fusion techniques to improve the quality of imaging features makes multimodal techniques efficient and accurate relative to unimodal techniques. Availability of a large number of techniques in feature processing, feature extraction and decision fusion makes the field of image fusion appealing to be used by medical imaging community.

III. Methodology

In image fusion, first step is to prepare the input images for fusion is called image pre-processing. In image pre-processing image registration and resampling of image pixel is done. Many times the images are geometrically uneven. Registration is needed to align the corresponding pixels in the input images.The images are to be properly aligned on a pixel-by-pixel in order to get the successful image fusion. The images captured from CT - and MRI are taken as input images Image 1 and Image 2 respectively.

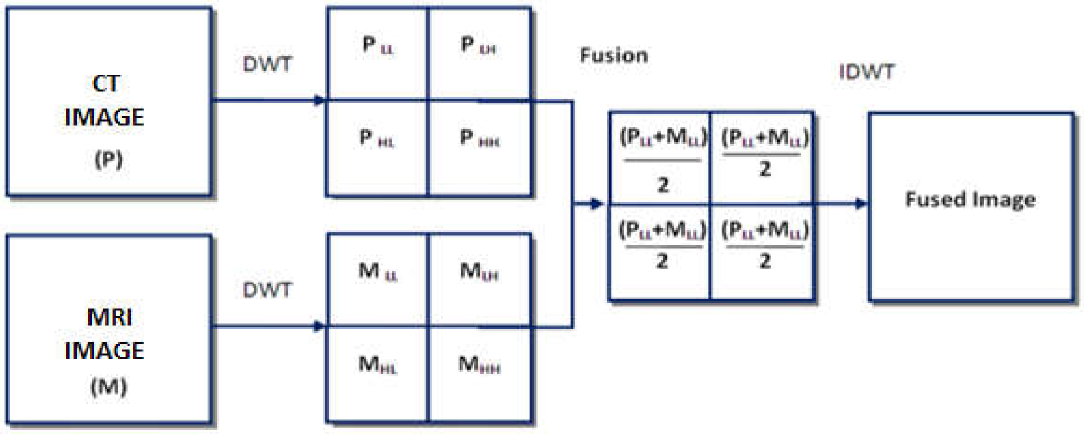


Figure 1: CT-MRI image fusion

In this research, these input images are pre-processed to apply DWT fusion effectively. The Figure 1shows the top level block diagram of image fusion using wavelet transforms. During the decomposition process, DWT lets the input images to be decomposed into different types of coefficients by retaining the original information. These coefficients coming from several input images are then combined according to some fusion rules to get the new fused coefficients. During the reconstruction process, Inverse Discrete Wavelet Transform (IDWT) is performed on the combined fused coefficients to get the resultant fused image.Initially, CT image are taken as input images the registered images have been passed as input signals through two different one-dimensional digital filters H0 and H1 respectively. These H0 and H1 digital filters perform high pass and low pass filtering operations respectively for both the input images. The output of each filter is followed by sub-sampling by a factor of two.

This step is referred as the Row compression and resultant is called as L-low frequency component and H-high frequency component. Then, the down sampled outputs have been further passed to two one dimensional digital filters in order to obtain Column compression. After two level compressions of both input images, the output frequency components High-

High (HH), High-Low (HL), Low-High (LH) and Low-Low (LL) are obtained.The obtained frequency components of one input image is fused with the frequency components of second image respectively. The HH components of both images have been added and then the resultant output has been divided by a factor two. Similarly, the average of HL, LL and LH components has been taken. This entire process is known as Image Fusion. The averaged result has been followed by the reconstruction process i.e., Inverse Discrete Wavelet Transform (IDWT). IDWT is the reverse process of DWT. In IDWT process, the output frequency components (HH, HL, LH and LL) have been first up sampled and then filtering operation has been carried out.Therefore in this paper three fusion techniques are used in first level are Maximum Method, Minimum Method, Average Method. Along these three method Maximum level is gives the best result.

- **Maximum Method**:In this method, the resultant fused image is obtained by selecting the maximum intensity of corresponding pixels from both the input image.

$$X(i,j)=\sum_{i=0}^{m} \sum_{j=0}^{n} \max(P(i,j)+M(i,j)) \quad (1)$$

- **Minimum Method:**In this method, the resultant fused image is obtained by selecting the maximum intensity of corresponding pixels from both the input image.

$$X(i,j)=\sum_{i=0}^{m} \sum_{j=0}^{n} \min(P(i,j)+M(i,j)) \quad (2)$$

- **Average Method:** In this method the resultant fused image is obtained by taking the average intensity of corresponding pixels from both the input image.

$$X(i,j) = \frac{(P(i,j) + M(i,j))}{2} \quad (3)$$

Where P(i, j), M (i, j) are input images, X(i, j) is fused image, (i, j) are pixel values.

IV. Image enhancement

Contrast enhancement for an image is attained due to redistribution of intensity values. The resultant contrast enhanced image provides a feature extraction in computer vision system. HE is one of the most commonly employed algorithms for contrast enhancement as it is simple as well as efficient. It remaps the gray levels based on the probability distribution of the input gray levels. It flattens and expands the dynamic range of the images histogram which produces overall contrast enhancement.The various changes in the levels of contrast enhancement can be achieved by changing the values of these parameters. In order to find the optimal value of these parameters, this procedure is viewed as an optimization problem and it is defined as follows:

Algorithm:

Input : An image X(i, j) with the grey level range $[X_0, X_{L-1}]$.

Output: The contrast enhanced image H_o(i,j)

Step 1: Input the given image X(i, j) with a total number of N pixels in the gray level range $[X_0, X_{L-1}]$.

Step 2: Segment the image into two sub-images (minima gravy level of the object and maxima gray level of the back threshold.)

Step 3: Generate the input (original) histograms H_iL and H_iU for lower and upper sub-images (foreground and background images) separately.

Step 4: For lower sub-image, perform the following to obtain uniform histogram.

(a) Compute Estimate tissue componentfor this sub-image.

(b) Apply the attenuation factor based transformation function.

Step 5: Obtain an optimal value of the contrast enhancement parameter 1 for minimum sub-image.

Step 6: Compute the modified attenuation component.

Step 7: repeat the same procedure various colour levels of imageuptomaximum level.

Step 8: Find an optimal value of the contrast enhancement parameter 2 for maximum sub-image.

Step 9: Compute the contrast leveland brightness preservationmetricto estimate the fusion weight.

Step10: Fuse the two modified sub-minimum and maximum images into a single enhanced output and display the final contrast improved and details preserved output imageH_o(i,j)

V. Objective measurement criteria

The two popular evaluation criteria were used. Objective measuring method takes advantage of image statistics properties to establish a steady standard of performance evaluation.To evaluate the effectiveness of the proposed method quantitatively, we use the metrics are correlation and Structural Similarity Index (SSIM). SSIM and Correlation coefficients measures the closeness and similarity in small size structures between the original and fused image. It can vary between -1 to +1 value. Value close to +1 indicates that they are highly similar while the values close to -1 indicate dissimilarity. In visual analysis we take the two parameters SSIM and correlation for comparison point of view for fused image and original image. Here we take the reference of normal patient images with abnormal patients. The effectiveness of the structure-centric SSIM method isbetter revealed by comparing the SSIM maps with theabsolute error maps.

- **Correlation:**

$$X(i,j)=\frac{1}{q^2}\sum_{i=0}^{q}\sum_{j=0}^{q}(\hat{P}(i,j)+\hat{M}(i,j))(4)$$

q = is size of both images

- **SSIM:**

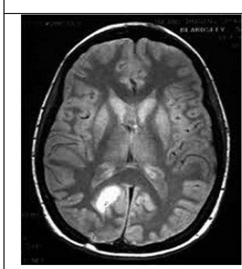
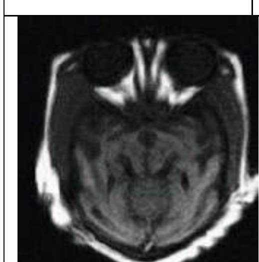
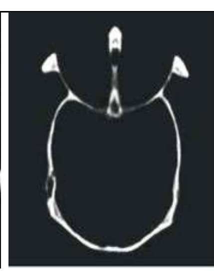
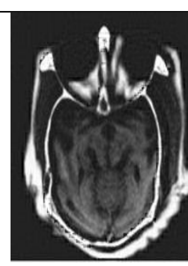
$$SSIM(i,j)=\frac{2(\mu_i\mu_j+C_1)2(\sigma_{ij}+C_2)}{(\mu_i^2+\mu_j^2+C_1)(\sigma_i^2+\sigma_j^2+C_2)} \quad (5)$$

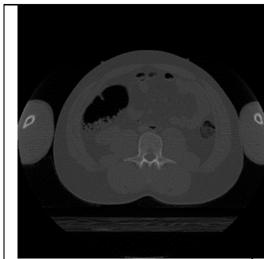
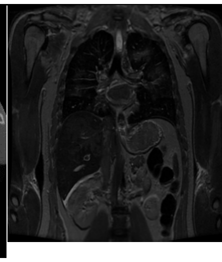
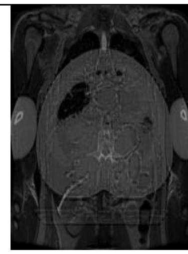
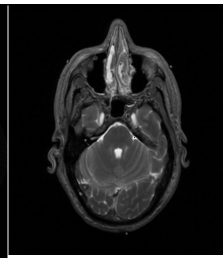
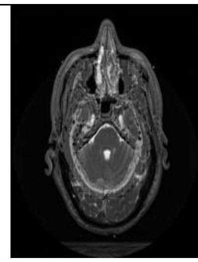
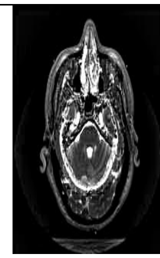
μ_i and $\mu_j$are Averages of i and j, $\sigma_i$and σ_j are Variance of i and j,$\sigma_{i,j}$ is Covariance of i and j

$c_1 = (k_1L)^2$, $c_2 = (k_2L)^2$ two variables to stabilize the division with weak denominator.

$k_1 = 0.01, k_2 = 0.03$

VI Experimental Results

CT IMAGE	MRI IMAGE	FUSED IMAGE	ENHANCED IMAGE (fused image as an input image for enhancement) method for fusin: MAXIMUM	Correlation between fused and enhanced image	SSIM between Fused and enhanced image
				0.9377	0.8739
				0.9604	0.8981

				0.7902	0.6739
				0.9454	0.7166
				0.8948	0.5574

VII. Conclusion

Multimodality medical image fusion have an important role in improving medical diagnosis, But real problem is to obtain visually enhanced images through fusion technique. In this thesis hybrid image fusion techniques are proposed. The main objective of this thesis was to design hybrid image fusion algorithm. The first technique was hybrid of wavelet transform and other was hybrid of dual tree dwttransform. Hybrid image fusion approach proved to be useful over other individual approaches as it encompasses all the advantages of individual image fusion transforms and provides a more clear and enhanced image having more details than that of the individual images. It is clear from previous results that hybrid image fusion techniques are successful in medical diagnosis.

References:

[1] S. Rajkumar, P. Bardhan, S. K. Akkireddy, & C. Munshi, "CT and MRI image fusion based on Wavelet Transform and Neuro-Fuzzy concepts with quantitative analysis", In Proc. of International Conf. on Electronics and Communication Systems, Coimbatore, India, pp.1-6, 2014

[2] Z. Wang, D. Ziou, C. Armenakis, D. Li, Q. Li, "A comparative analysis of image fusion methods", IEEE transactions on Geoscience and Remote Sensing, Vol. 43, No.6, pp.1391- 1402, 2005

[3] K. Sharmila, S. Rajkumar, & V. Vijayarajan, “Hybrid method for multimodality medical image fusion using Discrete Wavelet Transform and Entropy concepts with quantitative analysis”, International Conference on Communications and Signal Processing (ICCSP), melmaruvathur , India, pp.489-493, 2013.

[4] S. Rajkumar, S. Kavitha, “Redundancy Discrete Wavelet Transform and Contourlet Transform for Multimodality Medical Image Fusion with Quantitative Analysis”, In Proc. of 3 rd International Conf. on Emerging Trends in Engineering and Technology, Goa, India, pp.134-139, 2010.

[5] S.M. Darwish, “Multi-level fuzzy contourletbased image fusion for medical application”, IET Image Processing, Vol. 7, No.7, pp.694-700, 2013.

[6] D. Agrawal, and J. Singhai., “Multifocus image fusion using modified pulse coupled neural network for improved image quality”, IET image processing, Vol.4, No.6, pp.443-451, 2010

[7]] Y. Yang, Y. que, S. Huang, P. Lin, “Multimodal Sensor Medical Image Fusion Based on Type-2 Fuzzy Logic in NSCT Domain”, IEEE Sensors Journal, Vol.16, No.10, pp.3735-3745, 2016.

[8] Y. Yang, S. Tong, S. Huang, P. Lin., “Multifocus image fusion based on NSCT and focused area detection”, IEEE Sensors Journal, Vol.15, No.5, pp.2824-2838, 2015.

[9] R. Hassen, Z. Wang and M.M. Salama., “Objective quality assessment for multiexposuremultifocus image fusion”, IEEE Transactions on Image Processing, Vol.24, No.9, pp.2712-2724, 2015.

[10] D.M. Chandler and S.S. Hemami, “VSNR: A wavelet-based visual signalto-noise ratio for natural images,” *IEEE Trans. Image Process.*, vol. 16, no. 9,pp. 2284–2298, Sept. 2007.

Medisetti Kasi Annapurna is pursuing her M.Tech in Systems and Signal processing area from University College of Engineering, JNTUK, Vizianagaram, A.P, India. she pursued her B. Tech from V.S.Lakshmi Engineering college for Women’s, Kakinada, A.P, India.

Srinivasa Rao Chanamallu is currently working as a Professor of ECE at JNTUK, University College of Engineering, Vizianagaram, AP, India. He obtained his Ph.D. in Digital Image Processing area from University College of Engineering, JNTUK, Kakinada, A.P, India. He has 26 years of teaching and research experience. He published 65 Research papers in reputed International Journals and Conferences. He is a Fellow of IETE and member of CSI. His research interests include Content based Image and video retrieval, Medical image processing, video water marking and Image forensics. He is also acting as the Reviewer for many reputed International journals.