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IMAGE STATISTICS AND WIENER FILTER BASED MRI AND CT IMAGES FUSION

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ABSTRACT: The fusion of images is the mechanism by which two or more images are merged into one image with important features. Fusion is an important technology in many different areas, including remote sensing. In medical imaging using different modalities such as magnetic resonance imaging (MRI) and computed tomography (CT), complementary information of a targeted organ will be captured. All the necessary information from these two modalities has to be integrated into a single image for better diagnosis and treatment of a patient. Therefore this paper presents, Image Statistics and Wiener Filter based MRI and CT Images Fusion. The proposed algorithm is as follows: detail layers are extracted from each source image. Weights corresponding to each source image are calculated from the detail layers with help of image statistics. Then a weighted average fusion strategy is implemented to integrate source image information into a single image. The simulation results of improved framework show better performance over existing methods in terms of entropy, Standard deviation and fusion factor.

KEYWORDS: Image Fusion, image statistics, Wiener Filter, MRI, CT.

I. INTRODUCTION

Medical image processing plays a vital role for detecting the pathology of humans. Amid numerous medical imaging techniques like Computed tomography (CT), Ultra-sound and X-ray, Magnetic Resonance Image (MRI) provide more operative information about the anatomy of the human brain, during the diagnosis of abnormality [1]. Image Fusion is a process of merging two images into a single image that can provide

The fusion technology of magnetic resonance images (MRI) and computerized tomography (CT), which can get higher quality and clearer image than source image, has much attention in these ten years [2]. Theoretically, CT images can precisely detect dense structures such as bones and implants, and MRI provides high-resolution anatomical information for soft tissues, but is less sensitive to the diagnosis of fractures than CT. Image fusion techniques were created to produce a new image, which is more relevant to human vision or perception of the system. The Main advantage of image fusion is to improve reliability and capability. To obtain sufficient information for accurate diagnosis, doctors need to sequentially analyze MRI and CT images which are captured, but this manner may bring inconvenience and problem in many cases. Consequently, Multimodal medical images fusion technology, which can obtain more comprehensive, clear, easy for doctors to recognize illness, plays a key role in medical diagnosis [3].

Various types of images are available : (1) Multisource images- images taken from different sources, (2) Multi-view images- images taken at several angles or views ,(3) Multi-temporal images- images captured at different period of time, such images undergoes change in information due to temperature change etc., and (4) Multimodal images, these are images of different

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modalities like CT or MRI images. Nowadays image fusion is frequently been done in various fields like in medical, remote sensing, face detection etc.

The image fusion is acquired by three distinguished processing levels named pixel-level, feature-level, and decision-level. Many researchers employ pixel-level-based fusion in a variety of applications [4]. It directly merges the pixels of the input images to obtain the final output image. Feature-level-based image fusion on the other hand deals with high-level processing tasks. It extracts the image features and then amalgamates them using advanced fusion schemes like region-based fusion.

The decision level is the highest of the three processing steps described above. It extracts all information from images and then makes decisions to fuse the extracted features based on particular criteria. Medical images play an essential role in healthcare applications like disease diagnosis and patient treatment. These images are capturing from different modalities such as magnetic resonance imaging, computed tomography (CT), positron emission tomography (PET), and single-photon emission computed tomography (SPECT).

There are different methods available for image fusion in which the most popular one is pixel level fusion. It is further classified into four types, they are substitution, mathematical, optimization and transform domain. The substitution technique has been divided into PCA, Averaging, IHS, and color mixed [5]. The mathematical fusion is based on brovey transform, the optimization approach is defined under Bayesian and neural networking, and there are four methods in transform domain approach Laplacian, Curvelet, Counterlet, Wavelet. Need of CT and MRI image fusion arises from the fact that if one wants to perform any contrast enhancement on the images, it can only be done on individual scans. So fusion can save the efforts of processing different images. Another advantage is reduction of the storage capacity for different scans.

II. LITERATURE SURVEY

Anto. A. Micheal, K. Vani, et. al. [6] proposes a new image fusion method based on Dual Tree-Complex Wavelet Transform (DTCWT), and Curvelet transform for remotely sensed lunar image data in order to extract features accurately. Different fusion techniques have been used in the past separately for spatial and spectral quality image enhancement. In this study, we use a new image fusion technique based on Dual Tree - Complex Wavelet Transform (DT-CWT) and Curvelet transforms. Results indicate that the fused lunar image shows good spatial fidelity and the spectral resolution of the fused product was preserved after image data fusion. It is seen that 95.98% of the spectral content is preserved by curvelet fusion. From the results of statistical evaluation parameters demonstrated for the two study sites, it is found that curvelet transform gives better results than the other techniques commonly used.

Wei Mu, Zhe Chen, Jie Tian, Zhaohui Zhu, Di Dong, et. al. [7] presents a new fusion method based on the Pansharp model. Our proposed method consists of first up-scaling the PET image to the resolution of the CT data by bilinear interpolation and registering them with mutual information, then integrating the anatomical information into the original PET image and transforming it to a multi-channel RGB image using a color table, and then simulating the panchromatic image with multiple regression analysis, and finally obtaining the fused image according to the Pansharp model. Our method is verified based on 45 real data sets and both qualitative and quantitative analyses of the fusion results demonstrate the effectiveness and robustness of the proposed method.

Iliana Papamarkou, Nikos Papamarkos, Sofia Theochari, et. al. [8] presents a new image sharpening technique that can be applied to both gray-scale and color images. The proposed approach uses a multi-scale scheme and a wavelet based fusion algorithm. Specifically, the input image is initially processed by a cluster of un-sharp filters with different variance. The final image is then obtained with the aid of wavelet fusion. The application of the unsharp filters with different size Gaussian filters emphasizes important information in different frequency bands. It is shown that the proposed technique can be used as a preprocessing stage to general image fusion approaches. The quality of the resulting images is evaluated using three different sharpening indices. The experimental investigation demonstrates the effectiveness of the proposed technique.

Wenzhan Dai, Libo Tan, Aiping Yang, et. al. [9] presents an adaptive fusion algorithm of CT and MRI medical images based on NSC. The source images are decomposed in a multi-direction way by using the nonsubsampled pyramids (NSP) and the nonsubsampled directional filter banks (NSDFBs). In band-pass directional sub-band coefficients fusion rules, we use local energy and the weighted average combination, meanwhile for the larger selection of absolute value of the coefficient are applied in the highest levels. The combination of the adjustable parameter and objective evaluation index of the adaptive fusion rules are used in low frequency sub-band fusion. The experiment verifies the feasibility of the method in terms of visual quality and objective evaluation criteria, entropy, standard deviation, space-frequency and mutual-information etc.

VPS Naidu, et. al. [10] Multi-resolution image analysis by Fast Fourier Transform (MFFT) algorithm has been presented and evaluated for pixel level image fusion. The idea is to apply simple and proven technique of FFT to image fusion. The performance of this algorithm is compared with that of well known wavelet based image fusion technique. It is observed that the performance of image fusion by MFFT is slightly better than wavelet based image fusion algorithm. It is computationally very simple and it could be well suited for real time applications.

III. MRI AND CT IMAGES FUSION

The block diagram of Image Statistics and Wiener Filter based MRI and CT Images Fusion is represented in below Fig. 1. A total of 10 patients were studied with a focus on visualization of brain structures using CT and MRI data volume sets and considered one set for the experiment after consulting with medical doctors. Find the Size of Both Images. Check whether their size are equal, (I) If Size are Equal, then go to Step 3. (II) If Size are not equal, then resize and go to Step 3. Then M and N are two images of the same size representing the MRI and CT images.

The Images are decomposed by Discrete Wavelet Transform into approximation and detailed coefficients. DWT is mostly used in fields related to feature extraction, denoising, face detection, and image compression. Wavelets has an advantage over other transforms that wavelets can be scaled in accordance with the variations in

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the image components. Also, these are have faster computational time and requires less memory for storage. Wavelets can be stretched to capture slow varying components while compressed wavelets can be used to capture abrupt changes like at the edges.

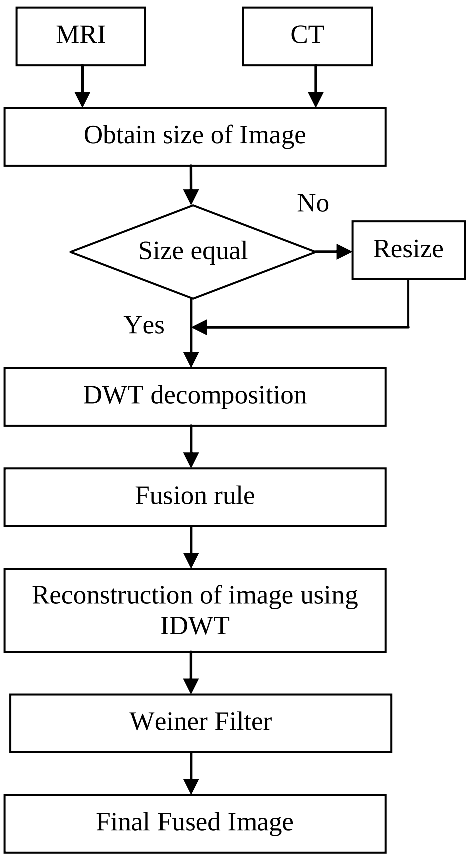

Fig. 1: BLOCK DIAGRAM OF MRI AND CT IMAGES FUSION

The fusion scheme uses weighted average scheme for the purpose of fusion. Using statistical properties, this method finds optimal weights adaptively. The fusion rule is discussed as follows. The basic idea is to find weight corresponding to a pixel in an image based on its horizontal and vertical edge strengths. In theory, to find a weight corresponding to a pixel at a location (x, y) in an image take a square window w of size m3m around its neighborhood. Consider Z as a matrix and find its covariance matrix by considering row as an observation, column as a variable. Repeat this process for each and every pixel present in the image to assign weights adaptively. Here, weight of a pixel depends on its edge strength but not on its intensity value.

After decomposition and fusion of images, the fused image is reconstructed using inverse transforms (IDWT). Generally filters do not have accurate de-blurring function, and also many coefficients of the image are missed during inverse filtering. After the decomposition of coefficients and fusion by applying fusion algorithm, the fused coefficients encounters noise and artifacts. These artifacts are detected and removed by wiener filtering. Under this filtering, assumption of a stationary signal and noise spectrum, is made. The Wiener filter approximates and minimizes the mean square error between the estimated and desired random signal. Further, it helps in de-blurring and noise reduction of the fused image.

IV. RESULT ANALYSIS

The images used for simulations consist of medical CT and MRI images. A total of 10 patients were studied with a focus on visualization of brain structures using CT and MRI data volume sets. Entropy (E), Fusion factor (FF) and standard deviation (SD) are calculated for both test image sets. We can observe different set of images gives variations in values of fusion metrics. The large values of Entropy indicates that the finally fused image carries sufficient amount of information that can be useful for clinical diagnosis. The degree of fusion, as represented by fusion factor is also up to the mark. High values of Standard deviation depict large variance in image.

The main criterion of image fusion is that the process should preserve all the

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information content. It should not degrade the quality of the original image. This can be measured by various performance parameters discussed below:

Entropy measures the amount of information carried by the image. If after undergoing fusion process, the value of entropy increases, this mean that the information of the fused image is better as compared to the original images.

Fusion factor (FF) measures the level of fusion, higher the value of FF- indicates more information in the fused image.

Standard Deviation is the measure of the amount of variance of each value from mean. It is square root of the variance.

Table 1 shows the comparative performance analysis of different fusion methods as PCA, Sparse+PCA with described model (Image Statistics and Wiener Filter).

Table 1: PERFORMANCE COMPARISON

Method	Entropy	Fusion factor (FF)	Standard Deviation
PCA	4.56	4.26	35.1
Sparse +PCA	4.81	4.86	38.4
Image Statistics and Wiener Filter	6.12	5.83	57.9

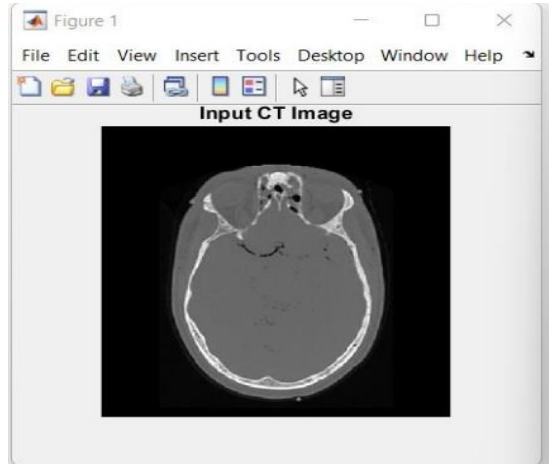

Fig. 2: INPUT IMAGE OF CT

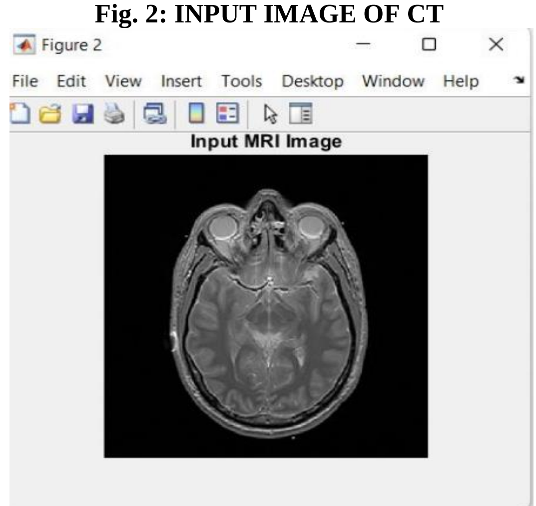

Fig. 3: INPUT IMAGE OF MRI

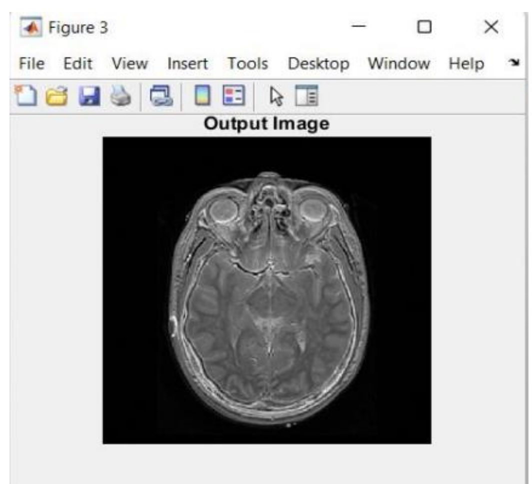

Fig. 4: OUTPUT FUSED IMAGE

Results depicts that, described model is efficient than other models inters of Entropy

(E), Fusion factor (FF) and standard deviation (SD).

V. CONCLUSION

In this paper, Image Statistics and Wiener Filter based MRI and CT Images Fusion is described. Brain image fusion plays a dynamic role in medical imaging applications by helping the radiologists for spotting the abnormality especially tumor in MRI brain images. Fusion is a process of merging two images into a single image that can provide more information than the individual images. Fusion process is followed by wiener filter of filtering of noise and artifacts introduced during fusion. Entropy (E), Fusion factor (FF) and standard deviation (SD) are calculated for both test image sets. Results depicts that, described model is efficient than other models inters of Entropy (E), Fusion factor (FF) and standard deviation (SD).

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