An International Open Access Journal

Front. Cur. Trends. Engg. Tech. SI:1, pp. 85 – 87 (2016)

OPEN ACCESS **ISSN:** ***2456 – 1185*** Available online: www.fctet.in

Published by ACET

Note on RECENT TECHNOLOGIES

Image Fusion of MRI Images using Discrete Wavelet Transform

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Abstract: The ultimate aim of the project is to develop an image that is a combination of Scanned images of MRI (Magnetic Resonance Imaging) and CT (Computed Tomography) of brain. CT scan is used to view the bone and MRI scan is used to view the tissues. therefore when a physician need to diagnose he/she should view both the CT scan and MRI scan at the same time side by side which is quite difficult for human eye and this can also lead to error and mismatch. In order to make it easier these two images can be fused to form a single image without affecting the contents of the image. The process of fusion of these two images is done by means of Discrete Wavelet Transform (DWT). Thereby making it easy for the physician to view the two images in a single image.

Keywords: *Computed Tomography, MRI scan, Discrete Wavelet Transform*

1. INTRODUCTION

1.1. Image Fusion

In computer vision image fusion is the process of combining relevant information from two or more images into a single image. The resulting image will be more informative than any of the input images. It is also defined as the set of methods, tools and means of using data from two or more different images to improve the quality of information.

In remote sensing applications, the increasing availability of space borne sensors gives a motivation for different image fusion algorithms. Several situations in image processing require high spatial and high spectral resolution in a single image. Image fusion techniques allow the integration of different image sources. In satellite imaging, two types of images are available. The panchromatic image acquired by satellites is transmitted with the maximum resolution available and the multispectral data are transmitted with courser resolution which is two or four times lower. At the receiver station, the panchromatic images are merged with the multispectral data to convey more information.

In medical imaging image fusion has become a common term used within medical diagnostics and treatment. The term is used when multiple images of a patient are registered and overlaid or merged to provide additional information. Fused images may be created from multiple images from the same imaging modality or combining images from multiple modalities. For accurate diagnosis, radiologist must integrate information from multiple image formats. Fused, anatomically consistent images are especially beneficial in diagnosing and treating cancer. With the advent of these new technologies radiation oncologist can take full advantage of intensity modulated radiation therapy (IMRT).

1.2. Image Fusion Algorithms

Lensit is often not possible to get an image that contains all relevant objects inDueto the limited focus depth of the optical focus. To obtain an image with every object in focus a multi-focus image fusion process is required to fuse the images giving a better view for human or machine perception. Pixel-based, region-based and wavelet based fusion algorithms were implemented.

1.2.1. Simple Average

It is a well-documented fact that the regions of image that are in focus tend to be of higher pixel intensity. Thus this algorithm is a simple way of obtaining an output image with all regions in focus. The value of the pixel P(i,j) of each image is taken and added. This sum is then divided by 2 to obtain the average. The average value is assigned to the corresponding pixel of the output image.

1.2.2. Select Maximum

The greater the pixel values the more in focus the image. Thus this algorithm chooses the in-focus regions from each input image by choosing the greater value for each pixel, resulting in highly focused output. The value of the pixel P (i, j) of each image is taken and compared to each other. The greatest pixel values is assigned to the corresponding pixel.

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1.2.3. Multiplicative Algorithm

The multiplication model combines data set by multiplying each pixel in each band of the input data by source data. To compensate for the increased brightness value, the square root of the mixed data is taken.

1.2.4 Subtractive Method

Subtractive Resolution Merge uses a subtractive algorithm to sharpen multi-spectral images. It produces highly preserved spatial and spectral resolution. It is limited to dual sensor platforms with specific band ratios between the high resolution panchromatic image and the low resolution multi spectral image.

1.2.5brovey Algorithm

Brovey algorithm is a ratio method where the data values of each band of the MS data are divided by the sum of the MS data set and then multiplied by the input data set. It increases the contrast in the low and high ends of an image histogram.

1.2.6 Discrete Wavelet Transform (Dwt)

Wavelets are finite duration oscillatory functions with zero average value. They have finite energy. They are suited for analysis of transient signal. The irregularity and good localization properties make them better basis for analysis of signals with discontinuities. Wavelets can be described by using two functions viz. the scaling function f(t), also known as 'father wavelet' and wavelet function or 'mother wavelet'. Mother wavelet undergoes translation and scaling operations to give self-similar wavelet families.

The wavelet transform decomposes the image into low-high, high-low, high-high spatial frequency bands at different scales and low-low band at the coarsest scale. The L-L band contains the average image information whereas the other band contains directional information due to spatial orientation. Higher absolute values of wavelet coefficients in the high bands correspond to salient features such as edges or lines.

1.2.7 Principle Component Analysis (PCA)

PCA is a mathematical tool which transforms a number of correlated variables into a number of uncorrelated variables. The PCA is used extensively in image compression and image classification. The PCA involves a mathematical procedure that transform a number of correlated variables into a number of uncorrelated variables called principle components. It computes a compact and optimal description of the data set. The first principle component accounts for as much of the variance in the data as possible and each succeeding component accounts for as much of the remaining variance as possible. First principle component is taken to be along the direction with the maximum variance. The second principle component is constrained to lie in the subspace perpendicular of the first. Within this Subspace, this component points the direction in the subspace perpendicular to the first two and so on. The PCA is also called as Karhunen-Loeve transform or the Hotelling transform. The PCA does not have a fixed set of basis vectors like FFT, DCT and wavelet etc. and its basis vectors depend on the data set.

2. PROPOSED METHOD

The two input images were fused in the wavelet domain, and an inverse transformation was applied to produce the result. Other variations of this technique include discrete wavelet transform, additive wavelet decomposition, the contourlet transform, the curvelet transform and the complex wavelet transform.

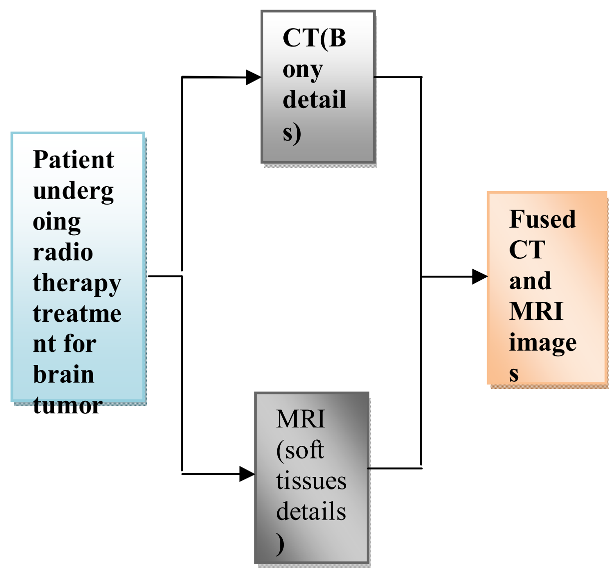

Fig. 1. Block diagram of proposed method

2.1 Input Images

The MR scans can be acquired using a 3-D T2 weighted pulse sequence, and the CT scans were acquired from either helical or axial slice CT images. No contrast should be used in either scan. T2-weighted 3-D MR images are used because they clearly present the cerebral fluid, occipital lobe and parietal lobe. Finally the images are fused as sets of 2-D images because radiologists typically view 3-D volumes as stacks of 2-D images. The 3-D MR/CT images are then pre-processed and registered.

2.2 Preprocessing and Registration

The given input image are resized from resolution to 256*256. In preprocessing filtering of the image is done were median filter is applied to remove salt and pepper noise from the medical image. The filtered images are given as the input to registration. Image registration is the process of transforming different sets of data into one coordinate. system Registration is mapping between two images both spatially and with respect to intensity.Two types of Image registration are Multimodal and Monomodal registration. Multi-modal registration methods are often used in medical imaging as images of a subject are frequently obtained from different scanners. Under Multimodal registration, default registration method is usedIt is intensity based (minimize intensity difference over entire image). After registration the images are fused (Fig. 1 & 2).

2.3 Discrete Wavelet Transform

Wavelet transform in two dimensions is used in image processing. For two-dimensional wavelet transform, we need one two-dimensional scaling function $\phi(x, y)$ and three two-dimensional wavelet $\varphi 1(x, y)$, $\varphi 2\ (x, y)$ and $\varphi 3(x, y)$ each is the product of a one-dimensional scaling function ϕ and corresponding waveletφ.

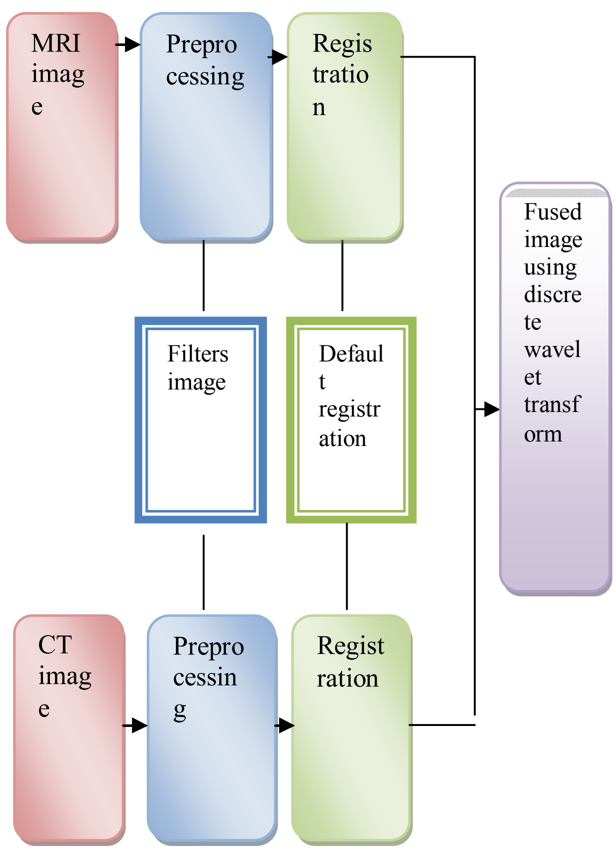

Fig 2. Block diagram of DWT fusion

2.4. Subband Coding

In sub band coding, an image is decomposed into a set of band limited components, called sub bands. It can be proved that we can perfectly reconstruct the original image using the sub bands. Because the bandwidth of the resulting sub bands y0 (n) and y1 (n) are smaller than the original x n, it can be down sampled without loss of information. Reconstruction of the original image is accomplished by up sampling, filtering, and summing the individual sub bands.

2.5. SSIM (Structural Similarity) Calculation

$$SSIM = \frac{(2\mu_x\mu_y+c_1)(2\sigma_{xy})+c_2}{(\mu_x{}^2+\mu_y{}^2+c_1)(\sigma_x+\sigma_y+c_2)}$$

where μ_x, μ_y, σ_x, σ_y, σ_{xy}represent the means in the x and y images, the variances in the x and y images and the covariance of the two images, respectively. $C1 = 0.01$ and $C2 = 0.03$ are positive constants.