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Review: Image Fusion Using CWT for Finding Disease Location

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Abstract:

Medical Image processing has vast applications in medical diagnosis. Image fusion is phenomenon of appending the significant data of given arrangement of pictures all together by camera at various points of an article into a single picture to get significant and obtained highlights from each of the taken images. This broadsheet offers the idea of a fusion of MRI (information on softer tissue with much distortion)-CT (information on denser tissue with less distortion) using Curvelet wavelet transform (CWT), which is used to produce helpful details from different format clinical pictures which gives more data to the physician to find the disease location in an image. This paper presents a fusion by concatenating of images using a coverlet wavelet transform technique.[5] In this research, various image type like MRI, CT, PET, ECT, SPECT models has been collected and apply the fusion process to calculate the performance analysis parameters like SSIM, PSNR, entropy, CWT, etc. This work covers the utilization of wavelet put together combination calculations with respect to restorative picture combination of CT and MRI. Finally calculated the parameters for disease finding and this research is helpful for disease location estimation and finding.

Keywords: *CWT, Multi-Modal, Fusion, MRI, CT*

1. Introduction

The term fusion implies by and large a way to deal with extraction of data obtained in a few domains. The resultant combined will be progressively helpful and complete then any of data pictures and is continuously proper for human visual and machine Observation. The demanding areas of image fusion are mechanical technology, microscopic imaging and remote detecting. Image fusion is the famous territory of the specialized research which is being updated as the examination is propelled by modern interest.

Medical images have varieties of image groups such as CT, MRI, PET, ECT, and SPECT [1].
Usually, doctors can combine images to detect the disease and can be used for diagnosis but, that will increase the workload on doctors and it's a tricky tasks. By implementing automatic fusion, we can decrease the workload on doctors. This paper presents a method for the fusion of Computer Tomography [1] (CT), Magnetic Resonance Imaging [1] (MRI) images based on wavelet changes. Different fusion rules are then performed on the wavelet coefficients of different frequency bands according to the area of interest.

Figure 1 Fundamental steps for Image Fusion

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2. Multi-Modal Image Fusion

In the continuing years, Multi modular photo combination calculations and gadgets, has advanced as a splendid asset in the clinical applications of therapeutic envisioning structures. It has demonstrated vital accomplishments in improving clinical exactness of willpower depending on therapeutic photos. The principle thought is to supply maximum applicable information from diverse sources right into a solitary yield, which assumes a vital job in healing analysis. Medical imaging consumes gained significant consideration due to its predominant part in health modalities used now-a-days are X-ray, Computed Tomography [1] (CT), Magnetic Resonance Imaging (MRI), Magnetic Resonance Agiography [2] (MRA), etc., These Imaging techniques are used for extracting clinical information, which are although complementary in nature most of the times, some are unique depending on the specific imaging modality used.

For example

X-rays - Is used to detect fractures, abnormality in bone situation.

CT - Is used toward providing additional accurate information around calcium deposit, air also dense arrangements similar bones through less distortion, acute bleeds also tumors. But then over it cannot detect physiological variations.

MRI - Under strong magnetic field also radio wave energy, information around the Nervous system, structural abnormalities of soft tissue, muscles container be improved visualized.

MRA - Is used toward evaluating blood vessels.

PET - (positron emanation tomography) offers quantitative examinations, enabling relative changes after a while to be determined as an ailment method advances or due to a specific improve with the aid of seeing bloodstream, digestion, synapses, and radio named tablets.

SPECT - Single positron emission computed tomography provides functional and metabolic information. It helps to diagnose and stage cancer.

FMRI - Utilitarian attractive reverberation imaging is a useful neuro-imaging machine utilizing MRI innovation that estimates cerebrum movement via spotting modifications related with blood movement.

3. Methodology

The objective of this paper is to study about the fusion of different images in medical field to analyze more than one images for finding the disease location and extracting maximum information out of it. Since MRI and CT Scan are he conventional imaging technologies in the field of diagnosis of disease and these technologies are used to take image of sensible parts of body which may have any tumor or any failure in the physiological aspects of the part of body. The images obtained from these imaging technologies have so much of harmonical disturbances and noise so it can't be directly used for analysis by doctors. Also an individual image is not sufficient to detect or estimate the location of disease. So it becomes essential to combine more than one images obtained from CT scan and MRI both techniques to make analysis better and proper estimation. And this process only is known as image fusion about which we are going to explain.

The extra ordinary advantage associated with image fusion is that it can also be used for memory and time efficient transmission of images from one device to another device. Since we know that it is too much space and time consuming to transfer image one by one which may also have unnecessary information. Image fusion is responsible to reduce the amount of redundant information in image.[3]

The concept behind the image fusion is to combine images and extract only necessary information. To overcome this task all the images with reference image are combined using discrete wavelet transform and then obtained image is used for performing curvelet transform. And this curvelet transform provide with some parameters that can be analyzed for characteristics of the fused image. These parameters are entropy (H), Mean square error, peak

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signal to noise ratio (PSNR), Fundamental Comparison Index, measure of enhancement.

3.1 Mathematical Aspects

In this section the mathematical aspects of the image fusion will be discussed.

Wavelet Transform

A wavelet transform (WT) can be defined as the decomposition of a signal into a set of basis functions which consist of contractions, expansions, and translations of a mother function ψ(t), called the wavelet. If the wavelets are discretely sampled In numerical and functional analysis, that is known as a discrete wavelet transform.

The DWT can be denoted as:

$$\psi_{x,y}(t)=1/\sqrt{|x|}\,\psi((t-Y)/X)$$

Where
Y= location parameter
X= scaling parameter

$$I(a,b)=W-1(\$(W(I_1(a,b),W(I_2(a,b))$$

Different methods for image fusion
A. Pixel Averaging
B. Fusion with discrete wavelet transform
C. Proposed fusion method

3.1.1. Pixel Averaging

This is the only simplest method which is used for image fusion. In this method average of two neighbor pixel is taken and intensity value of pixels is replaced by mean value. This method is rarely used as it can't reduce redundancy from image and also time consuming. The method is suitable for only two images if multiple images are there then it is not preferable.

3.1.2. Discrete Wavelet Transform Method

The principal of image fusion is dependent upon discrete wavelet transform, which is an important tool in image processing. The basic idea is that the DWT is taken of both the images. Then fusion of both low and high frequency bands is performed under predefined fusion rules. Many fusion rules are determined there according to the need of interest. Widely used rule is maximum selection scheme in which maximum information is extracted from fused image. In this simple scheme all the coefficients with higher magnitude in each sub band are picked up. This process gives the fused image in the form of it's discrete wavelet transform. So to get original fused image inverse discrete wavelet transform is performed. Concludely the whole process can be understood as following:

Reading the two images

↓

Applying the wavelet decomposition on both the images

↓

Taking the average of approximation coefficients

↓

Applying inverse discrete wavelet transform

↓

Display the final fused image

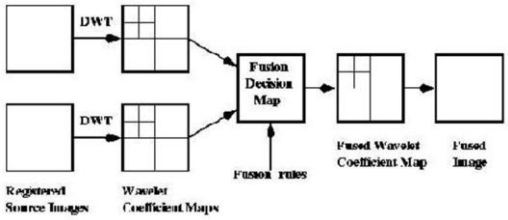

Figure 2. Image fusion based on DWT

Figure 3. Image from CT scan

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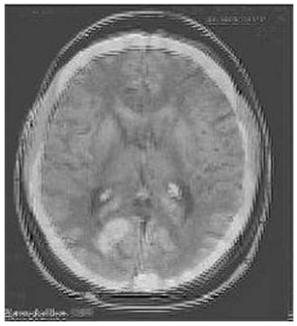
Figure 4. Image from MRI



$$H = -\sum_{l=1}^{l=L} P_l \log(P_l)$$

4.2 Mean

The mean of an image is defined as mean value of the intensities values of pixels present in the image. It is expressed as:

$$= (1/ M \times N) \sum_{x=1}^{x=M} \sum_{y=1}^{y=N} \dagger(x, y)$$

M x N = Size of the image
f (x,y) = Gray level of the pixel with coordinates x,y
μ= Mean

4.3 Standard Deviation

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Figure 5. Image after fusion of both the images

4. Parameters of performance in Image Fusion

Many parameters are analyzed for estimation of performance of image fusion process. These parameters become more essential when it comes to the comparison of various methods of fusion. The parameters simply give the characteristics of different aspects of fusion. Usually MATLAB is the software tool which is used to perform fusion. It comes under the image processing facility provided by MATLAB. All the image processing tools are used in it. Parameters can also be calculated with the help of MATLAB using built in functions or some standard formulas explained below.

4.1 Entropy

Entropy is the measure of information contained in an image. It depends upon the frequency of each and every gray level present in the image. For proper and adequate analysis of image it is desired that image should have maximum entropy. Entropy of an image can be maximized if each gray level in fused image has equal frequency.

Standard deviation is the measure of statistical dispersion of gray level of pixels in the image. It can be expressed as :

$$a = (1/ M \times N) \sum^{x=M} \sum^{y=N} f(\dagger(x, y) - \mu)$$

4.4 Root Mean Square Error

This parameter provides the amount of deviation in the image in the comparison to the referenced image. It can be expressed as:

RMSE =

$$\sum^{x=M} \sum^{y=N} f\overline{[g(x, y) - \dagger(x, y)]^2}/MxN$$

G= Input Image
F= fused image

4.5 Peak Signal to Noise Ratio

It is defined as the ratio of maximum intensity value of the pixel present in the image to the background noise.

$$PSNR = \log_{10}[(2n -1)^2/MSE]$$

5. Conclusion

The use of electronics and biomedical engineering is growing day by day in the medical field to improve health care. To get image of the parts of body MRI and CT are used which are two different techniques to take image of same thing in two different manners. For analysis both the image individually are not sufficient. So fusion techniques are used to combine both images, which has more information for better clinical diagnosis. Now the fusion is done using CWT method. After obtaining the fused image it's performance analysis is done by evaluating different parameters like Entropy, PSNR, RMSE, and standard deviation etc.[6]

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