WAVELET TRANSFORM BASED IMAGE FUSION OF MRI AND CT IMAGES FOR BETTER DIAGNOSIS

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ABSTRACT

The main objective of Image fusion is to mix information from multiple images of an equivalent scene in to one image retaining the important and required features from each of the original images. Nowadays, with the rapid evolution in high-technology and modern instrumentation, medical imaging has become an important component of an outsized number of applications, including diagnosis, research, and treatment[1]. Medical image fusion is that the idea to deepen the image content by fusing images taken from diametric imaging tools like computerized tomography (CT), resonance Imaging (MRI), Positron Emission Tomography (PET) and single photon emission computerized tomography (SPECT). For diagnosis, computerized tomography (CT) provides the simplest information on denser tissue with less distortion. Magnetic Resonance Image (MRI) provides better information on soft tissue with more distortion [2]. during this case, just one image might not be sufficient to supply accurate clinical requirements for the physicians. Therefore, the fusion of the multi-modal medical images is important [3]. This paper presents a way of image fusion based on discrete wavelet transform. 2- dimensional DWT is employed to separate the image[4]. The fusion performance is evaluated on the idea of the basis mean square error(MSE), Root Mean Squared Error (RMSE) and peak signal to noise ratio (PSNR).

Keywords: Computed Tomography (CT), Discrete wavelet Transform (DWT), Magnetic Resonance Image (MRI), Medical Image Fusion, Peak signal to noise ratio (PSNR), Root mean square error (RMSE).

I. INTRODUCTION

The term fusion means broadly an approach to extraction of data non heritable in several domains[5]. the target of Image fusion is to mix data from multiple images of a tantamount scene in to one image retaining the important and required features from each of the first image. the most task of image fusion is integrating complementary information from multiple images in to single image [6]. The resultant fused image are going to be more illustrative and complete than any of the input image and is more suitable for human visual and
machine perception. Image fusion is that the process that combining information from multiple images of an equivalent scene [7]. Medical image fusion is that the technology that would compound two mutual images in to at least one consistent with certain rules to realize clear visual effect. By perceptive medical fusion image, doctor could easily sustain the position of illness [8]. Medical imaging provides an extended modes of image information for clinical diagnosis, like CT, X-ray, DSA, MRI, PET, SPECT etc. Different medical images have different characteristics, which may provide structural substance of various organs. for instance, CT (Computed tomography) and MRI (Magnetic resonance image) with high attribute resolution can provide structure information of organs [9]. And PET (Positive electron tomography) and SPECT (Emission computed tomography) with comparatively poor spatial resolution, but cater information on organ metabolism [10]. Thus, a spread of imaging for an equal organ, they're contradictory, but completing and interconnected. Therefore the satisfactory image fusion of various property becomes urgent requirement for clinical diagnosis [11].

In this paper, a completely unequaled approach for the fusion of computerized tomography (CT) and resonance images (MR) images based wavelet transform has been presented. Different fusion rules are then performed on the wavelet coefficients of low and high frequency portions [12]. The registered computer tomography (CT) and resonance imaging (MRI) images of an equivalent people and same spatial parts are used for the analysis.

II. WAVELET TRANSFORM BASED IMAGE FUSION

“Wavelet transforms allow time – frequency localization”

Wavelet means “small wave” so wavelet analysis is about analyzing signal with short duration finite energy functions.

They alter the signal under investigation in to a different creation which presents the signal during a more recyclable form. Mathematically, we denote a wavelet as;

$$\psi(t) = \frac{1}{\sqrt{|a|}} \psi\left(\frac{t - b}{a}\right)$$

(1)

Where b=is location parameter a=is scaling parameter

for a given scaling parameter a, translate the wavelet by varying the parameter

b. the wavelet transform can be defined as

$$w(a,b) = \int f(t) \frac{1}{\sqrt{|a|}} \psi\left(\frac{t - b}{a}\right)$$

(2)

According equation (2), for every (a, b), we have a wavelet transform co-efficient, representing how
much the scaled wavelet is similar to the function at location, \( t = b/a \)

### III. IMAGE FUSION METHODOLOGY

Image fusion method can be generally categorized into three categories-

(i) Pixel level  
(ii) Feature level  
(iii) Decision level

Pixel level fusion has the advantage that the pictures used contain the first measured quantities, and therefore the algorithms are computationally efficient and straightforward to implement, the foremost image fusion applications employ pixel level based methods. Therefore, during this paper, we are still concerned about pixel level fusion [14]. Fusion methods are

#### 3.1 Average Method

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

\[
F(x, y) = \frac{(A(x, y) + B(x, y))}{2}
\]  

(3)

Where \( A(x, y), B(x, y) \) are input image and \( F(x, y) \) is fused image. And point \((x,y)\) is the pixel value.

For weighted average method-

\[
F(x, y) = \sum_{x=0}^{m} \sum_{y=0}^{n} (WA(x, y) + (1-W)B(x, y))
\]  

(4)

Where \( W \) is weight factor and point \((x, y)\) is the pixel value.

#### 3.2 Select Maximum

In this strategy, the resultant combined picture is acquired by choosing the most extreme power of comparing pixels from both the info picture.

\[
F(x, y) = \sum_{x=0}^{m} \sum_{y=0}^{n} \text{Max}(A(x, y) + B(x, y))
\]  

(5)

Where \( A(x, y), B(x, y) \) are input image and \( F(x, y) \) is fused image, and point \((x,y)\) is the pixel value.
3.3 Select Minimum

In this technique, the resultant combined picture is gotten by choosing the base force of relating pixels from both the information picture

\[
F(x, y) = \sum_{k=0}^{m} \sum_{l=0}^{n} \text{Min}(A(x, y) + B(x, y))
\]  

(6)

Where \(A(x, y)\), \(B(x, y)\) are input image and \(F(x, y)\) is fused image, and point \((x,y)\) is the pixel value.

3.4 Image fusion by wavelet transform

![Figure 1: Image fusion using the wavelet transforms.](image)

IV. EXPERIMENTAL RESULTS

![Figure 2 (a) CT image (Brain)  (b) MRI image (Brain)](image)
The above mentioned fusion algorithms have been implemented on MRI and CT images of brain shown in fig.2. The corresponding output images have been shown in fig 3. Fig. 3(a) shows the fused image using average fusion rule, The fused images using maximum selection rule and Select minimum method are shown in fig. 3(b) and 3(c) respectively. The quality evaluation parameters like MSE, RMSE and PSNR are tabulated in table.1. The PSNR in maximum selection rule is more compared to other two fusion rules implemented in this work.

<table>
<thead>
<tr>
<th>Fusion Rule</th>
<th>MSE</th>
<th>RMSE</th>
<th>PSNR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>69.8073</td>
<td>9.6204</td>
<td>22.1394</td>
</tr>
<tr>
<td>Select Minima</td>
<td>67.7480</td>
<td>8.7240</td>
<td>24.1684</td>
</tr>
<tr>
<td>Maximum Selection Rule</td>
<td>62.0784</td>
<td>7.6532</td>
<td>32.5528</td>
</tr>
</tbody>
</table>

V. Conclusions

In this paper, multi modal images like MRI and CT have been combined fused to get better image for medical diagnosis. The wavelet transform and various fusion rules viz., average, Maximum selection Rule and Select minimum methods were used to fuse CT and MRI images. This method yields encouraging results in terms of smaller RMSE and better PSNR values. Among all the fusion rules, the maximum Selection fusion rule performs better as it achieved least MSE and highest PSNR values. The images used here are grayscale CT and MRI images. However, based on the results obtained, this fusion says that the images of other modalities (like PET, SPECT, X-ray etc) with their true color may also be fused to get better information for better diagnosis purpose.

REFERENCES


