A novel approach of MRI-CT Image fusion using CWT for finding Disease location

Syed Inthiyaz*1, Hasane Ahammad Sk1, Praveen SR Konduri2, Apoorva Inani1, Nagineni Risthitha1, Dhiraj V1, Siva Kumar M1, Saikumar K1

1Department of Electronics and Communications Engineering, Koneru Lakshmaiah Education Foundation, Guntur, Andhra Pradesh, India-522502
2Department of Computer Science and Engineering, Malla Reddy College of Engineering and Technology (MRCET), Hyderabad, Telagana, India

Article History:
Received on: 09.08.2019
Revised on: 01.11.2019
Accepted on: 15.11.2019

Keywords:
Medical Image fusion, MRI, CWT (coverlet wavelet transform), Entropy, PSNR (peak to signal noise ratio), SSIM

ABSTRACT
Medical Image processing has tremendous applications in medical diagnosis. This broadsheet offerings the idea of a fusion of MRI(Magnetic Resource Imaging)-CT (Computed tomography) using Coverlet wavelet transform (CWT), which is used to find the disease location in an image. In the Medical field, CT provides maximum information on denser tissue with less amount of distortion and higher resolution images. Whereas, on the other hand, MRI provides information on softer tissue with much distortion. However, both are similar; the main difference lies where CT uses X-rays to produce images while MRI uses radio-Waves to produce images. This paper presents a fusion by concatenating of images using a coverlet wavelet transform technique. The presentation is estimated on the source of locating the disease in the resultant image. In this research, various image type like MRI, CT, PET, ECT, SPECT models has been collected and apply the fusion process such that calculate the performance analysis parameters like SSIM, PSNR, entropy, CWT, etc. this research consist of processing and classification in the step -1 process the image with fusion model has been implemented, for classification estimate the samples with probabilistic functions. Finally calculated the parameters for disease finding and location estimation such that this research is helpful for disease location estimation and finding. At final achieves the better outcomes compared to existed methods.

*Corresponding Author
Name: Syed Inthiyaz
Phone:
Email: saikumarkayam4@gmail.com

ISSN: 0975-7538
DOI: https://doi.org/10.26452/ijrps.v11i1.1850

INTRODUCTION
Medical images have varieties of image groups such as CT, MRI, PET, ECT, and SPECT. These images kinds have different applications of their own. The term ‘fusion’ means acquiring information from images and combining images as a single image. The leading task of image fusion is integrating data commencing different images, hooked on solitary image. The main use of image fusion is to decrease the amount of data in addition to construct images that are more accurate and are easily understandable for the human and machine point of view. Apart from these in the Multisensory field, the definition of image fusion is combining two images into one image by extracting relevant formation. The resultant image will give us the required information. Usually, doctors can combine images to detect the tumor and can be used for diagnosis but, that will increase the workload on doctors and it’s a tricky
By implementing automatic fusion, we can decrease the workload on doctors. The wavelet transform used is Cwt. The perception of Curvelet wavelet convert is it procedures edges as its simple components. The features of this transform are that it possesses maturity, and is well adaptable to the image processing. It also can provide anisotropy and well suited to Image characteristics. Curvelet Wavelet transform represents the image smoothness, which has the same precision as inverse transform (Hariharan et al., 1437; Li et al., 2001). CT well-known scanning technique provides more information related to bones rather than soft tissues. On the other hand, MR imaging, which is also a well-known technique, works quite opposite that is it provides more information on soft tissues rather than bone structures’ is expected to give improved consequences than any other wavelet converts in the fields of image fusion. Image fusion is a process to syndicate multi basis imagery data using progressive fusion methods, including fusion framework, schemes and algorithms (Zheng et al., 2007). The main purpose is the addition of dissimilar also complementary data to improve the data apparently in the pictures as well as to growth the dependability of the interpretation, as shown in Figure 1.

Combination activates more and more precise facts (Yang et al., 2008; Li et al., 2002) and increased software and it can likewise enhance the exceptional and increment the usage of those information. Join higher spatial facts in a unmarried band with better ghostly statistics in another informational index to make ‘manufactured’ better desires multi otherworldly informational indexes and pics with rapid headway in innovation; it’s miles currently manageable to gather data from multi supply photos to create a superb blended picture with spatial and unearthly facts (Wang et al., 2003; Zhang et al., 1999). The fundamental factor of photograph mixture is to

1. Reduce the measure of statistics
2. Retain sizable facts
3. Create a new picture that is an increasing number of appropriate for the motivations at the back of human/machine commentary or for further making ready errands.

It is step by step reasonable for visual discernment and for automated dealing with. Picture aggregate is typically implemented to automatic symbolism for the accompanying packages that are huge in human lifestyles, for instance (Rani and Sharma, 2017; Agarwal1 and Bedi, 2015).

1. Medical imaging
2. Microscopic imaging
3. Remote sensing
4. Robotics
5. Battle field surveillance
6. Automated target recognition
7. Guidance and control of the autonomous vehicle.

**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
Figure 3: Multimodal image fusion (a) NMR (b) PET (c) Fused Image

care. Some of the dissimilar kinds of imaging modalities used now-a-days are X-ray, computed tomography (CT), magnetic resonance imaging (MRI), magnetic resonance angiography (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 (Yang et al., 2010; Nunez et al., 1999).

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 tumours. 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 (Mehta and Mara, 2013; Kaur et al., 2014).

**MRA**
Is used toward evaluating blood vessels also its abnormalities.

**PET**
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.

**SIGNIFICANCE OF WORK**
In medical imaging, all the necessary information from MRI and CT images has to be integrated into a single image for better treatment of a patient and better diagnosis. This method will save a lot of time and will be helpful for a doctor for easy identification of the disease location. The projected technique is compared to the idea image also reference image in the fusion method. The output shows superior performance (Rodrigues, 2015; Sapkal and Kulkarni, 2012).

![Figure 4: Flow diagram of curvelet transforms](image)

Importance of image fusion
Image fusion is actually a procedure of extracting the useful data by combing two otherwise multiple images hooked on a solitary image. The technique of image fusion is widely castoff in numerous applications of image processing. It is basically used to enhance the image. There are multiple uses of image fusion, such as it sharpens the image, feature enhancement in an image, accurate classification, and creating stereo data sets, geometric corrections and many more. Founded on the stages of images fusion it container remain separated addicted to three levels, they are pixel level, feature flat in addition to decision level. Pixel level is mostly used technique also is used to process on images and it gives more accuracy than the other two techniques. Feature Level is used to fuse the data more effectively (Ibrahim and Wirth, 2009).

The highest level of image fusion, which is region founded which takes it input from feature level or pixel level and makes the decision to achieve explicit results. The preprocessing steps of image fusion includes the following Figure 2 & Figure 3.

The distribution of the coefficients of contourlet transform is associated through the limitation-levels assumed in the DFB phase decomposition where n-levels are one-dimensional vector (Do and Vetterli, 2005; Qiguang and Baoshul, 2005).
CURRENT TRENDS IN IMAGE FUSION

There remain many amounts of different image fusion methods that consume been evolved till now. Some of them are,

Intellectual Robots
Image fusion is useful for controlling the moment of robots. Which is inculcated with a camera. Basically, it is used to carry a survey in an effective manner. It is helpful to identify the specific target for the system.

Artificial neural networks
It is a network which consists of the feedback network. It has its own importance in Image processing. It is a pulse coupled neural network.

HIS (Hue saturation Intensity)
These three properties they give a complete vision of an image. It is considered to be one of the oldest image fusion techniques. It comprises the greatest of the spectral data.

High pass Filtering
In this technique, the data commencing the in elevation resolution image is additional to the image with a low-resolution image to get the subsequent image.

Pyramid technique
In this technique, we obtain the fused image by integrating multiple images to get the resultant image. Image fusion is approved out at every level to get the bonded pyramid.

There are quite more used in medical diagnosis and is very useful to save time. Image fusion is also used in satellite vision, remote sensing and military areas (Ahmammad et al., 2019a; Saikumar et al., 2019).

The principle gain of curvelets is its potential of talking to a bend as a variety of superimposed factors of various lengths and widths. The curvelet change, on no account like wavelet exchange, is a multi-scale changes, be that as it could, in contrast to wavelets, consists of directional components. Curvelets depend upon multi-scale part we could with a banded bypass sifting to isolate image into disjoint scales. The facet length of the restricting home windows is accelerated at each other dyadic sub-band. The method which might be being trailed via the Curvelet Transform Process are clarified with the help of the circulation graph as seemed beneath in Figure 3. However, it offers confined directionalities 90°, 180°, 270°

Then again, wavelet alternate works productively with multi-middle, multispectral pictures when contrasted with a few other combination rules. It expands the recurrence dreams of the photo by way of deteriorating it to a unique corporation’s time and again until numerous frequencies and desires are obtained. Accordingly, a crossover of wavelet and curvelet would set off better outcomes as evaluation with currently existed techniques shown in Figure 4.

The circulation graph indicates the machine of consolidating picture 1 and photo 2 into unmarried blended wavelet coefficients. These agencies were given are then long past through curvelet change, which fragments it into distinctive added substance parts everyone in all, which is sub-band of the picture. These businesses are then long past through tiling hobby, which isolates the band to covering tiles (Ahmammad and Rajesh, 2018; Ahmammad et al., 2019c).

A go breeds of wavelet and curvelet carries one-of-a-kind pixel stage concepts in a solitary melded image. Pixel put together policies work with admires to singular pixels within the image but disregards some sizable subtleties, for instance, edges, limits of the image (Ahmammad et al., 2019d,b). Wavelet-based widespread by myself may lessen the complexity in positive pics and can't efficiently evacuate the ringing influences and commotion showing up in the source photos. Curvelet approach can feature admirably with edges and boundaries and bend bits of the snapshots using Ridge to let modifications. The circulate graph of existed strategy with is the blend of wavelet and curvelet alternate is seemed in Figure 5.

Methodology
The main objective of this paper is toward finding the disease location in an image. So, firstly we take input images of MRI and CT which have disease or are tumoured and then we take reference image and concatenate both the images and then we combine both the images using discrete wavelet transform and the image is then used for performing curvelet transform and the output can be figured by measuring entropy, Mean square error, peak signal to noise ratio, Fundamental Comparison Index, measure of enhancement (Kumar et al., 2019).

After applying sub-band decomposition using CT, a set of coefficients remain attained (on behalf of both the images). These frequency constants remain fused together based on certain fusion algorithms are reconstructed using the inverse CT. The schematic diagram of our proposed methodology, which is the hybrid image fusion using wavelet-contourlet transform is shown in Figure 5.

Form permit provides a high stage of directionality and anisotropy wherein as alternate wavelet
Figure 15: Input Image & Reference Image

Figure 16: PSNR analysis

Figure 17: Sample of MRI-CT image fusion
Table 1: Performance metrics for Fusion of CT and MRI image size for head

<table>
<thead>
<tr>
<th>Hybrid fusion technique for image</th>
<th>Performance quality metrics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PSNR</td>
</tr>
<tr>
<td>DWT</td>
<td>41.72950</td>
</tr>
<tr>
<td>DWT counterlet</td>
<td>69.9135</td>
</tr>
<tr>
<td>Proposed method-1</td>
<td>164.130</td>
</tr>
</tbody>
</table>

Table 2: Performance metrics for Fusion of MRI_T1 AND MRI_T2 image size [256 256] for the brain (cholesterol)

<table>
<thead>
<tr>
<th>Hybrid technique for image fusion</th>
<th>Performance quality metrics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PSNR</td>
</tr>
<tr>
<td>DWT</td>
<td>45.46080</td>
</tr>
<tr>
<td>DWT counterlet</td>
<td>68.89570</td>
</tr>
<tr>
<td>Proposed method-1</td>
<td>159.82350</td>
</tr>
</tbody>
</table>

Entropy is a measure of the randomness of an image being processed. As the image consisting of higher entropy, harder to predict or conclude from the information. We need to maintain entropy as low as possible.

\[
H = - \sum_{k} k p_k \log_2(p_k) \\
K = \text{no. of gray levels,} \\
p_k = \text{probability.}
\]

Mean square error and peak to signal noise ratio

MSE and PSNR remains used to compare image compression quality of an image. For cumulative squared error between the referenced image and the input image is measured through MSE. For Measuring peak error, we need PSNR. By maintaining Lower MSE, we can get a lower error.

\text{Structural similarity index}

This is an enactment of the algorithm for calculating the structural similarity (SSIM) index flanked by2 images. For measuring the excellence of an image, we use SSIM. A bluer image can be viewed better using SSIM.

default value: \(K = [0.01 \ 0.03]\) shown in Table 1

Comparison of PSNR, MSE and Entropy in terms of bar charts for CT and MRI of Head shown in the Figures 9, 10 and 11 respectively.

From these, we can observe that curvelet-contourlet transform has given better results for which PSNR and Entropy values are of high values when compared to other transformation techniques and the MSE is less when compared with other methods, which satisfied the conditions of better image quality that will obtain after fusion shown in Table 2

Figures 12, 13 and 14: Comparison of PSNR, MSE and Entropy in terms of bar charts for MRI_T1 AND MRI_T2 for the brain (cholesterol)These bar charts and Tabular values give the experimental values.
performed on different images we discussed previously.

RESULTS

The above images are the input image and the reference image of MRI and CT images, which are fused together in further process.

The above are the processing steps for image fusion. We perform curvlet transform to find the curves of the disease and in a resultant image, we can see the location of the tumour. Curvlet Transform DWT Resultant image shown in Figure 15 & Figure 16.

The overall analysis is shown in the Figure 17 in this fusion process has been implemented and output has been obtaining with accurately.

CONCLUSIONS

In this project, a pass breed method for picture aggregate making use of the blends of wavelet, curvelet, contourlet is being mimicked. The reproduced outcomes for various pass breed blends of previously stated adjustments are attempted and checked out for extraordinary therapeutic picture mixes like MRI, and furthermore for unique information photo sizes. In all instances, curvelet-contourlet primarily based pass breed technique is seen to outflank, which gives excellent satisfactory melded photo than the other two blends in wording PSNR, MSE and Entropy. Here Curvelet-Contourlet based crossbreed approach suites first-class for medicinal locating. There are various fusion techniques which work differently with various algorithms. The disease location of the tumor can be found by the resultant image. It also provides entropy, peak to signal noise ratio also a structural comparison of the resultant image. Thus, this method can be used in various medical image processing techniques which helps doctor for quick estimation of tumor location and is also save time.

ACKNOWLEDGEMENT

We would like to thanks the Management and the respective faculty who have supported us throughout the work and provided us with all the required facilities.

REFERENCES


Li, S., Kwok, J. T., Wang, Y. 2001. A combination of images with diverse focuses using spatial fre-
Mehta, S., Mara, B. 2013. CT and MRI image fusion using curvelet transform. pages 848–852.