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IMAGE FUSION WITH CT AND MRI IMAGES FOR IMPROVING QUALITY OF DIAGNOSTICS

K.Rajasekhar[1], S.Vinay Krishna[2], V.Srinivasu[3], B.Neeraj Kumar[4], K.Jyothi[5]
Department of Electronics and Communication Engineering,
Godavari Institute of Engineering and Technology (A), Affiliated to JNTUK, Kakinada, Andhra Pradesh,
NH-16, Chaitanya Knowledge City, Rajahmundry, Andhra Pradesh, INDIA.

***Abstract*-Fusing several medical images will enhance sickness diagnosis and demonstrate the complicated relationship between them for medical research. Existing techniques are time consuming and require a higher amount of data to train the models.We will obtain complex information from medical pictures such as Magnetic Resonance Imaging (MRI) and Computed Tomography (CT) in this model by fusing them using multi-stage fusion networks. We will utilise the Dual Tree Complex Wavelet Transform (DTCWT) to extract the challenging and related information from each image, and then divide the segmentation to get the segmented picture. The suggested technique uses the Dual Tree Complex Wavelet Transform to integrate several sample medical images, with the source medical image being converted to grayscale and degraded before the wavelet coefficients are produced using the DTCWT.The fused coefficients are then produced using wavelet approximation. The Inverse Dual Tree Complex Wavelet Transform is employed to develop the final fused picture. Segmentation is often used to create a segmented picture for better visual representation. The suggested technology has the potential to provide a higher quality final fused image.**

***Keywords:* Computed Tomography (CT), Single Photon Emission Computed Tomography (SPECT), Positron Emission Tomography (PET), Magnetic Resonance Imaging (MRI).**

I. INTRODUCTION

Medical imaging systems will give a variety of medical information about tissue, which is usually difficult. For example, X-rays are used to diagnose bone injuries and fractures, but CT pictures provide detailed information about interior organs, tumours, and blood arteries. The information about tissues is provided by MRI. SPECT will indicate how blood flows to tissues and organs, whereas PET will tell how the tissues and organs are functioning. All of these attributes will not be acquired from a single image; instead, in order to extract all of the complex information from a single image, we are merging medical images from single or various systems.A great image fusion technique should include complimentary information from the source photos into the final fused image while ignoring undesired and unexpected aspects. Before beginning the image fusion process, the source picture should be preprocessed, that is, correctly registered and aligned. Image fusion may be performed at three different levels: the pixel level, the characteristic level, and the decision level. The discrete wavelet transform suffers from two flaws: shift variance and directionality. The shift variance may cause mistakes in fused pictures owing to some little movement in the source image, and the source image will also become difficult to analyse geometric elements such as contours and edges due to poor directionality. To address this, the suggested technique would merge several medical pictures using the Dual Tree Complex Wavelet Transform (DTCWT). The dual tree complex wavelet transform will address the inadequacies of the Discrete Wavelet Transform (DWT). The DTCWT will provide better directionality and the shift variance which is easy to process the edges and contours of the source image.

II. LITERATURE SURVEY

Several ongoing medical fusion research endeavours that use the Dual Tree Complex Wavelet Transform are mentioned and researched.Image fusion utilising the Intensity-Hue-Saturation transform: Intensity, hue, and saturation are three colour properties that offer a visual representation of a pictureThe IHS transform technique is the most common method of image fusion.

Medical Image Fusion Using Transform Techniques was proposed by B. Ashwanth and K.Veera Swamy. The paper examines medical picture fusion in the transform domain utilising the DWT and SWT (Discrete Wavelet Transform and Simple Wavelet Transform, respectively) (Stationary Wavelet Transform). The DWT, SWT-based image fusion border and energy methods are enforced.The improved fusing rule resulted in a better fused picture. The suggested method's performance is evaluated using entropy. The two pictures are integrated using DWT, SWT, and the suggested edge and energy algorithms (MRI, PET). The fused image contains the deconstructed band, which has more information.

Karishma C Bhataria and Bhumika K Shah suggested A Review of Image Fusion Techniques. The technique of fusing two or more images together to generate a composite fused image. Because it contains all of the important information, The resulting merged image outperforms the source photographs.

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The bulk of modern apps employ this fused picture to speed up their processing processes in their respective sectors.

In medical picture fusion, the Laplacian Pyramid Technique is used. Image pyramids can be thought of as a metaphor for binocular fusion in the human visual system.The pyramid structure reflects an original image in several levels. A composite image is formed by using a pattern selection approach to photo fusion. The pyramid decomposition is initially applied to each source image. All of these photographs are merged to create a composite image, and the inverse pyramid transform is employed to generate the final image. This paper illustrates the PYTHON implementation of the pyramid method.At each step of decomposition, image fusion is conducted to create a fused pyramid from which the fused picture is acquired. The pyramid has been characterised as a data structure made up of band pass copies of a picture that may be resized. The pyramid, on the other hand, may be viewed as a picture transformation or code.The pyramid nodes are then viewed as code elements, and the similar weighting functions are sampling functions that yield node values when convolved with the image. A image should be changed from one representation to another for two reasons.

The transformation may remove important components of the visual pattern so that they may be analysed more directly, or it may organise the data in a more compact form so that it can be stored and conveyed more effectively. Both of these objectives are met by the Laplacian pyramid. A pyramid is used to compress data. The original image was represented using an 8 bit per pixel format. The node values of the image's Laplacian pyramid representation were measured to produce effective data rates of 1 b/p and 12 b/p. Pyramid approaches may be applied to analysis in a number of ways.

For medical image fusion, the Butterworth high pass filter is used: Image fusion is the technique of integrating two registered photographs of the same scene to create a a single fused image suitable for both human and machine learning Image fusion offers a wide range of applications, including medical diagnostics,robotics, military, remote sensing, and surveillance, due to its benefits in enhancing dependability and capabilities.The first and most important stage in image fusion is image registration. Visual filtering is useful for reducing noise and improving image elements like borders and lines. The LPF smoothes the picture by eliminating high frequency components, where as the HPF sharpens it.

III. EXISTING METHOD

Imaging methods such as computed tomography (CT) and magnetic resonance imaging (MRI) have given practitioners with data in the field of medical imaging.Various imaging methods keep different attributes, and different sensors get different image data from the same component. Fusion is intended to increase contrast, fusion quality, and perceived experience.Traditional medical image fusion approaches are classified into two types: spatial domain and transform domain.The Discrete Wavelet Transform was used to merge multimodel medical pictures such as computed tomography (CT) and magnetic resonance imaging resonance (MRI). To compensate for the lack of information in a single imaging technology, the combination of MRI and CT pictures combines the benefits of clear bone information in CT images and clear soft tissue information in MRI images. The fused picture not only keeps the original image's edge information, but it also extracts feature information, removing edge degree and clarity problems. When evaluated visually, the contrast and structural similarities of the fusion results are visibly improved. The discrete wavelet transform can generate a wide range of input frequency signals while maintaining stable output and has good positioning in both the time and frequency domains, which aids in the preservation of image-specific information.

The discrete wavelet transform overcomes the restrictions of principal component analysis, yielding an effective visual and quantitative fusion effect.The source picture is improved and preprocessed before recovering the intensity component of the CT image using the IHS transform, which maintains more anatomical information while decreasing colour distortion. The DWT transform is used to the intensity components of MRI and CT to get high- and low-frequency subbands. The high- and low-frequency subbands are fused independently using distinct fusion criteria, and the fused picture is created using the inverse DWT transformFigure 3.1 is a one-step 2-D DWT blocks design. The decomposed high-frequency coefficients are fused using the absolute high-value technique, the low-frequency coefficients are fused using the equity method, the weights are generated and increased using the predator-optimizer, and the fused images are created using the inverse transform.The concept of fusion is realised by the application of two fusion rules. Because the meanings of the low and high frequency coefficients different independent rules.Figure 3.1 High and low frequency filters The first set of principles states that greater wavelet coefficients highlight prominent elements of pictures such as corners and edges; picking larger wavelet coefficients is the most popular technique to fuse details since higher values signal stronger edges and are preferred as a significant portion of information content. Because low wavelet coefficient values reflect source image approximation, averaging is used to get information about both source images. After estimating the resulting wavelet coefficients, the fused image is obtained using the Inverse Discrete Wavelet Transform.Figure 3.2 illustrates a CT image of a Sarcoma-affected patient's brain. Figure 3.3 shows an MRI scan of the same person. The Discrete Wavelet Transform method was used to integrate these two multimodal images. Following the extraction of the wavelet coefficients, a fusion rule is utilised to fuse the coefficients. The Inverse Discrete Wavelet Transform is used to get the final fused image after fusing the obtained wavelet coefficients according to the fusion criteria. Figure 3.4 shows the final fused image.

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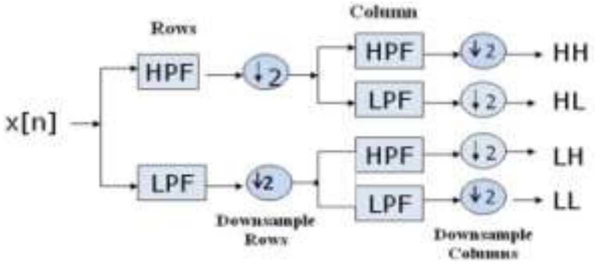

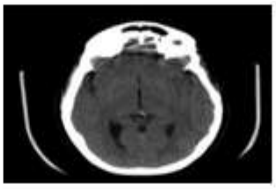
Fig.3.2.CT of a patient

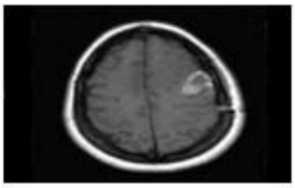
Fig.3.3. MRI of a patient

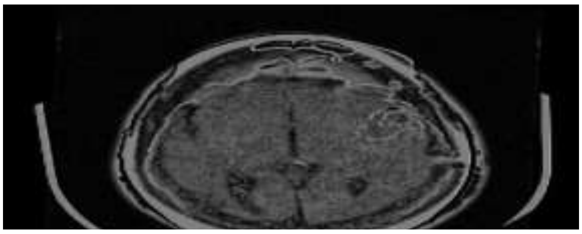
Fig.3.4. DWT fused image

One of the problems with DWT is that it does not provide enough directional information, resulting in images with shift variance and additive noise. It also does not keep track of time and frequency, which makes the better visual representation of the combined image less efficient.

IV. PROPOSED METHOD

The process of integrating numerous types of medical photos or equivalent types into a single image that provides more accurate information for diagnosis and will help in better and more accurate treatment is characterized as medical image fusion. Doctors will be able to extract significant and detailed data from merged medical images that would be impossible to collect from individual shots. Oncology and cancer research therapy make use of medical image fusion technology. A good image fusion approach incorporates complementary information from the source photographs into the final fused image while avoiding undesirable and unexpected characteristics.Image fusion may be done at three different levels: pixel, characteristic, and decision. Pixel level fusion aims to combine several source images into a single composite image that contains more information for machine and human perception than any of the source images. The features level image fusion, also known as the intermediate level image fusion, is the next step of image fusion. This method may describe and analyse multi-sensor data in order to accomplish classification. Because the density of protons in the nervous system, fat, soft tissue, and articular cartilage lesions is high, the image is exceptionally clear and devoid of artefactsIt has a high spatial resolution and causes little radiation harm to the human body, and the advantage of having a multitude of information makes it a valuable tool in clinical diagnostics. The MRI bone image is hazy because the density of protons in bone is extremely low. Computed Tomography imaging is what the CT image is called. Because bone tissue absorbs more than soft tissue, the bone tissue in the CT image is quite visible.

IMAGE FUSION FRAME WORK

The Anaconda tool is used in conjunction with Tensorflow, Keras, Numpy, Seaborn, Opencv, Pandas, Matplotlib, Pytorch, and Python3. The Tensorflow and Keras frameworks are essential for image fusion. Entropy, standard deviation, peak signal to noise ratio, root mean square error, and fusion factor are the performance metrics used in this image fusion architecture employing DTCWT. Picture Fusion Framework: The suggested framework implements the Dual Tree Complex Wavelet Transform in image fusion. The dual tree complex wavelet transform will be the answer to the Discrete Wavelet Transform's inadequacies (DWT).The DTCWT will give improved directionality and shift variance, making it easier to comprehend the source image's edges and contours. The DTCWT's higher shift variance and increased directionality attributes result in a fully functional picture fusion tool. Medical imaging technologies aid in the detection of numerous flaws and disorders in our bodies. Medical imaging systems include Magnetic Resonance Imaging (MRI), Computed Tomography (CT), X-rays, Positron Emission Tomography (PET), and Single Photon Emission Computed Tomography (SPECT) are some types of medical imaging system.Each will give distinct details, but none of these technologies will be able to deliver all of the necessary information in a single image. The solution to this dilemma is medical image fusion. All of the required information from several source photos might be gathered in a single imageFigure 4.1 depicts the processes needed to fuse the two source medical images using the Dual Tree Complex Wavelet Transform and obtain the fused image. First, register the CT and MRI images, then do wavelet decomposition, merge the two images, and finally, restore the fused image after decomposition.

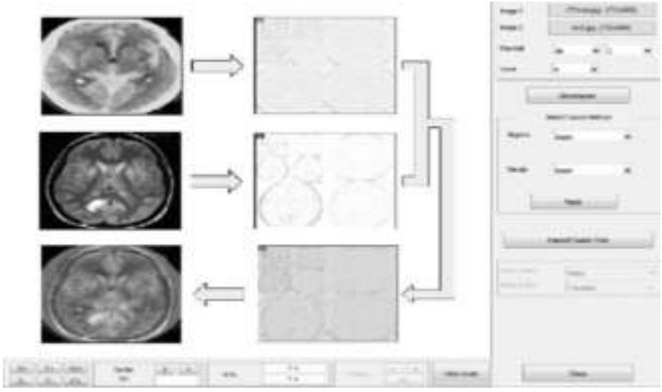

Fig.4.1 Fusing Mriand Ct images using Python wavelet tool.

The basic idea behind wavelet image fusion is to combine the wavelet decompositions of the two original pictures utilising fusion algorithms applied to approximations and details coefficients. This package contains analytical tools and Wavelet toolbox software, which is a collection of various functions based on the PYTHON technical computing environment. It also aids in the generation of picture deterministic and random signals utilising wavelets and wavelet packets in the PYTHON programming language.

V. RESULTS

The combined medical image will be used to generate more accurate diagnoses and collect more thorough data for better treatment. We obtained CT and MRI images of a Sarcoma patient to test this. We merge two photographs connected to the patient while working on this project to obtain correct information about the patient. To obtain the result, we first code the MRI picture of the patient and then code the CT image of the patient to obtain the fused image of the patient, which provides us with precise information about the patient.

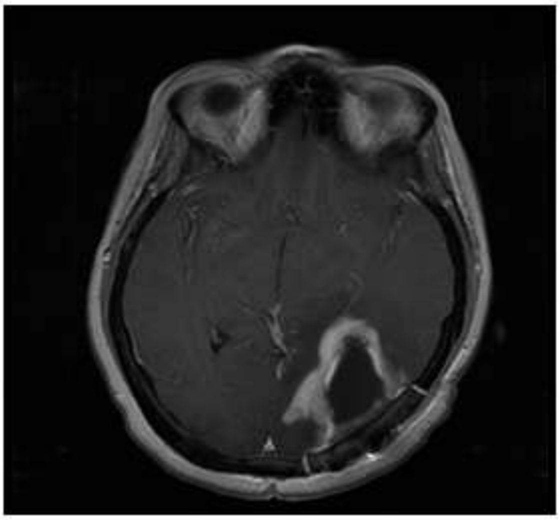

Fig 5.1: Input MRI Image

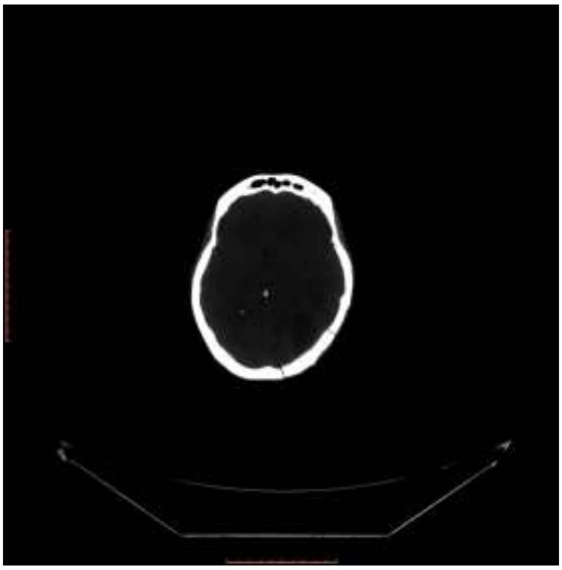

Fig 5.2: Input CT Image

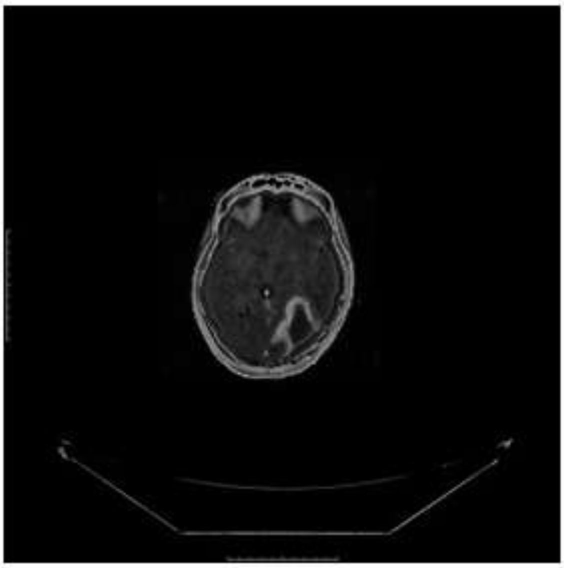

Fig 5.3: Output Fused Image

VI. CONCLUSION

In this study, we use Medical image fusion to combine all important information from many source pictures into a single image. Medical pictures are used to diagnose diseases and to aid in therapy. The merged medical picture will be utilised to make more accurate diagnoses and to collect more detailed information for improved treatment. Our suggested approach of medical image fusion is based on the Dual Tree Complex Wavelet Transform (DTCWT), which has demonstrated that it gives the fused picture with more precise representation of the tumor's spectral, spatial, and soft tissue features. Concerning performance, our suggested technique has high entropy, fusion factor, and peak signal to noise ratio values. As a result, our suggested method outperforms others, in comparison to previous fusion methods. In the future, block level fusion may be employed, and the outcomes, such as performance assessment and the final fused image in terms of increased visual representation, can be improved

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