Multimodal Medical Image Fusion based on Hilbert Transform

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Abstract

The process of clinical image combination involves combining at least two clinical images, such asan MRI and a PET scan, and planning them into a single image to create a composite image. Our review'smotivationistoaidphysiciansincontinuouslydiagnosingandtreating patients.Wecombinedinformationimagesusing Hilberttransformations(2-DHT)andHueSaturationValue (HSV)techniques.Theidealpresentationofthesuggested technique is to preserving both spatial and spectral information. The main goal of clinical image combination, it can be assumedthat our suggested method can do the same based on the mathematical results of assessment measurements likemean, standard deviation, average gradient, spatial frequency, modified spatial frequency, mutual information aswellasdesiredrecreatedresults. Index Terms: 2-D HT, PET, MRI, andHSV.

I. INTRODUCTION

The term "image fusion" describes the act of combining many pictures into one. Image fusion's primary goal is to keep any and all useful data from the source photos. When talking about picture fusion, medical image fusion is among the most crucial sub-categories. The term "fused picture" refers to the final product of multi-modal medical image fusion, which consists of information from many input medical images, each of which was obtained of a different part of the body.The combined picture has more diagnostic value than the individual medical images utilized to create it. Today's medical professionals rely heavily on imaging tools to aid in the prevention, detection, and management of illness. The need for medical image fusion originates from the fact that individual medical imaging modalities do not provide enough information about the organ under investigation.The MRI, which use a very strong magnetic source and radio waves, are one kind of medical imaging that stands out from others in terms of its unique characteristics. Soft tissues including the heart, brain, lungs, and livers may be seen in such pictures, providing important diagnostic information. MRI imaging systems provide a number of significant benefits, the most notable ones being their ability to produce high-resolution pictures without causing any harm to the patient and their lack of reliance on ionizing radiation. It also gives details on the internal anatomy of several organs. However, positron emission is at the heart of what we see in PET scans. In addition to providing anatomical data, this imaging technology may also reveal the metabolic activities of individual tissues. Because of this quality, doctors can now detect illness and tumour progression at earlier stages. We require a specialized fusion approach to combine PET and MRI images to provide a single fused picture with both spatial and spectral meaningful information [1, 2].

II. RELATED WORK

Pixel-level fusion, feature-level fusion, and decision-level fusion are the typical three levels used by medical picture fusion systems. In this article, we aim to combine PET and MRI scans at the pixel level. Computer vision, pattern recognition, and machine learning are just few of the many subfields that fall within medical image fusion. The Brovey Transform (BT), Intensity Hue Saturation (IHS), and Principal Component Analysis (PCA) are just a few of the numerous picture approaches used as the foundation for standard image fusion methods. This is a standard practice for merging RGB photos together. The aforementioned methods of picture fusion all have their own set of benefits and drawbacks. While the fused image's spatial resolution may be improved using these approaches, its inability to maintain the original colors in the input photos is their principal downside. Image fusion so often employs transform domain methods.Some examples of these transformation strategies are the discrete wavelet transform (DWT), the curvelet transform (CVT), and the contourlet transform (CT). Gradient pyramids, Gaussian pyramids, FSD pyramids, and Laplacian pyramids are all examples of pyramid approaches that may be used for picture fusion. Both the FSD pyramid methodology and the Gradient pyramid are contrasted with our suggested method for greater clarity. If you're looking for a computationally efficient variant of the Gaussian pyramid, the FSD pyramid approach is a good bet. While the Laplacian pyramid approach to fusion is conceptually similar to FSD pyramid, the latter omits the up sampling stage. As a result of the issues outlined above, we choose to employ the FSD pyramid method instead of the Laplacian pyramid method. The Gradient Pyramid Technique is yet another approach of combining pyramids. Using a combination of horizontal, vertical, and two diagonal filters, the performance of a Gradient pyramid may be improved. In this part, we will provide a short explanation of the Hilbert transform (HT) and the HSV technique, which together make up our suggested approach [1-5].

III. METHODOLOGY

One of the most significant and beneficial changes in signal handling is the Hilbert Transform (HT) [6]. This result implies that if the incoming signalcosine capability after determining its Hilbert Transform, and we'll be able to do sine. The implementation of Hilbert Transform (HT) as follows:

1. ApplyingtheFourierTransformtoeachindividual informationsignal
2. Takingstepstoreducenegativefrequencies
3. Using the reverse Fourier transform to obtain the capacity for complicated structures component ofthe signal is a controlled Analytic Signal (AS) and imaginative component Information signal's HT, or Hilbert Transform.

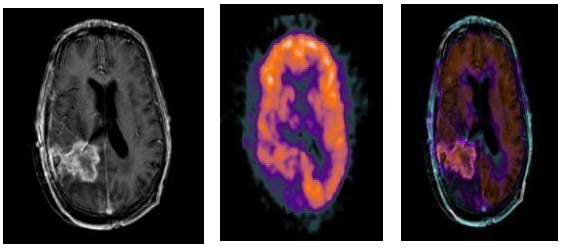
IV. PROPOSED METHOD

Thisalgorithmissummarizedasfollows:

1. Take two input images.
2. Using RGB to HSV algorithm to convert the color PET/SPECT image from RGB space to HSV space.
3. Separating the intensity component (V) of PET image in HSV domain. Hue (H) and saturation (S) of PET/SPECT image in HSV space are kept the same.
4. Applying 2-D HTfor intensity component (V) of PET/SPECT image and MRI image.
5. In this paper we use maximum fusion rule to fuse PET/SPECT and MRI images based on combination of 2-DHT and HSV method.
6. Apply Inverse HT and perform HSV to RGB to obtain fused image.

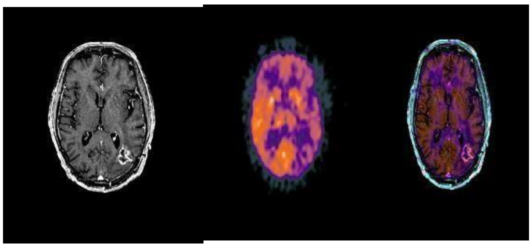
V. RESULTS

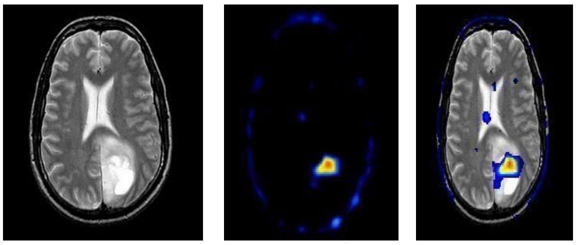
Any fusion algorithm's goal is to combine the necessary data from the two source images into the final image. It is not possible to evaluate a fused image solely by looking at the fused image or by examining fusion metrics. This should evaluate it in objectively and qualitatively utilizing visual displays hybrid metrics. We give visual quality and quantitative analysis of several methods in this part.



MRI image PET image Fused image

MRI image PET image Fused image





MRI image SPET image Fused image

Fig 1. Fused images for MRI-PET and MRI-SPECT images

Table 1:For evaluating parameters.

Datasets	**Fusionmetrics**					
	MEAN	*STD*	*AG*	*SF*	*MSF*	*MI*
MRI-PET	22.4029	35.2851	4.9226	14.8175	32.0899	4.5475
MRI-PET	18.0137	42.0856	6.9014	28.3248	57.9962	3.0452
MRI-SPECT	48.8759	65.3509	7.4158	24.9739	52.9676	3.5520

VI. CONCLUSION

In this research, we fused MRI and PET/SPECT images using a method that combines the HSV technique with 2-D HT. Table 1 contains the values for the quantitative evaluation criteria, and Fig. 1 displays the simulated results. Different measures of our suggested method's ability to maintain spectral properties and ideal performance are used to demonstrate its superiority..

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