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# Medical Image Fusion based on Multiscale Decomposition and Hybrid Transform Technique

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**ABSTRACT:** This research work proposes an improved fusion technique for medical images using Discrete Wavelet Transform (DWT). The proposed approach is based on two processes, namely, image enhancement and image fusion to obtain more information on the fused image. The low resolution Positron Emission Tomography (PET) image is enhanced using Lagrange interpolation technique and then combined with the Magnetic Resonance Image (MRI) using proposed image fusion. By adopting the proposed interpolation the edge preservation is achieved, the spectral and spatial qualities are improved. The comparative study has been made among Intensity-Hue-Saturation (IHS), Principal Component Analysis (PCA), DWT, Curvelet and proposed image fusion algorithm. Experimental results show that the application of proposed fusion has higher Peak Signal to Noise Ratio (PSNR) values with good visual perception. Comparing with other fusion methods, the proposed method has higher average gradient lower discrepancy and less Mean Square Error (MSE). Therefore the method proposed exhibits better image quality and proved to be advantageous.

**KEYWORDS:** PCA, Image Fusion, DWT, Curvelet Transform.

## I. INTRODUCTION

The idea of picture combination has been generally utilized in numerous applications like medication, machine vision, programmed change identification, biometrics and so on. Medicinal picture combination is one of the cutting edge and precise demonstrative methods in restorative field. Imaging in medicinal field help the specialists to see the inside segments of the body for simple determination and make keyhole medical procedures for achieving the inside parts without truly opening a lot of bit of the body. The pictures that are taken care of through picture preparing contain assortment of issues, for example, low goals, abnormal state of clamor, low differentiation, geometric twisting, nearness of imaging ancient rarities, reproduction and so forth. While dealing with the picture, these issues make the picture blemished for exact determination of sickness. There are various circumstances that require high spatial and high phantom goals at the same time in a solitary picture. In any case, as a rule, instruments are not ready to give such information either by structure or by observational requirements. For exact determination, radiologists must incorporate data from various pictures of a patient. Picture preparing is one sort of flag handling for this picture goes about as information, it might be either photograph or video outline and the result of picture handling might be either a picture or a lot of qualities identified with the picture. The majority of the picture handling methods, picture of two-dimensional flag is treated as info and standard flag preparing strategies are connected to it. Picture and video pressure is a functioning application zone in picture preparing. In the field of Image handling, picture combination has gotten a huge consideration for remote detecting, therapeutic imaging, machine vision and the military applications. A various leveled thought of picture combination has been proposed for joining critical data from a few pictures into one picture. The point of picture combination is to accomplish improved circumstance evaluation as well as increasingly quick and exact fulfillment of a pre-characterized assignment than would be conceivable utilizing any of the sensors independently. Principally picture combination requires exact methods and furthermore great comprehension of information. The last yield of picture combination is hoping to give more data than any of the single pictures by diminishing the MSE.

## II. METHODOLOGY

### Image Fusion

A combination strategy, which can join reciprocal directional data of a various picture into a solitary super picture, improves the data thickness. Using the excellence of wavelet changes that is multi band disintegration, best view can be chosen in some random band. The combination results show improved in general complexity.

Picture combination is the procedure that joins data from various pictures of a similar scene. These pictures might be caught from various sensors, obtained at various occasions, or having diverse spatial and ghashly qualities. The object of the picture combination is to hold the most attractive qualities of each picture. With the accessibility of multi sensor information in numerous fields, picture combination has been accepting expanding consideration in the looks into for a wide range of utilizations.

### Principal Component Analysis

PCA is a measurable procedure generally utilized in flag preparing, insights, and numerous different applications. Chavez et al. [1991] utilized important part investigation; the shading twisting in the combination is not exactly the Intensity-Hue-Saturation (IHS) combination technique. The primary preferred standpoint of PCA technique is that it can process boundless multispectral groups and mutilations less extreme. The primary Principal Component (PC) contains the spatial data. The main central part (red) will show a high level of difference, the second (green) will show just constrained accessible splendor esteem and the third one (blue) will exhibit a significantly littler range. The RGB relationship coefficients rely upon the scenes portrayed in the pictures. In PCA, the excess data can be composed so that each yield band is uncorrelated with others. The PCA combination plan can be connected to all groups in the MS picture at the same time (Krista Amolins et al. 2007). The weakness is that this strategy is touchy to dead pixels, commotion and other undesirable antiquities.

### Discrete Wavelet Transform

The wavelet change is a straightforward and exquisite device that can be utilized for some computerized flag preparing applications. It beats a portion of the confinements of the Fourier change with its capacity to speak to a capacity at the same time in the recurrence and time areas utilizing a solitary model capacity (or wavelet) and its scales and moves. This page centers explicitly around two as of late created discrete wavelet changes (DWTs), in particular the twofold thickness DWT and the twofold thickness complex DWT.

The twofold thickness DWT is an improvement upon the basically tested DWT with vital extra properties:

- (1) It utilizes one scaling capacity and two particular wavelets, which are intended to be balanced from each other by one half,
- (2) The twofold thickness DWT is over finished by a factor of two,
- (3) It is about move invariant. In two measurements, this change beats the standard DWT regarding denoising; be that as it may, there is opportunity to get better in light of the fact that not the majority of the wavelets are directional. That is, in spite of the fact that the twofold thickness DWT uses more wavelets, some come up short on an overwhelming spatial introduction, which keeps them from having the capacity to separate those headings.

An answer for this issue is given by the twofold thickness complex DWT, which joins the qualities of the twofold thickness DWT and the double tree DWT. The twofold thickness complex DWT depends on two scaling capacities and four unmistakable wavelets, every one of which is explicitly structured with the end goal that the two wavelets of the primary pair are balanced from one other by one half, and the other pair of wavelets structure a rough Hilbert change pair. By guaranteeing these two properties, the twofold thickness complex DWT has improved directional selectivity and can be utilized to actualize perplexing and directional wavelet changes in numerous measurements.

### Discrete Curvelet Transform

Multiresolution techniques are profoundly identified with picture preparing, organic and PC vision, and logical registering. The curvelet change is a multiscale directional change that permits a practically ideal nonadaptive scanty portrayal of items with edges.

Curvelets can be viewed as an expansion of wavelets for multidimensional information. The key distinction between the wavelet and curvelet is that just curvelets are extremely directional. Curvelets fulfill the anisotropic scaling connection  $2\text{lengthwidth} \approx$  in the spatial area. For instance, as appeared in Fig. 1(a), it would take numerous wavelet coefficients to precisely speak to such a bend. Contrasted and wavelets, curvelets can speak to a smooth form with many less coefficients for a similar accuracy (Fig. 1(b)).

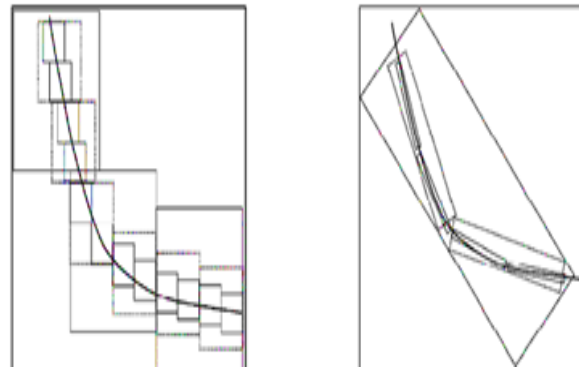


Figure 1: Comparison of non-linear approximation performance for wavelet and curvelet. (a) Wavelet representation, (b) Curvelet representation International

The curvelet change has advanced as an apparatus for the portrayal of bended shapes in graphical applications. At that point, it was stretched out to the fields of edge identification and picture denoising [10]. As of late, a few creators have proposed the use of the curvelet change in picture combination. The calculation of the curvelet change of a picture P can be condensed in the accompanying advances:

- A) The picture P is part up into three sub-groups  $\Delta_1, \Delta_2$  and P3 utilizing the added substance wavelet change.
- B) Tiling is performed on the sub-groups  $\Delta_1$  and  $\Delta_2$ .
- C) The discrete Ridgelet change is performed on each tile of the sub-groups  $\Delta_1$  and  $\Delta_2$ . A schematic graph of the curvelet change is delineated in Fig. 2.

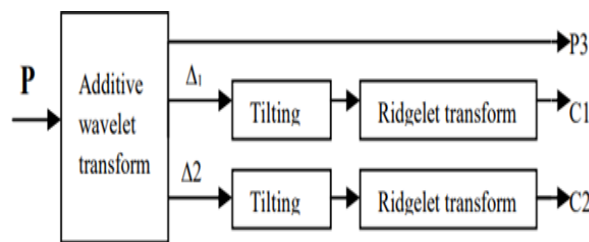


Fig. 2: Discrete curvelet transform of an image P

## II. PROPOSED METHODOLOGY

The prerequisite for the fruitful picture combination is that pictures must be accurately adjusted on a pixel-by-pixel premise. In this venture, the pictures to be consolidated are thought to be as of now superbly enlisted. The Fig. 3 demonstrates the best dimension square graph of picture combination utilizing wavelet change. The two info pictures picture 1 and picture 2 that are caught from noticeable and infrared camera separately are taken as data sources.

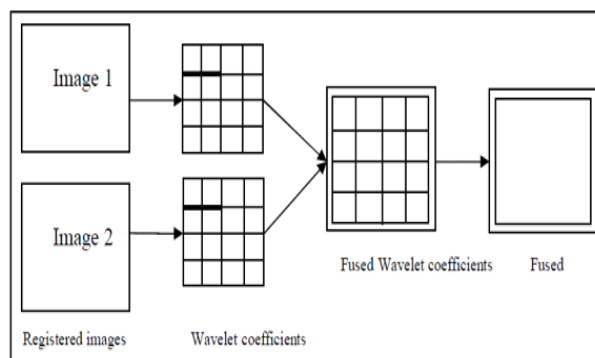


Figure- 3: Block diagram of DWT based image fusion

The wavelet change decays the picture into low-low, low-high, high-low, high-high recurrence groups. The wavelet coefficients are produced by applying the wavelet change on info pictures. Wavelet coefficients of the info pictures are intertwined by taking the normal of information pictures. The resultant melded picture is gotten by applying the opposite wavelet change. The structuring and displaying of combination of two pictures by averaging and 2-D DWT with various channels like Haar, Daubechies and Biorthogonal channels in MATLAB Simulink. The aftereffect of all combination procedures for three diverse arrangements of pictures has been completed. The PSNR of various arrangements of pictures for various combination systems has been classified.

The calculation of picture combination utilizing DWT depicted in the accompanying advances

1. Size of sources of info pictures: Given a two-dimensional picture (model, picture A, picture B) it is important to change over it into a similar size an intensity of two square structures.
2. Calculation of two measurements DWT: In this progression, the two-dimensional Discrete Wavelet Transform ought to be connected to the resized two-dimensional pictures.
3. Combination rule: The most utilized of picture combination rule utilizing wavelet change is greatest choice, think about the two coefficients of DWT of the two pictures and select the most extreme between. While the low-pass sub-band is an estimate of the info picture, the three detail sub-groups pass on data about the detail parts in level, vertical and corner bearings. Distinctive combining techniques will be connected to guess and detail sub-groups. Low-pass sub-band will be combined utilizing basic averaging tasks since they both contain approximations of the source pictures.
4. Opposite discrete wavelet changes: After chose the combined low recurrence and high recurrence groups, melded coefficient is remade utilizing the Inverse quick discrete wavelet change to get the intertwined picture which speak to the new picture.

#### Picture Fusion Method Based On TheCurvelet Transform

We currently give the particular operational technique for the proposed curvelet-based picture combination approach. The operational strategy is a conventional one, in spite of the fact that IKONOS pictures were taken for instance so as to represent the technique.

- (1) The first IKONOS container and multispectral pictures are geometrically enrolled to one another.
- (2) Three new IKONOS container pictures I1, I2, and I3 are delivered, whose histograms are indicated by the histograms of the multi-phantom pictures R, G, and B, individually.
- (3) By utilizing surely understood wavelet-based picture combination technique, we acquired melded pictures I1+R, I2+G, and I3 +B, individually.
- (4) I1, I2, and I3 are deteriorated into  $J + 1$  sub-groups, separately, by applying " 'atrous" sub-band sifting calculation. Each disintegrated picture incorporates  $c_j$  which is a coarse or smooth form of the first picture and  $\omega_j$  which speaks to "the subtleties of I " at scale  $2^{-j}$ .
- (5) Each  $c_j$  is supplanted by intertwined picture which acquired from (3).
- (6) The ridgelet change is then connected to each square.
- (7) Curvelet coefficients (or ridgelet coefficients) are adjusted so as to upgrade edges in the combined picture.
- (8) The Curvelet reproductions are completed for I1, I2, and I3, separately. Three new pictures ( F1 , F2 , and F3) are then gotten, which mirror the unearthly data of the first multi-ghostly pictures R, G, and B, and furthermore the spatial data of the dish picture.
- (9) F1, F2, and F3 are joined into a solitary intertwined picture F.

In this methodology, we can acquire an ideal intertwined picture which has more extravagant data in the spatial and unearthy areas at the same time. In this way, we effectively can discover little items in the melded picture and separate them. This is the motivation behind why curvelets-based picture combination technique is extremely proficient for picture combination.

### III. SIMULATION RESULT

The proposed strategy for picture combination for tumor discovery is executed and recreated utilizing MATLAB. The low goals PET picture is upgraded by Lagrange insertion system to improve the goals. This exploration manages the Detection of Brain Tumor utilizing Discrete Wavelet Transform based Medical Image Fusion for the analysis and better treatment. Picture Fusion is the way toward incorporating at least two pictures from a solitary methodology or various modalities. In this work, DWT based picture upgrade and combination system has been actualized and reproduced utilizing MATLAB. The proposed picture combination strategy comprises of two noteworthy procedures, for example, (I) picture improvement and (ii) picture combination both rely upon wavelet change. Lagrange interjection is utilized for picture improvement. X-ray and PET pictures are intertwined by the proposed technique. The combined picture has extra data from both MRI and PET pictures and the visual quality has improved. The combination parameters' Average Gradient, Discrepancy, PSNR, MSE and Entropy are determined and the outcomes demonstrate the viability of combination dependent on DWT. This work can be reached out to recognize any sort of irregularities in every single human organ like lungs, cervix, and kidney, etc.

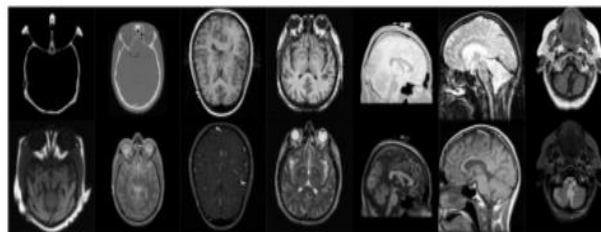


Figure 4: Input Image

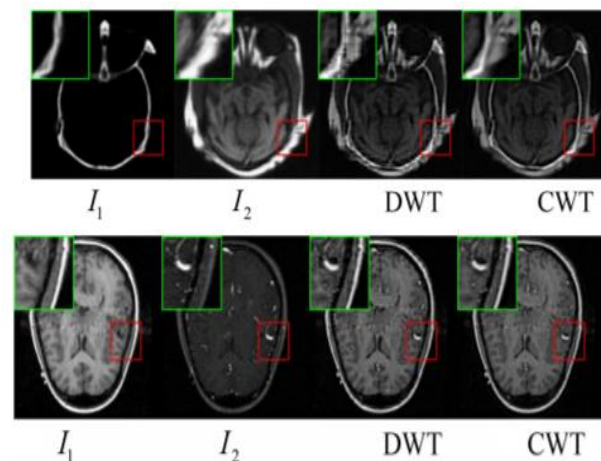


Figure 5: Fusion Result

Table 1: Result for PSNR

Method	DWT	CWT	DWT+CWT
MRI-I	26.45 dB	26.03 dB	27.90 dB
MRI-II	27.56 dB	26.99 dB	28.22 dB

Table 1: Result for MSE

Method	DWT	CWT	DWT+CWT
MRI-I	3.453	3.003	2.554
MRI-II	4.902	4.547	2.004

#### IV. CONCLUSION

With the growing technological advancements in the medical arena, it is necessary to keep up the research on medical image fusion standards to handle a host of problems such as integrating multiple images on common workspace and computational complexities in fusing image without jeopardizing quality. Handling problems of such mammoth proportion has been an arduous task, which is to some extent addressed by available image fusion techniques. Still, it requires a lot of energy and research in addressing improved fusion technique and more suitable hardware architecture catering more efficient functionalities in terms of reduced computational complexity and without sacrificing image quality. In this background, present research study has designed and implemented certain fusion technique with specific hardware architecture and has arrived at the following conclusions. In this research, an improved fusion technique for medical images using Discrete Wavelet Transform (DWT) is proposed. This new approach to fuse two medical images with DWT technique is better than other techniques in terms of spatial and spectral quality. The presented fusion rules are based on image enhancement.

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