Multi Modal Hybrid Image Fusion using Discrete Wavelet and Contourlet Transform

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Abstract*: Image fusion is used to enhance the quality of images by combining two images of same scene obtained from single or multiple modalities. In medical diagnosis different types of imaging modalities such as X-ray, Computed tomography (CT), Magnetic resonance imaging (MRI), Magnetic resonance angiography (MRA), PET scan etc., provide limited information where some information is common and some unique. This paper presents a hybrid combination of Discrete Wavelet and Contourlet. For the obtained fused images, it is proposed to compute performance metrics like Entropy, Peak signal to noise ratio and Mean square error and compare them with existing methods as to come out with best combination of transformations that yield highly informative fused image. Proposed method will be simulated using MATLAB tool.

***Index Terms*: Image fusion, Computed tomography, Magnetic resonance angiography, Discrete wavelet and contourlet, Entropy.**

I. INTRODUCTION

Image fusion is a procedure to consolidate multisource symbolism information utilizing propelled combination methods including combination structure, plans and calculations. The primary object is the mix of unique and correlative information to upgrade the data evident in the pictures and additionally to expand the unwavering quality of the translation as appeared in the Figure 1

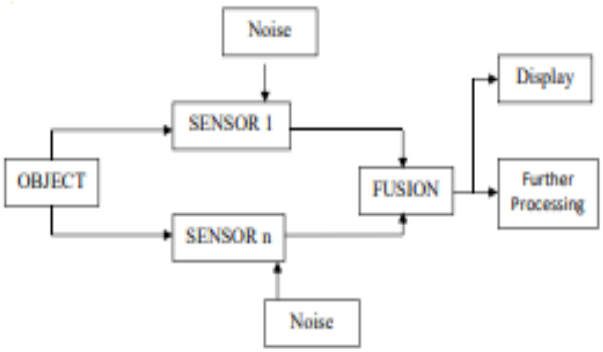

Fig. 1. General block diagram of image fusion

In the current years, Multi modal picture combination calculations and systems, has developed as an intense device in the clinical applications, of medicinal envisioning systems. The fundamental inspiration is to create most significant data from various sources into a solitary yield, which assumes an urgent part in medicinal diagnosis. Medicinal imaging has increased critical consideration because of its prevalent part in human services. A portion of the diverse sorts of imaging modalities utilized now-a-days are Xray, computed tomography (CT), attractive reverberation imaging (MRI), magnetic reverberation radiography (MRA), and so on.

X-beams: Is utilized to distinguish breaks, irregularity in bone position. CT: Is utilized to give more precise data about calcium store, air and thick structures like bones with less mutilation, intense drains and tumors .X-ray: Under solid attractive field and radio-wave vitality, data about Nervous framework, basic variations from the norm of delicate tissue, muscles can be better pictured. MRA: Is utilized to assess veins and its variations from the abnormalities. FMRI: Functional magnetic resonance imaging is a practical neuron-imaging system utilizing MRI innovation that measures mind action by recognizing changes related with blood stream Hence, we can see none of these modalities can convey all pertinent data in a solitary picture. So, that anatomical and useful medicinal pictures are should have been joined for a succinct view. For this reason, the multi modal medicinal picture combination has been distinguished as a source with better potential. It intends to coordinate data from numerous modalities to get a more entire and exact portrayal of a similar question which encourage in more exact determination and better treatment. Melded picture gives higher precision and unwavering quality by evacuating repetitive data. Proposed technique will be reenacted utilizing MATLAB device.

II. LITERATURE SURVEY

To advance proficient and viable image fusion algorithm, generous research work has been done as of late. Various combination components have been proposed by different creators to address the issues and difficulties of instatement for Multisensory picture combination, and to enhance the sensor combinations utilizing distinctive separating systems are examined in the writing [01]. In this article, the process of closeness measures, for example, Boundary Based Sameness Measurement and Structural Similarity Scale Measure is assessed and furthermore contrasted and the current therapeutic picture combination strategies. Immaterial and Performing: Multi methodology Medical Picture combination is the way toward melding two Surgical pictures acquired from two distinct detectors for best conclusion. This material advises a strategy for combination of Surgical pictures utilizing Dual Tree Complex Wavelet Transform (DTCWT) and Self Organizing Feature Map (SOFM). [02It spoke to Picture blend methodology of merging at least two image of same view to shape respective consolidated icon which demonstrates major information in the inter-weaved image. In this paper assorted frameworks

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have been reviewed and the essential target is to build picture quality and decrease the mistake. [03] This paper proposed a technique for combining CT (Computed Tomography) and MRI (Medical Resonance Imaging) pictures in light of second era curvelet change. Proposed technique is contrasted and the outcomes got in the wake of applying alternate strategies in view of Discrete Wavelet Transform (DWT), Principal Component Analysis (PCA), and Discrete Cosine Transform (DCT).

III. EXISTED FUSION METHOD

A. Wavelet-Curvelet Fusion technique

The current strategy which is half breed of two strategies that is the wavelet based picture combination and the curvelet based picture combination (cross breed of wavelet and curvelet combination rules). Curvelet based picture combination proficiently manages the bent shapes, accordingly its application in therapeutic fields would bring about preferred combination comes about over got utilizing wavelet change alone On the other hand wavelet change works effectively with multi center, multispectral pictures when contrasted with some other combination run the show. It expands the recurrence determination of the picture by deteriorating it to different groups over and over till various frequencies and resolutions are acquired. The stream outline of existed technique with is the blend of wavelet and curvelet change is appeared in Figure 2.

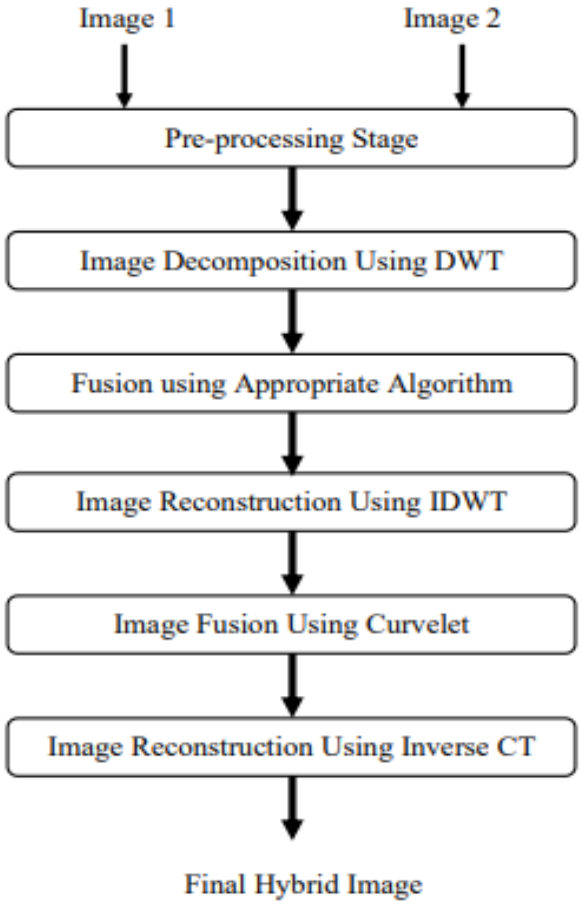

Fig. 2. Hybrid fusion of Curvelet transforms.

B. Proposed Methodology

General Image Based On DWT

Image based on DWT in Figure 3 is utilized to apply the wavelet change to computerized world. Channel banks are utilized to surmised the conduct of the consistent wavelet change. The coefficients of these channels are registered utilizing numerical investigation. DWT goes under the order of multi-scale disintegration. This is utilized to delineate wavelet change to computerized world.

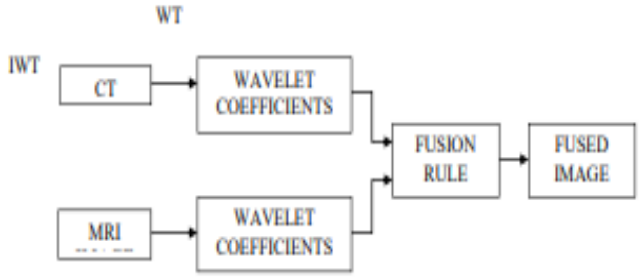

Fig. 3. General block diagram of DWT

Discrete wavelet changes (DWT). The coefficients of these channels are assessed utilizing numerical investigation. The wavelet change is utilized to recognize nearby highlights in a picture.

C. Procedure for implementation of wavelet transform

Step 1: The pictures to be melded must be enrolled to guarantee that the comparing pixels are adjusted.

Stage 2: These pictures are decayed into wavelet changed pictures, separately, in view of wavelet change. The changed pictures with K - level decay will at long last have 3K+1 distinctive recurrence groups, which incorporate one low-recurrence partition (ILL) and 3K high-recurrence parcels (low-high groups, high-low groups, and high- high groups).

Stage 3: The change coefficients of various segments or groups are performed with a specific combination run the show.

a) Fuse rough coefficients of source picture utilizing normal strategy.

b) Fuse detail coefficients of source picture utilizing Maxima strategy.

Stage 4: The intertwined picture in spatial space is built by playing out an opposite wavelet change in light of the joined change coefficients from Step 3.

D. General image fusion based on contourlet transform

Contourlet change in Figure 4 is another two-dimensional change technique for picture representations. The Contourlet change has properties of,

1. Multi-determination: The portrayal ought to enable pictures to be progressively approximated, from coarse to fine resolutions.
2. Localization: The fundamental components in the portrayal ought to be confined in both the spatial and the recurrence spaces.
3. Critical inspecting: For a few applications (e.g., pressure), the portrayal

should shape a premise, or an edge with little repetition.

4. Directionality: The portrayal ought to contain premise components situated at an assortment of headings, considerably more than the couple of bearings that are offered by distinct wavelets.
5. Anisotropy: To catch smooth forms in pictures, the portrayal ought to contain premise components utilizing an assortment of lengthened shapes with various angle proportions.

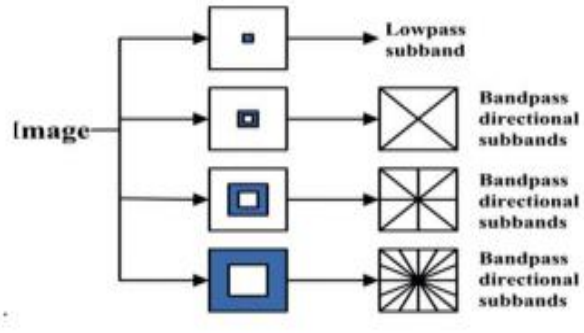

Fig. 4. General block diagram of contourlet

The forms of unique pictures can be caught adequately with a couple of coefficients by utilizing Contourlet change. Contourlet change gives multi-scale and multi directional disintegration. It comprises of two phases, Laplacian Pyramid and Directional Filter Bank.

Flow chart of proposed methodology

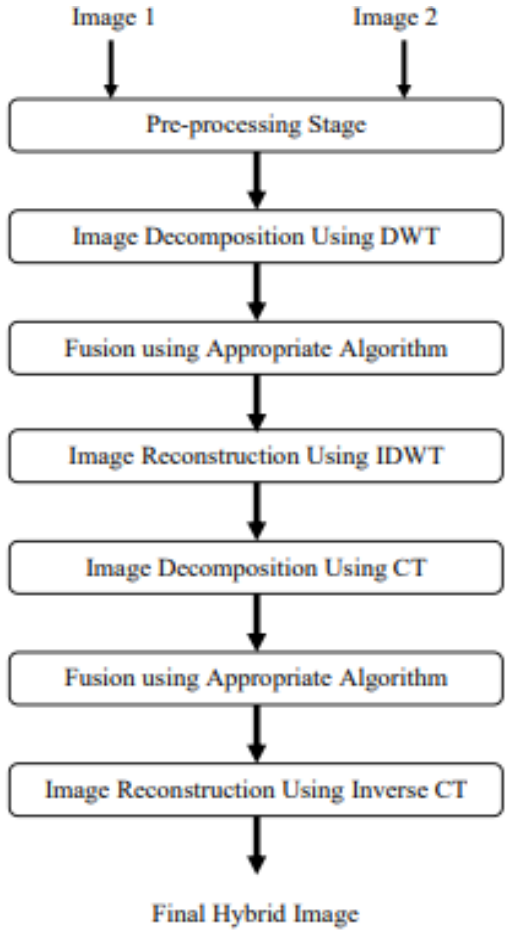

Fig. 5. Flow diagram of proposed methodology

Algorithm for DWT-Contourlet transform

Proposed methodology in Figure 5 includes following steps

Step 1: Conceive two source picture.

Step 2: These images are set to pre-processing which includes RGB to gray scale conversation and also ensured image alignment.

Step 3: The images obtained from step-2 are first decomposed using Discrete Wavelet Transform (WT).

Step 4: United image is obtained in wavelet domain using succeeding fusion rules.

1. Fuse approximate coefficients of source image using average method.
2. Fuse detail coefficients of source image using Maxima method.

Step 5: Apply inverse DWT to reconstruct fused image in spatial domain.

Step 6: Apply contourlet transform on the fused image which is obtained in step-5.

Step 7: Implement step-4 again.

Step 8: To get final hybrid fused image in spatial domain inverse contourlet transform is applied.

IV. RESULTS AND ANALYSIS

A. Simulation Results of DWT – Curvelet Transform

In this area the reenactment consequences of mixture Discrete Wavelet Transform is examined and Curvelet Transform for different restorative pictures acquired from various modalities.

Fusion of CT and MRI: Image Size [256 X 256] having tumor in brain is considered. In Figure 6 the first information source picture which is obtained from CT sweep of cerebrum. CT gives more exact data about calcium store, air, bones, and any blockages. The second information picture which is considered as a source of perspective acquired from MRI output of cerebrum. X-ray gives data about Nerve framework, delicate tissues and muscles. Discrete Wavelet Transform (DWT) is applied on input image. The output is as in Figure 7.

Fig. 6. Input image of brain tumor

Fig. 7. Hybrid DWT Curvelet fusion of brain tumor

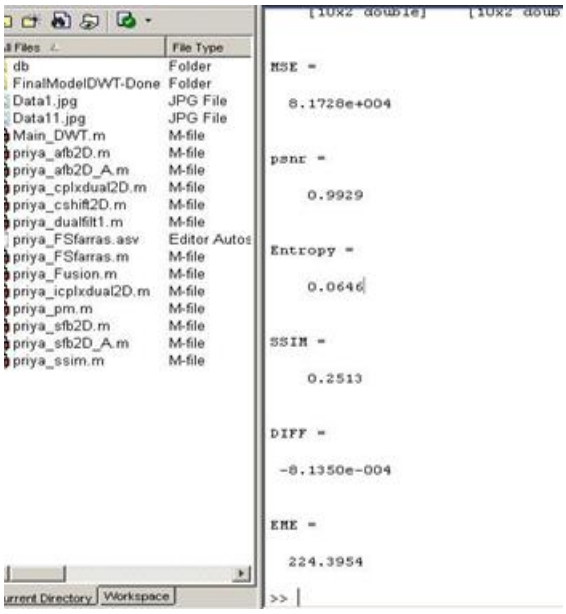

Fig. 8. Screenshot of resultant fused image

B. Simulation Using DWT-Contourlet Transform

The CT and MRI: Image Size [256 X 256] having tumour in brain is input image as in Figure 9, a DWT-Contourlet fusion is applied. The resulting output is as in Figure 10.

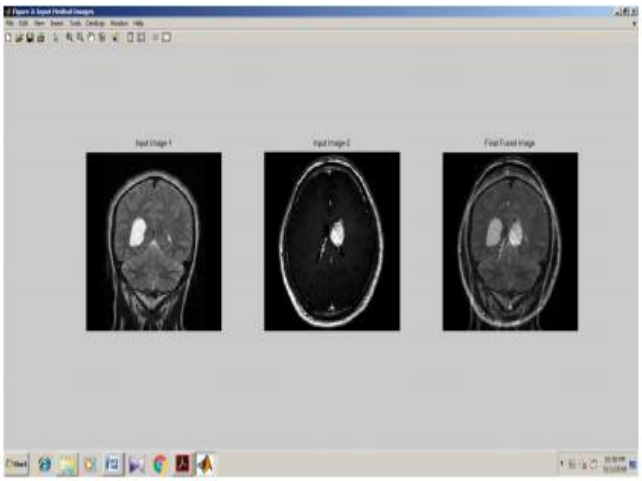

Fig. 9. Input images of brain tumor

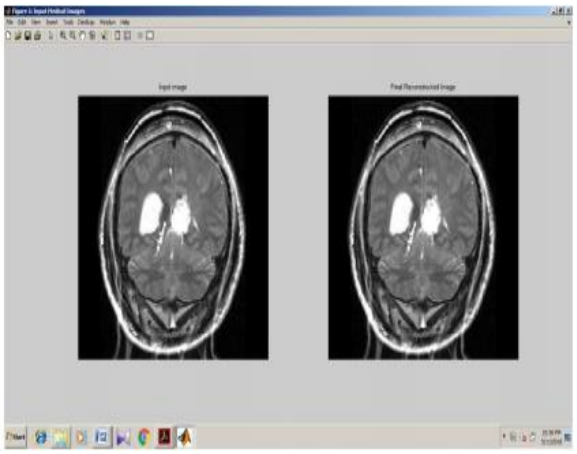

Fig. 10. Hybrid DWT Contourlet fusion of brain tumor

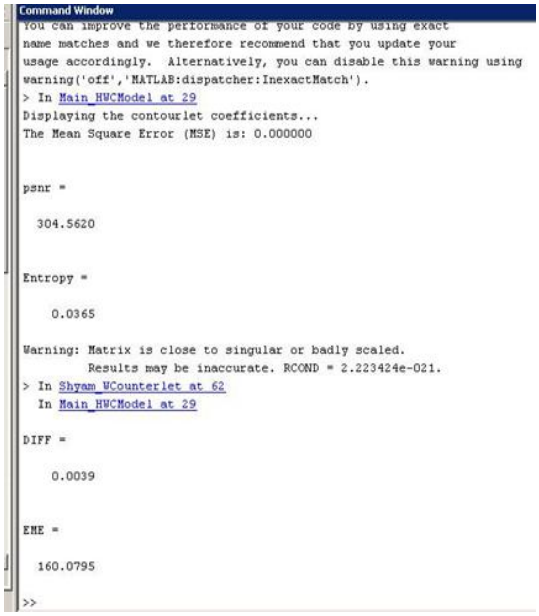

Fig. 11. Screenshot of resultant fused image

V. COMPARISON OF RESULTS AND ANALYSIS

In this segment different parameters such as Entropy, PSNR, and MSE are utilized to assess the adequacy and looked at the execution measurements among the proposed techniques and existed one.

Comparison of performance metrics for proposed method and existing method is as in Table 1.

Table I. Overall performance of matrices for fusion of CT and MRI Image

Hybrid technique for image fusion	Performance quality metrics		
	PSNR	ENTROPY	MSE
DWT	36.5465	0.2497	11.402
CONTOURLET	57.7921	0.4000	6.697
WAVELET-CURVELET (Existing method)	30.5658	0.0646	57.0817
WAVELET-CONTOURLET (proposed method)	307.0784	0.0365	0.0000

VI. CONCLUSION

In this project, a hybrid technique for picture fusion using the combinations of wavelet, curvelet, contourlet is being simulated. The simulated results for different hybrid combinations of above mentioned transforms are tested and compared for various medical image combinations like MRI, and also for various input image sizes. In all cases, wavelet-contourlet based hybrid technique is observed to be outsmarting, which provide best quality fused image than other two combinations in terms PSNR, MSE and Entropy. Here Curvelet- Contourlet based hybrid technique suites best for medical diagnosis.

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