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Medical Image Enhancement Based on Design of Adaptive Wavelet fusion

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Abstract:* This process and interpreting medical pictures has become crucial for diagnosing and treating both internal and exterior diseases of portions of the human body. Healthcare photos have low contrast because they are taken using various sensors. Consequently, combined image techniques are frequently employed to combine images obtained from multiple sensors or electrodes in order to enhance the clarity of the resulting images. Using fusion based enhancement may improve the performance of medical image segmentation or object recognition tasks. Different fusion rules works differently for different type of medical images. Therefore it is require designing an adaptive fusion method capable of choosing write rule for improved information. This dissertation proposes to design the adaptive wavelet fusion for enhancing the quality of medical images taken under different environment. There are various fusion rules designed based on distinguish between pixels, features or symbol level. This dissertation adapts pixel based fusion method in 2-D discrete wavelet transform domain. Pixel fusion is having advantage of processing every pixel for contrast improvement thus fused images preserves original information. In addition these methods are easy to implement and computationally less costly.

Key Words: **Medical Image Enhancement, MRI, Fusion, DWT, Pixel level Fusion.**

I. INTRODUCTION

Wavelet analysis is widely being used for processing the medical images in past. In many applications medical image fusion is used for performance improvement and feature enhancement. Multi-resolution characteristic of discrete wavelet transform (DWT) have made it popular for wavelet based fusion methods. DWT decomposed the medical images into several sub-images each of different frequency bands. To fuse the pictures, pixel-based fusing rules are subsequently applied to the aforementioned sub-band values. Lastly, the opposite of the discrete wavelet transformation (IDWT) is applied to generate the fused picture. For certain medical imaging, various fusion techniques work differentially. Consequently, the main goal of the research is to create an adaptable fusion technique that can effectively process various medical picture types.

The term "medical picture fusion" refers to a wide range of combination of images techniques used to solve medical problems revealed by interior imaging of human tissues, organs, and parts of the body. The use of fusion image algorithms for healthcare diagnosis and area evaluation is extremely widespread. When images from several modalities—such as PET, CT, MRI, thermal [1, 9], apparent or ultraviolet—are combined for digenesis, it is referred to as multifunctional imaging.

These dissertations have proposed to adapt the optimum pixel level fusion rule or method based on the entropy analysis in discrete wavelet transform domain.

A. Wavelet based Fusion

It should be easier for machines or humans to perceive the combined image. Figure 1 below displays the wavelet transform fusion technique's block structure. Heterogeneous merging methods are frequently employed. combining different pixel-level fusing rules into an individual merged image using the combination fusion technique. a hybrid design based on algorithms that combines the benefits of both. Figure 2 depicts the structure of wave fusion. It is necessary to evaluate the outcomes and the combination of fusing and wavelet filter effectiveness [8] using the average squared error and signals to noise proportion (SNR). It is necessary to apply fully adaptable wavelet-based pixel-level fusing techniques rather than hybrids.

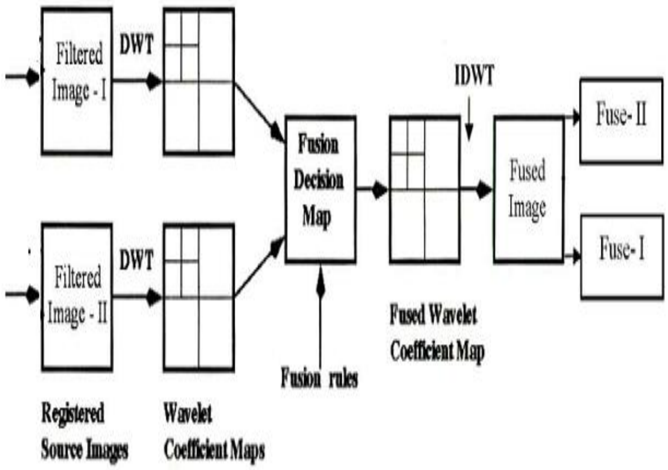

Fig.1. Block diagram of wavelet image fusion

II. LITERATURE REVIEW

At the signal, pixels, characteristic, and sign stages, among others, fusion of images can be carried out. Pixel layer fusing encompasses almost all picture fusion methods created in the modern era. An overview of wavelet-based synthesis for use in medical imaging applications is provided in this research.

A. Review of Medical image Fusion

Nayera et al. [1] have suggested using pixel-level integration principles and the discrete wavelet transformation (DWT), however the results vary depending on the type of medical picture. They have fused images from both MRI and CT using the idea of multimodality, or A succinct overview of multiple mediums fusion strategies for medical pictures has been provided by Bhavana et al. [16]. The poll has determined that there are benefits to using various fusion algorithms for these kinds of photos. This alloy chooses the most effective fusion techniques for what is needed.

Bhavana. Et al, [6] have suggested a technique for watermarked healthcare photos after seeing how useful fusion is for photographs with several models. To enhance the features, they combined the pictures from the computed tomography (CT) and MRI. However, the technique was exclusive to the photos with many models. The majority of the time, only one medical picture is provided and these photographs are not accessible.

Peng et al. [9] have put forth a medical picture fusion technique in the domain of transformation that uses multi wave and non-sub sampling directional filter sets for multiple-modal pictures. The wavelet fusing has been suggested by Maruturi et al. [10] to fuse medical images of FDG-PET and MRI.

B. Challenges and Motivation

After going through the review following gaps are identified.

- Wavelet based fusion is widely used for enhancing the image quality. But it is required to analyse the performance of various fusion rules.
- A picture of medicine although fusion is an increasingly popular area of study; neither technique is universally effective for all medical disciplines.
- Pixel level fusion is the simplest method but it needs to improve the performance under non uniform illumination as in the case of medical images. Therefore it is required to design an adaptive fusion method capable of opting the fission rule for better performance.

C. Motivation

Based on the study the following major motivations for the current research can be stated:

- In last two decades the image fusion has been used for the many applications as in remote sensing, night vision, military and civilian avionics, in vehicle navigation systems, in medical imaging and surveillance systems applications.
- The medical images are captured in various noisy environments using the multi sensors. Therefore it is required to enhance the visual quality
- The wavelet fusion techniques based on pixels are commonly employed because of their ease of usage in improving the quality of images. However, the outcome varies depending on the type of imaging procedure setting.\

The development of an environment-independent adaptable fusing approach is necessary. Additionally, when a wavelet domain has been combined, the data content must be preserved.

III. FUSION RULES

Image fusion is proved to be very advantageous in medicine for medical imaging applications and computer visions. This is because of use of different medical equipment for accusation and extraction of futures. The simplest and efficient method is to use pixels values for image fusion. The pixel level fusion has therefore become popular way of data enhancement. In this dissertation the first three and simple fusion rules are considered for the analysis.

A. Pixel Based Fusion Rules

Assume that you want to merge two image inputs, A (y, x) & B (x, y). lAJ (x,y) & lBJ (y, x are the deconstructed lower-frequency sub pictures that match A (x,y) and B (x,y). hAj,k(x,y) and hBj,k(x,y) are the deconstructed highly frequent sub images that match A(x,y) and B(x,y). The number of pixels parameters are denoted by j and k, where j can vary between j=1,2,3….J and k can vary between k=1,2,3… K. There are various techniques for pixel-level mergers, such as:

1. Pixel Averaging (Method1)

The process of obtaining all four sub bands of the combined image F involves merely average the coefficients of wavelets of the original images A and B together.

$F_{j,k} = (A_{j\ k} + B_{j,k})/2$ & $F_J = (lAj + lBj)/2$ (1)

2. Pixel Level Maximum (PLM) (Method 2)

PLM refers to the highest value of the wavelet parameters obtained from the two source pictures, which are used to produce all four sub bands of the combined picture F.

$F_{j,k} = \max(A_{j,k}\ B_{j,k})$ & $F_J = \max(lAj, lBj)$ (2)

3. Pixel averaging / absolute (Method 3)

This technique chooses the highest possible amount for the highest frequency groups & employs averages to fuse lower-frequency sub groups.

$F_{j,k} = \max(\text{abs}(A_{j,k}), \text{abs}(B_{j,k}))$ & $F_J = (LA_j + LB_j)/2$ (3)

In case of image fusion using pixel level fusion since all the pixels are used thus efficiency of image registration is higher. Since different image fusion rules account for different medical images thus selection of the proper pixel level fusion rule is still a challenging problem.

IV. PAPER CONTRIBUTIONS

Some of the main objectives of the image fusion are as follows:

- To test the parametric performance of adaptive fusion method for different image enhancement.
- To reduce the artifacts or inconsistencies such as contrast which will distract quality of the fused medical images
- Implement adaptive image fusion using 2-D discrete wavelet transform to improve the performance of the existing pixel level fusion method working efficiently for medical images.
- To analyze the performance of the various wavelet fusion rules for better fusion performance and preserve the brightness and maximize the entropy

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- To analyze the performance of the pixel based fusion rules and taking adaptive decision of optimum rule.

V. PROPOSED ENTROPY EFFICIENT ADAPTIVE FUSION

Utilizing the idea of entropy maximization, the suggested adaptive fusing technique uses the optimal pixel-level merging rules to improve the quality of medical images.

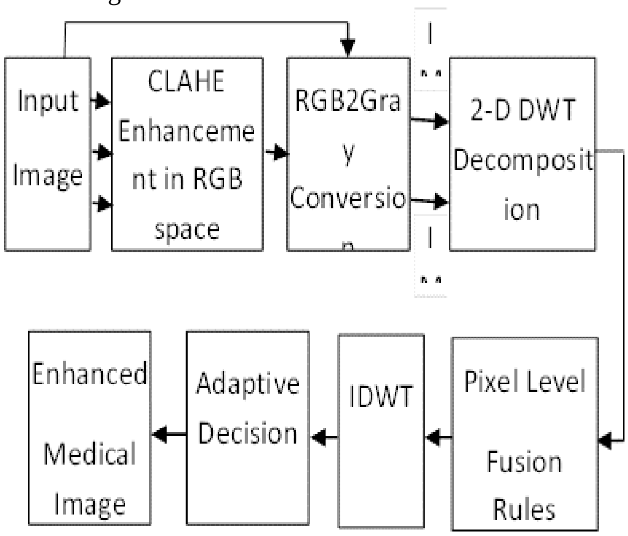


Fig.2. Proposed Wavelet based Fusion methods

VI. PROPOSED METHODOLOGY

The Brightness Limiting Adaptable Hierarchical Equalization (CLAHE) approach, which is constructed in RGB colors space independently, is used in this adaptive technique to improve the initial input healthcare image. The original picture and the improved image are both transformed to grayscale before both of the source images are subjected to decomposition using wavelets up to level N. In order to create numerous improved images, both the low pass as well as high pass segments are then combined using various individual pixel fusion techniques. To obtain full-size fused pictures, the reverse wavelet conversion is then used. Entropy assessment is used for contrasting the outcomes of fused images at the pixels level. The final improved image with the most data is determined by selecting the outcomes with highest complexity.

A. Pre Enhancement

Using the common CLAHE enhancement technique, the colours of medical photographs are individually equalized in the RGB hue spaces. In order to create several focused healthcare images for fusing from one picture, color medical pictures are upgraded in this thesis. The changed grey levels for the conventional CLAHE approach with a consistent distribution may be expressed mathematically as follows:

$$g = [\, g_{max} - g_{min} \,] * P(f) + g_{min} \quad (1)$$

The g_{max} is defined as maximum pixel value, g_{min} is defined as minimum pixel value and g is the finally computed pixel value. Results of CLAHE Enhancement are given in Figure 3

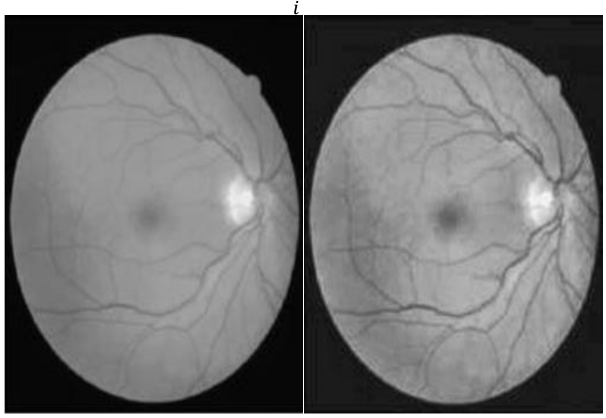
B. Wavelet Decompositions

In the proposed enhancement method, the wavelet decomposition of the input medical image is performed up to second level using 2-D discrete wavelet transform (DWT). The four decomposed sub bands for input patient_2_CT_image images and MRI image are shown in Figure 4.

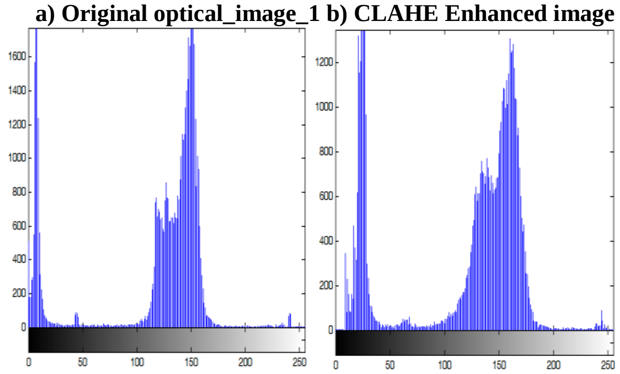
C. Adaptive Decision

The entropy of the images are determined and is defined as the measure of the information available in an image. Entropy of a picture used in performance evaluation tests is calculated by using the formula used by the Galileo:

$$Entropy = \sum_i P_i \, Log_2 \, P_i \quad (2)$$



a) Original optical_image_1 b) CLAHE Enhanced image



c) Histogram of original image d) Equalized with CLAHE

Fig.3.Results of CLAHE Enhancement for the optical_image_1

The three pixel-by-pixel fusion rules—pixel level maximums, pixel level minima, and pixel level averaged or mean—are used to combine the original medical photograph and improved image. P_i is the likelihood, or density function of the probability (PDF) that in a picture the distinction between two overlapping pixels corresponds to improve the quality of medical images, the recommended adaptable fusion technique uses the tri step approach to optimize Shannon. Comparing entropy It has been noted that the effectiveness for medical imaging improvement is increased when adaptable fusing rule choice is used, as the fusion outcomes are now unaffected by the surroundings.

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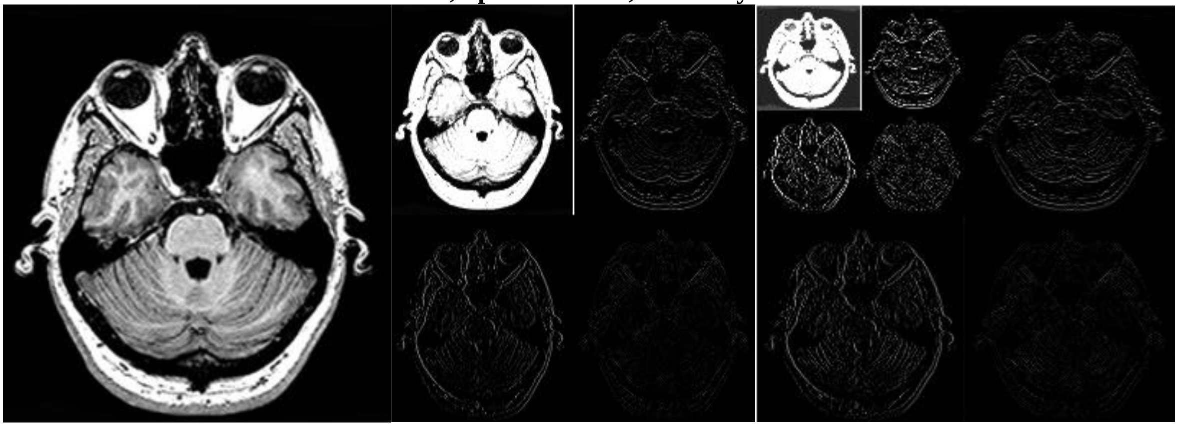
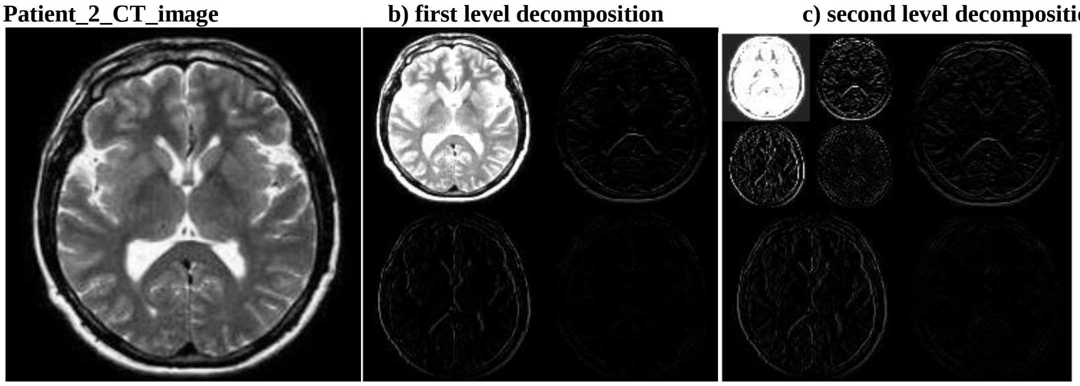
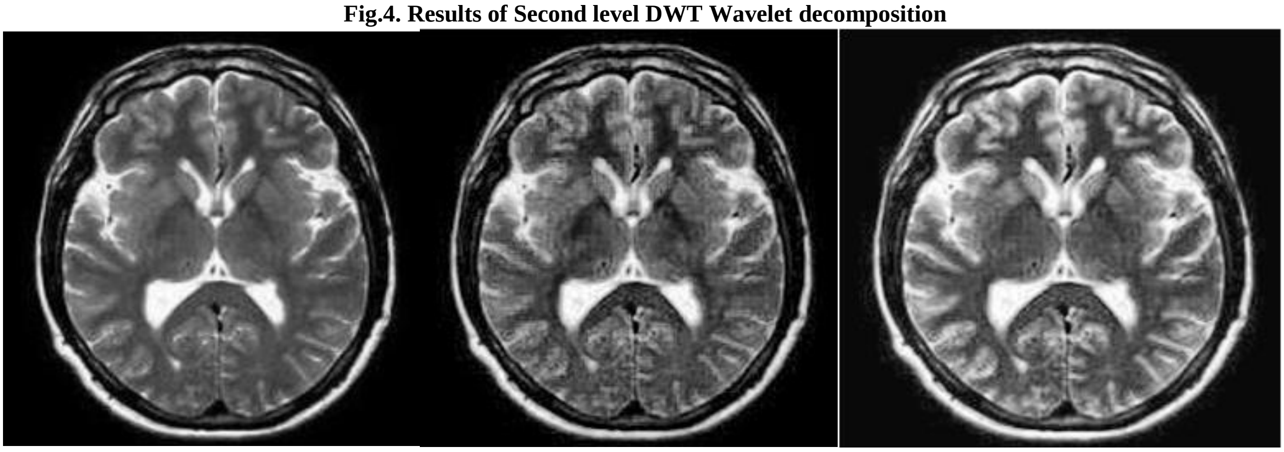


a) Patient_2_CT_image b) first level decomposition c) second level decomposition

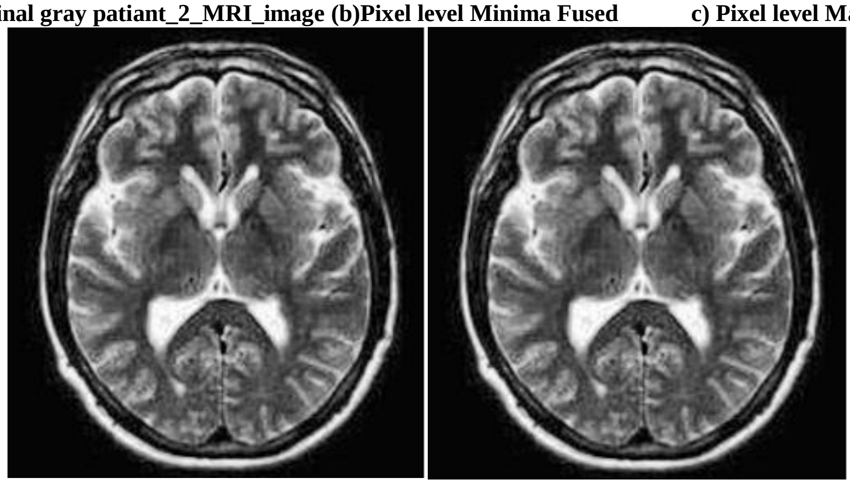


a) Patient_2_MRI_image b) first level decomposition c) second level decomposition

Fig.4. Results of Second level DWT Wavelet decomposition



a) Original gray patiant_2_MRI_image (b)Pixel level Minima Fused c) Pixel level Maxima Fused



d) Pixel level Average Fused e) Adaptive Fused Averaging image

Fig.5. Adaptive pixel level fusion results for Patient 2 MRI image

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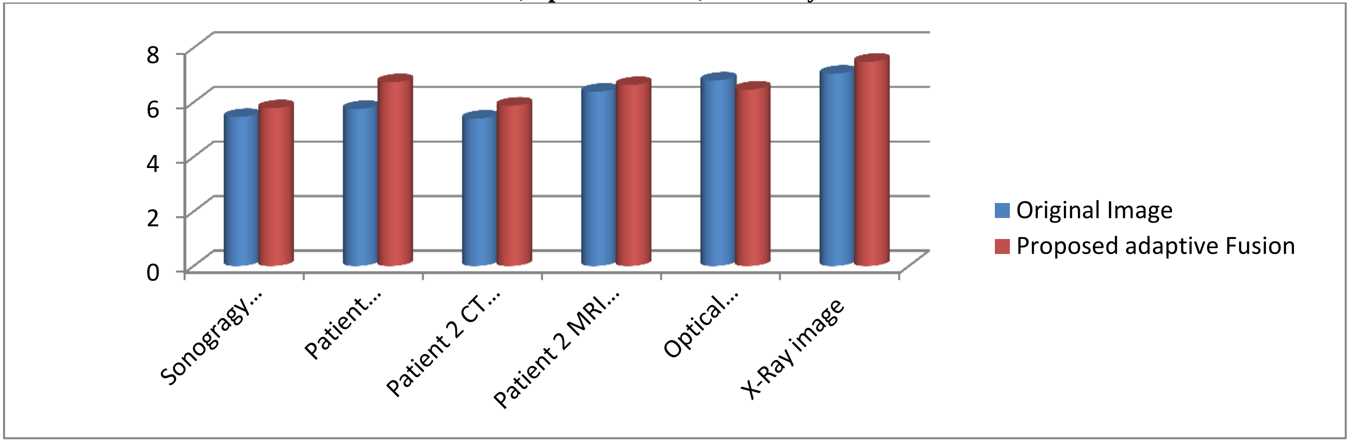

Fig.6. Entropy improvements Chart

VII. RESULTS AND DISCUSSION

Contrast-limited dynamic distribution balance using a histogram as the basis Because CLAHE [5] improves entropy; it not only maintains brilliance but also enhances contrast. This technique improves contrast between images in addition to producing a flat histogram. Figure 5 makes it evident that the improved sonography picture with CLAHE augmentation produces flat probability dispersion and more accurately describes the characteristics of the infant.

As a result, the multi-focused picture set is created from one input image employing CLAHE improvement, as seen in Figure 5a) and b). It is also visible in Figure 5. Using sensitivity and the norm's deviation (SD) as a comparison tool, the various fusion algorithms' capabilities are evaluated. The analysis also includes wavelet filter effectiveness. Because of enhanced data claims, it is anticipated that the suggested strategy works higher in both objective as well as subjective criteria. Figure 6 displays the combined outcomes of multiple approaches for ultrasound image 1. Characteristics in the level of the pixel maximum combined image are seen to be apparent greater than those in the other images.

VIII. CONCLUSION

Distinct medical source images are used for evaluating the performance as "Sonography Image 1, Patient image 1, Patient 2 CT image, Patient 2 MRI image, eyes Optical image 1, and X-Ray image. It can be observed that,

- The results based on the proposed adaptive wavelet fusion provide the better results than normal fusion methods. The results are compared with results of Peng et al. [9]. They have fused the images in multi-modality. It is found that our adaptive fusion method enhances the image quality in the absence of the multiple image samples.
- The performance of the different pixel based wavelet fusion methods are evaluated using entropy and standard deviations.
- It is observed from performance comparison that different pixel based fusion rules perform better for different images. For most of images Pixel level maxima gives the more entropy.

It is found that the proposed method provides the maximum Entropy performance. The method adopts right fusion rule thus entropy is significantly improved by the current enhancement method.

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