Neutrosophic DICOM Image Processing and its applications

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Abstract

Medical images are essential in contemporary medicine because they provide practicable entropy, which is used to diagnose medical conditions. It is useful to visualize abnormality in several parts of the body. Image segmentation in the medical has an important function in various applications in diagnosis systems. Researchers have become interested in segmentation algorithms as a result of Computed Tomography (CT) and Magnetic Resonance Imaging (MRI). The Region of Interest (ROI) extracts used in medical applications depend heavily on processes including cancer identification, bulk detection, and organ segmentation. Due to its capacity to deal with uncertainty and imprecision, Neutrosophic image processing (NIP) is a significant domain for uncertainty in medical image processing. Its methods in medicine demonstrate their transcendence. In the suggested work, the primary medical domains that NIP can create for image segmentation from DICOM pictures are highlighted. Due to the way it handles uncertain information, it has been found to be a better method.

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Keywords: Image processing, Neutrosophic image processing, Image segmentation, DICOM images.

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1. Introduction

Digital imaging is a vital role in medical image analysis in clinical theory therapy [18],[25], and [28]. Medical image classification has been thoroughly explained [4],[29]. outlined how crucial the problem of image segmentation is to image processing [16]. image segmentation techniques were explained [33]. The use of images has attracted the attention of several researchers [10], [11], [46], [41], [48] and [14]. image analysis was reviewed [45]. An explanation of an image segmentation pattern [12]. Some novel medical segmentation concepts are proposed in [2], [9], [13], and [22]. Explained image segmentation by threshold [39]. Segmentation is handled by region [52]. In this investigation, operators defined in the Neutrosophic theory will be applied for digital image processing. Neutrosophic is the branch of philosophy that studies everything related to neutralities. Along with the membership and non-membership function, it now also provides an indeterminacy membership function for the first time, allowing any one of them to exist independently of the others. Contradictions, inconsistencies, and ignorance in knowledge or information are modelled by indeterminacy. Explained filters in Neutrosophic image processing [42]. Studies on edge detection based on uniforms [18], [24] Using evolutionary algorithms and an enhanced Sobel operator, locate edges in photos [26]. Using hysteresis thresholds in thresholding techniques to detect edges [33]. There has been some investigation on the effectiveness of the Neutrosophic set approach filtering method for image denoising [39]. Grey picture extraction and segmentation using fuzzy logic [34]. [50]. ultrasonography breast image segmentation using the Neutrosophic approach. area merge approach using Newton-Raphson logic (49). [8] utilising ultrasound pictures for automated identification and categorization of breast cancer. [15]. Neutrosophic Sets: A New Approach for Improving Image Retrieval. [20],[35]. MRI denoising using the Wiener filtering nonlocal Neutrosophic set technique. [30],[19] innovative method for segmenting coloured images using fuzzy c-means and the Neutrosophic. [27] Modified Neutrosophic method for segmenting coloured images. [39] a DICOM image extraction type-2 fuzzy. [38] Using Type-2 Fuzzy Triangular Norms, find edges in a DICOM image.

Random noise throughout the process reduces the processing speed and quality of the MRI pictures. Denoising plays a crucial function in the earlier stage of picture processing. In Neutrosophic based noise reduction is MRI images converted to Neutrosophic sets. True, indeterminacy, and false in defined in Neutrosophic sets. The entropy is measured from indeterminacy. Image segmentation is considered for pattern identification [12].[3]. Proposed a new image segmentation in images on Neutrosophic histogram estimation. Neutrosophic set is high impact on deducing indeterminacy of uncertainty [6],[5],[7],[36],[44],[47] and [43]. After the development of Neutrosophic theory so many researchers concentrated on medical image processing [21],[17].[31] proposed breast lesion image segmentation from computed tomography. [32] introduced a contour model image segmentation. [1] Neutrosophic based liver tumor segmentation. [23] and [32] propose to introduce image processing through the Neutrosophic sets.

2.Methodology

Evaluation Metric

Cardinality for Neutrosophic images

If the image is being the pixel coordinate A(x, y), G(x,y) be the gray level pixel of A(x,y). $\mu_A(x)$ represent the membership function of the expert knowledge of the image. $I_A(x)$ is indeterminacy of the expert knowledge of the image and $F_A(x)$ is the non membership of the expert knowledge of the image. $\pi_A(x)$ is represent as hesitation value. If an image of size M x N pixel gray level L between 0 to L-1.

$$\pi_A(x) = 3 - \mu_A(x) - I_A(x) - F_A(x)$$

$\mu_A(g_{ij}), I_A(g_{ij})$ *and* $F_A(g_{ij})$ represent as the (i,j) the pixel of membership, indeterminacy and non membership function.

$\mu_A(g_{ij}) = \frac{g_{ij} - ming_{ij}}{g_{ij} - maxg_{ij}}$ mingij,maxgij represent the gray level of images.

If N is a neutrosophic crisp set. The neutrosophic measure defines as

$$E(N) = \frac{1}{n}\sum_{i=1}^{n} \frac{Maxcount(E_i \cap E_i^c)}{Maxcount(E_i \cup E_i^c)}$$

Where n is the cardinal(E), Ei denotes a single element. The cardinality of E is given by

$$Maxcount(E) = \sum_{i=1} (\mu_E(x_i) + \pi_E(x_i))(E) + \sum_{i=1} (V_E(x_i) + \pi_E(x_i))$$

DICOM image is mapped in to Neutrosophic space, where the Neutrosophic space image N_I(x,y)={T(x,y),I(x,y).F(x,y)}.

Where T(x,y), I(x,y) and F(x,y) are the true ,indeterminate and false respectively on the image N.

$$T(x,y) = \frac{\bar{N}\,(i,j) - \bar{N}\,min}{\bar{N}\,max - \bar{N}\,min} \quad (1)$$

$$\bar{N}\,(x,y) = \frac{1}{w\,x\,w}\sum_{i=a-\frac{w}{2}}^{a+\frac{w}{2}}\sum_{j=b-\frac{w}{2}}^{b+\frac{w}{2}} N(i,j) \quad (2)$$

$$I\,(x,y) = \frac{\delta(x,y) - \delta min}{\delta max - \delta min} \quad (3)$$

$$\partial(x,y) = abs(N(x,y) - \bar{N}\,(x,y)) \quad (4)$$

$$F(x,y) = 1 - T(x,y) \quad (5)$$

$$\text{Accuracy} = \frac{N_{\text{True Positive}} + N_{\text{True Negative}}}{N_{\text{True Positive}} + N_{\text{True Negative}} + N_{\text{False Positive}} + N_{\text{False Negative}}} \quad (6)$$

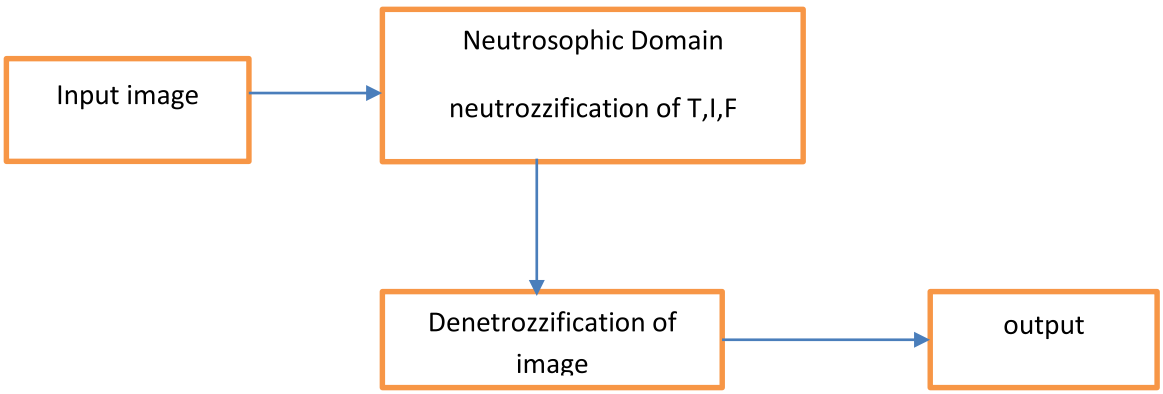
$$\text{Precision} = \frac{N_{\text{True Positive}}}{N_{\text{True Positive}} + N_{\text{False Positive}}} \quad (7)$$

$$\text{Harmonic mean} = \frac{2 \times N_{\text{True Positive}}}{2 \times N_{\text{True Positive}} + N_{\text{False Positive}} + N_{\text{False Negative}}} \quad (8)$$

True ,Indeterminacy and false entropies in Neutrosophic image are measured from entropy domain

$\bar{N}\,(x, y)$ is the local mean and $\partial(x, y)$ is the absolute value of difference between $N(x, y)$ *and* $\bar{N}\,(x, y)$. If the intensity have equal probability with uniformly distributed. Guo et al .,(2009)

3.Neutrosophic image processing



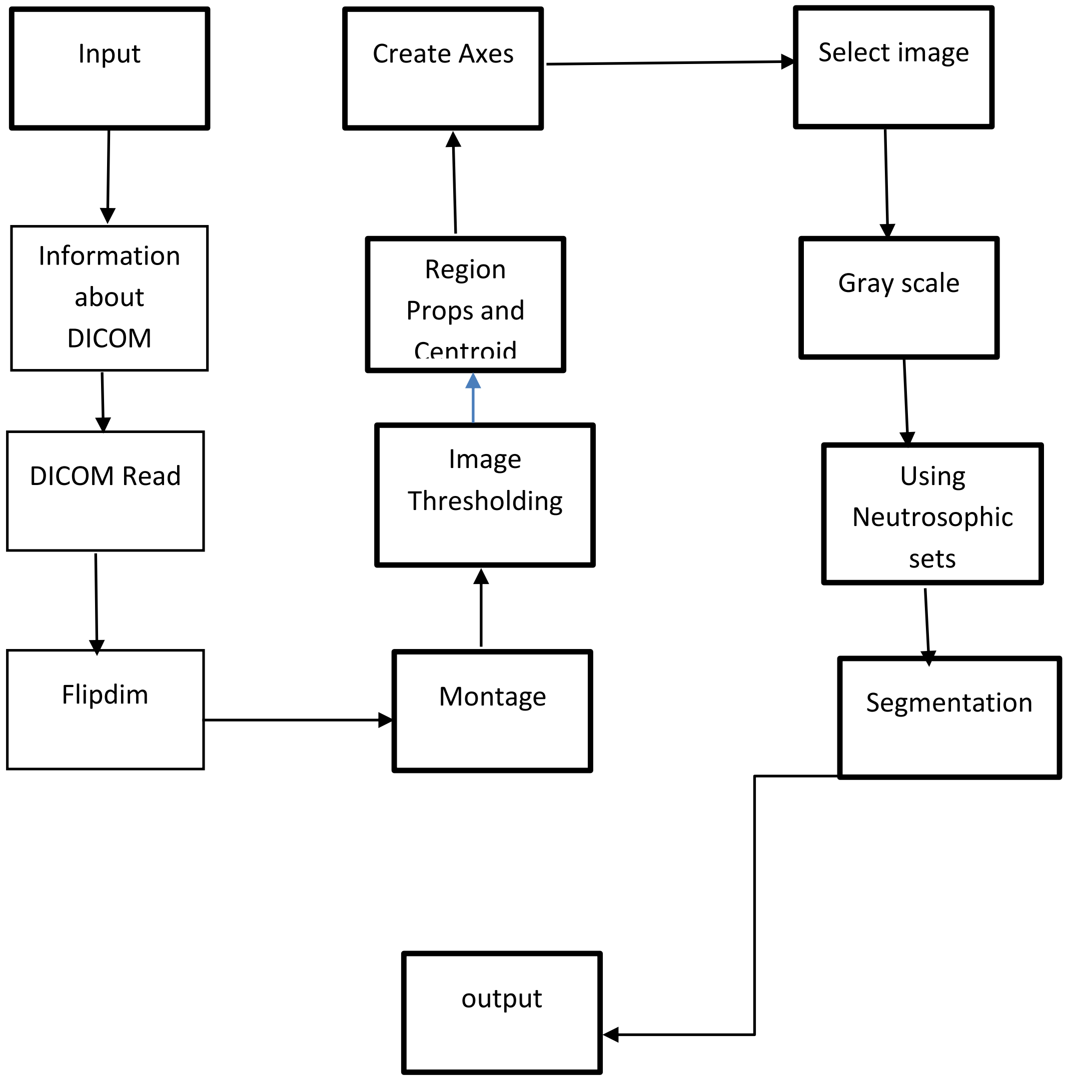
Fig(1) Neutrosophic image processing

The approved and standard data is called Digital Imaging and Communication in Medicine (DICM) .It is impossible to determine whether an edge is visible in a picture because most photographs lack sufficient brightness. Before the edge detection technique begins, edges may be improved. Opening and Closing, Maximum Erosion, and Minimum Dilation are morphological operations used in image processing (Idempotency).

4.Architecture of edge detection by Neutrosophic

Here the proposed design of the process of edge detection is described (Figure 2.)

Figure 2: Architecture of Edge Detection on DICOM image



5.Proposed edge detection algorithm

Step 1: Convert CT scans files to DICOM through filpdim

Step 2: Image convert to Gray Scale

Step 3: Do thresholding and region growing

Step 4: Convert RGB to green channel complement

Step 5: Give contrast limited adopting histogram equalization

Step 6: Use morphological operation

Step 7: Remove optic disc

Step 8: Use 2D medium filter and reduce the noise

Step 9: Remove background and image adjustment

Step 10: Do the segmentation using Neutrosophic sets

Step 11: Detect the edge

Step 12: End

6.Programme of DICOM image processing

```
g=imread('image.jpg');
g=rgb2gray(g);
g=double(g);
w=3;
for i=3:size(g,1)-2
for j=3:size(g,2)-2
s=0;
for m=i-round(w/2):i+round(w/2)
for n=j-round(w/2):j+round(w/2)
s=s+g(m,n);
end
end
g1(i,j)=s/(w*w);
segma(i,j)=abs(g(i,j)-g1(i,j));
end
end
g1min=min(min(g1));
g1max=max(max(g1));
segmamin=min(min(segma));
segmamax=max(max(segma));
for i=3:size(g,1)-2
for j=3:size(g,2)-2
T(i,j)=((g1(i,j)-g1min)./(g1max-g1min));
I(i,j)=((segma(i,j)-segmamin)./(segmamax-segmamin));
F(i,j)=1-T(i,j);
end
end
figure
subplot(3,1,1),imshow(T),title('T domain')
subplot(3,1,2),imshow(I),title('I-domain')
subplot(3,1,3),imshow(F),title('F-domain')
```

APPLICATION OF IMAGE PROCESSING

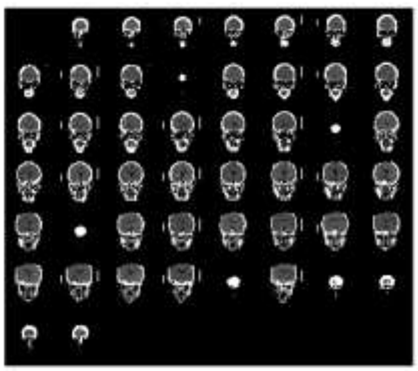
Image analysis is using MATLAB 2021b. The three-dimensional image in this instance is changed to a two-dimensional image. The image in Figure 1 was taken from a patient DICOM image as part of our experimental data collection.

For the purpose of the whole image in Figure 3, The data image was produced using computed tomography and is coloured in grayscale. The facial bone of a 50-year-old woman is mentioned in the study's description.Figure

3 displays a portion of the DICOM data collection. Convolution models for image segmentation can benefit from the usage of medical imaging. There are few data sets for medical picture segmentation.

Fig :3 DICOM Montage

S	Accuracy	sensitivity	specificity	Negative Rate	Predictive Value	score	precision	Harmonic mean
T	0.9668	0.1287	0.9838	0.0162	0.1394	0.1338	0.13944	0.13384321
I	0.1946	0.9583	0.048	0.952	0.162	0.2771	0.16197	0.27710843
F	0.3733	0.8333	0.3118	0.6882	0.1393	0.2387	0.13927	0.23866348
normal	0.987	0.037	0.9945	0.0055	0.0514	0.043	0.05139	0.04304932



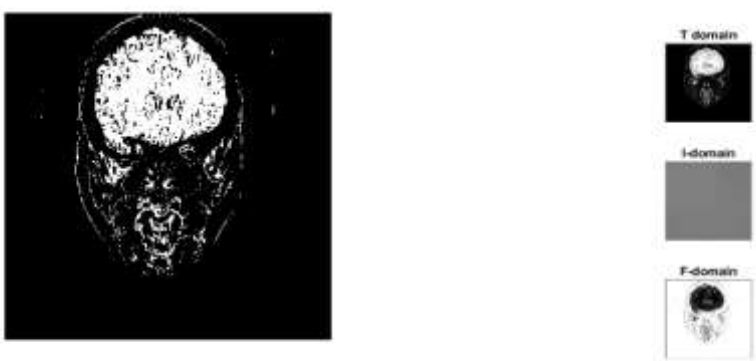


Fig :4 Image with Best view and Neutrosophic images

The optimum filter for extracting the image from DICOM data in the suggested system is found to be the 2D median filter. The experiment's classification result shows that the genuine membership image extraction accuracy is 97%, the sensitivity is 1%, the specification is 98%, the PPV is 12%, and the 12 harmonic mean of precision and sensitivity is 12%. In Table 1, the categorization outputs are displayed.

Table:1 Measures of the images.

Fig :5 Thresholding Images and Neutrosophic images

Fig :6 Image segmentation and Neutrosophic images

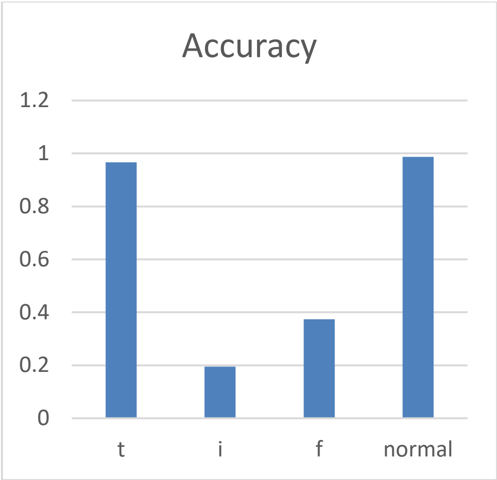


Fig. 7 Accuracy Analysis

Fig 7 shows that true membership is very nearest value from original images.

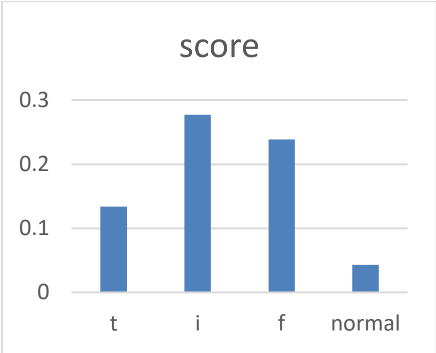


Fig. 8 Score Analysis

Fig 8 shows that true membership is very nearest value from original score images.

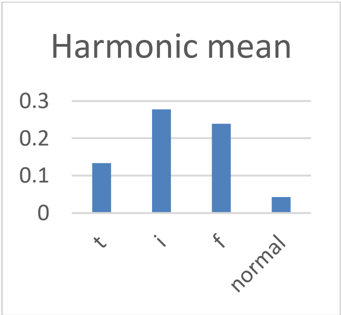


Fig. 9 Harmonic Analysis

Fig 9 shows that true membership is very nearest value from harmonic value of an images.

Conclusion

In Decision making using DICOM images involve vagueness, incompleteness, uncertainty and indeterminacy due to object orientation, staining degree and colors. NIP can achieve a better output in the vagueness of the images. NIP using three membership , it is effectively handled indeterminacy and uncertainty. NIP have impressive performance in DICOM image segmentation. NIP images transforming into Neutrosophic sets. Because of its imaging process, image's noise, inhomogeneity, and contrast, DICOM images play a crucial role in the diagnosis and treatment of brain cancers. For segmentation in these situations, neurosophic image processing is applied. This procedure seeks to make the image easier to depict as more significant and to determine or analyse. A patient's MRI's DICOM picture has undergone image segmentation. It has been noted that it requires extremely precise segmentation. Additionally, plithogenic conditions may be added to the process

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