Original Research Article

INTUITIONISTIC FUZZY LOGIC IMPLEMENTATION IN IMAGE FUSION TECHNIQUE

Abstract

Image fusion (IF) is integrating more than one image into a single image. It accepts multiple images as input and produces a single image as an output. Image w needs an image with high spectral and spatial information. It has wide varieties of application in medical diagnostics and treatment. It is more reliable and compact, easily combined with other methods. Different methods were proposed for remote sensing image and medical image fusion. The aim of the proposed technique is to present an image fusion technique using Intutionistic fuzzy logic (IFL).Mis – registration is the major issue of IF and the research work found solution for the problem. Image features were filtered and integrated with IFL and compute pixels. The proposed method produced better results compared to the existing methods.

Keywords: Image fusion, Intuitionistic fuzzy logic, wavelet transform, Medical imaging sensor

1. Introduction

Vision based Intelligence is the technology of modern time. The development of technology in the field of computer science leads to more number of innovative research in the image processing. Many kinds of algorithms exist for the extraction of image features such as edges and segments. Each technique in image processing provides different level of information to the users. Image Fusion (IF) is one of the efficient techniques in image processing combines' more than one image together and forms a blended image and conveys information to the user. Computer Tomography (CT), Magnetic Resonance Imaging (MRI) and Position Emission Tomography(PET) are the medical diagnostic tools uses IF to study the health of human beings.

The figure 1.1 explains the process of IF using fuzzy logic system (FLS). P1, P2, P3 and P4 are the images supplied to the FLS. Image features were extracted and blended with the original image. Threshold will be provided for the image processor to hold the input images and wait for FLS to blend the features with the supplied images.

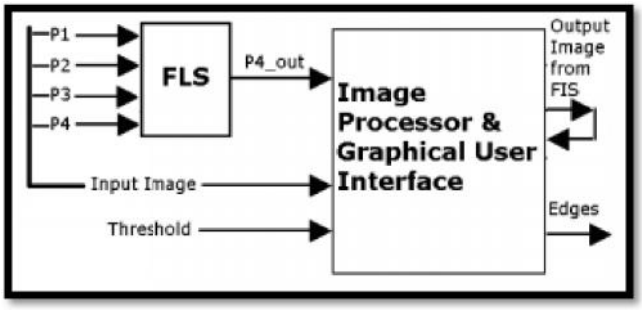


Figure 1.1 IF with Intuitionistic Fuzzy set

Fuzzy approach proposed by L.A.Zadeh in 1965. It has attracted many researchers to implement in the field of computer science. Automated machines started using the technology and reduced complexities in the previous versions. Many tools and software are available for fuzzy and neuro approach. The following part will discuss the application of fuzzy in IF.

Figure 1.2 explains the membership function in Black and white colors.X – axis shows the pixel value supplied to the fuzzy system to generate images. Y – axis is the threshold used for the generation of images.

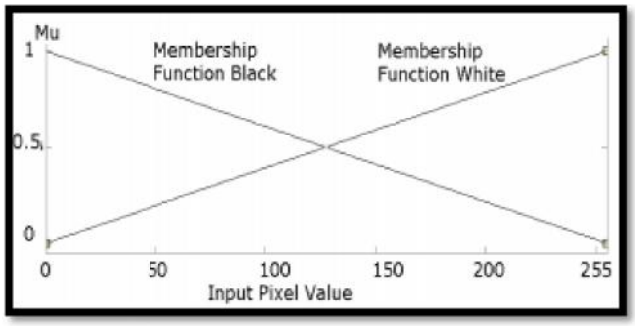


Figure 1.2 Membership function

Figure 1.3 shows the IF generated by fuzzy system. The X – axis depicts the pixel value of the output image and Y – axis shows threshold for the production of fused image.

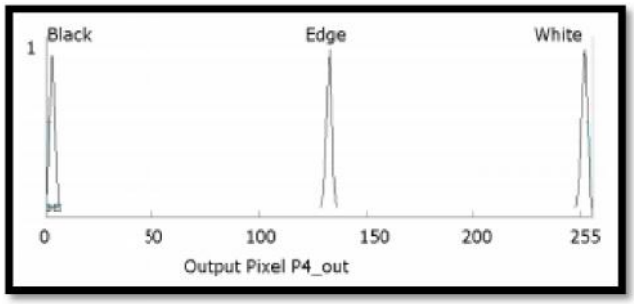


Figure 1.3 Edge detection using Fuzzy logic

Figure 1.4 shows the whole process of Fuzzification and Defuzzification of images using fuzzy system. Dilation, Erosion, opening and closing were done in membership level. Defuzzication generated the final fused image.

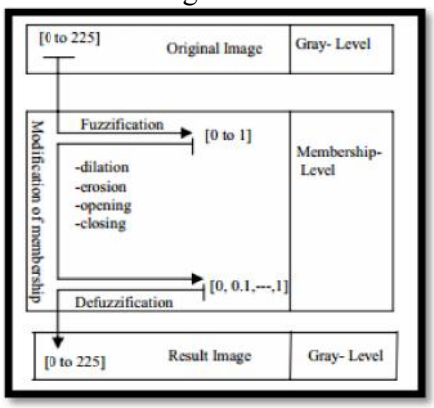


Figure 1.4 Structure of Fuzzy logic in image processing

IFL is the extension of fuzzy approach and deals with more possibilities of input and output. Existing techniques in IF have used fuzzy approach and found solution for the problems faced in the previous techniques. The proposed methods have implemented IFL to fuse images and generate more interesting applications.

The following sections of the research work discuss about the literature review, methodology, and experimentation results.

2. Review of Literature

Umar javed et.al., proposed an IF technique using fuzzy logic to fuse MRI and PET images. The goal of the research was to maximize the combination of MRI and PET images. CT is not suitable to analyse soft tissues and physiological defects in the human bodies. MRI has better visualization of tumors, soft tissues and other complications. PET provides data about the flow of blood in the body but suffers from low resolution problem. IF helps to extract sufficient information from fusion of images from MRI and PET. It has the ability to reduce the memory to store fused images. Pyramids, discrete wavelet transform, contourlet, stearlet, framelet transform are the multi – resolution techniques used to fuse images by different bands. Consistency verification and activity measures of discrete wavelet transform are not suitable for the transition of sharp images. Fusion of low frequency images is the important issue of existing methods. Existing schemes failed to handle the low frequency image.

Harpreet singh et.al., designed an algorithm for IF using fuzzy logic and defined some terminologies and applications of it. The fusions of images provide interesting information about the object. Automotive and medical fields widely use the IF technology. Sensor fusion was the familiar technology in image processing but the introduction of IF has attracted more researchers to develop new methods for automotive, military and medical fields. Redundant information will be filtered by the IF technique and keeps supporting information of an image.

Dhiraj kumar patel et.al., proposed edge detection technique based on fuzzy logic and cellular learning automata using fuzzy image processing. Edges have a basic role in higher level processing. Object border, gray and color or texture discontinuities are the features of image. Canny algorithm is the gradient based edge detection method to optimize the effort in the detection of edges. Image fuzzification, fuzzy inference system and defuzzification are the important stages in fuzzy image processing. Cellular learning automata with fuzzy rules improved the quality of edges.

Yee yee Htun et.al., proposed morphology approach based on fuzzy logic. Dilation and erosion are the binary mathematical morphology. It is based on fuzzy set theory and fuzzy mathematical morphology. Gray scale morphological operation is the mathematical form of morphological operation for gray scale images.

Kiran preet kaur et.al., designed an algorithm of edge detection based on fuzzy logic system. Edge detection is a terminology in the area of feature extraction of image. The advantage of edge detection is to find the picture element related to the edges of the objects seen in the image. Detection of sharp changes in the image clarity yields vital events in the properties of the globe. Registration and identification of image segmentation based on edge detection. Noise removal is the process to filter the pixels falsely recognized as edge by the processor.

3. Methodology

The research uses IFL to implement IF. The images has to be supplied as input and fused image is an output of the system. Local features of an image will be extracted by the following equation. LV is the local variance and defined by

$$I_{\mathrm{LV}}(\beta, m, n) = \frac{1}{(2m_1+1)(2n_1+1)} \times \sum_{m_2=m-m_1}^{m+m_1} \sum_{n_2=n-n_1}^{n+n_1} \left(I_{\mathrm{PET}}(\beta, m_2, n_2) - \bar{I}_{\mathrm{PET}}(\beta)\right)^2,$$

LB is the local blur and defined by

$$I_{\mathrm{LB}}(\beta, m, n) = -\frac{1}{2} \ln\left(\sum_{k}^{K} P_{\beta mn}^{3}(k)\right)$$

The algorithm 3.1 shows the IFL based IF. Number of images can be supplied as input to the system and fused image will be generated as an output. The IFL will use the intuitive logic to find the local features in the images and generate the output image.

3.1 Algorithm Fuze_ifuzzy

> function Y=fuse_ifuzzy(No. of images Mn)
> clc;

> for n =1 to N repeat
> %Y = fuse-fuzzy(Mn) image fusion with Fuzzy

>Next
> %Logic method

> for n = 1 to N repeat
> % Mn

>Next
> %YO Y - fused image
> % check inputs
> %YO Size of the two input images should be same

> For n = 1 to N
> Mn=imread('image1');

> Next

> For n = 1 to N
> [zn sn] = size(M1);
> Next
> if (z1 ~=z2) || (s1~=s2)

```
> end;
> For n = 1 to N

> Mn=imresize(Mn,[ 99 98]);
> size(Mn)
> size(Mn(:))

> Next
> %Co I onnap
> m = gray(225);
> f=readfis('tipper');
> colormap(m);
> im=evalfis([Mn(:) n);
> % Converting the column into matrix
> k = 1 ;
> for i=l to zl
> %rror('lnput images are not of same size'):

>next
> for j = 1 to s1
> img(j,i)=im(k);
> k=k+1;

>Next
> end
> end
> Y=img;
> %Computing entropy for input and fused images

>For n = 1 to N
> entropy(Mn);

> next
> entropy( img)
```

4. Experiment and results

The experimentation of proposed and existing methods was performed on MRI, PET and CT scan images collected from Alquwayiyah Hospital, Kingdom of Saudi Arabia. Group – 1 is the tumour images in the Abdomen area. Group – 2 is the back side spine images. Both Group – 1 and 2 were complex and clarity is out of focus from the viewport. The experiment was conducted on i7, 2.4 GHz, Windows 10 machine. Matlab used to build the algorithm.

Figure 4.1 shows the Group – 1 results. The output images of fuzzy and IFL shows that the proposed method has more clarity than fuzzy generated images.

Figure 4.2 shows the Group – 2 results, proposed method generated more clear results than existing method. IFL has the ability to generate more possibilities.

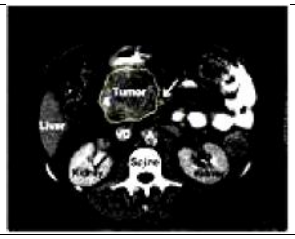
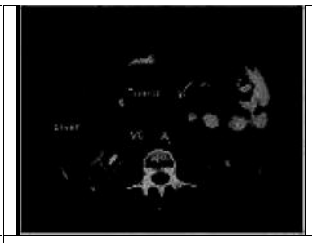
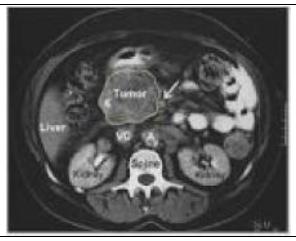
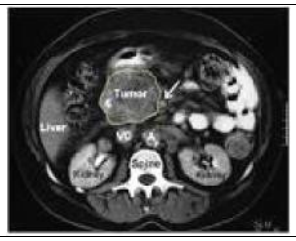
Input Images		
		
Image – 1	Image – 2	Image – 3
Output Image		
		
Fuzzy Logic	IFL	

Figure 4.1 Experimentation – 1 outcomes

Input Images	

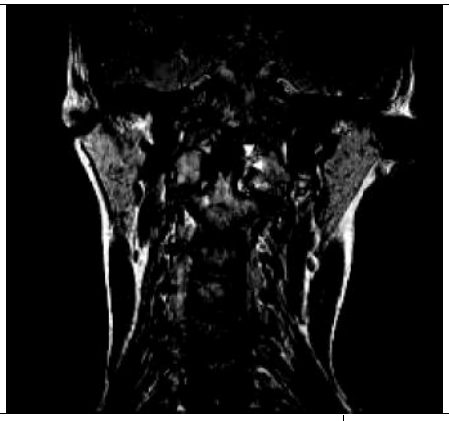



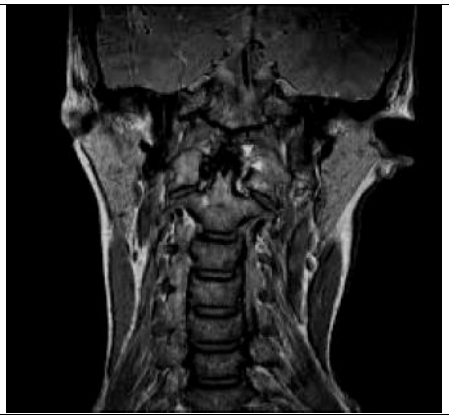
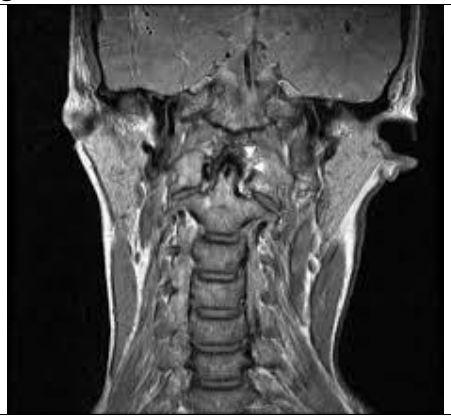
Image – 1	Image – 2
Output Image	
	
Fuzzy Logic	IFL

Figure 4.2 Experimentation – 2 outcomes

Table 4.1 shows the comparison of fuzzy and IFL, metrics used are entropy, structural similiarity(SSIM) , Xydeas and Piella. Proposed method got effective results than fuzzy methods.

Scenarios	Techniques	Entropy	SSIM	Xydeas and Petrovic	PIella
Group _1	Fuzzy	5.36	0.689	0.46	0.38
	IFL	5.78	0.712	0.56	0.87
Group_2	Fuzzy	5.68	0.819	0.39	0.52
	IFL	5.96	0.864	0.58	0.89

Table 4.1 Comparison of Results

Conclusion

IFL is a problem solving tool offers solution for classical logic and imprecision data of real world problems. The imprecision in the image leads to a distraction in the image. Intuitionistic fuzzy sets have the ability to solve the imprecision found in an image. IF is one of the finest technique to extract local features and interesting pattern. The proposed method used IFL for the process of fusing images and experimental results shown that the effectiveness of the method is more than fuzzy logic IF. The future scope of the research is to develop an IF to combine MRI, PET and CT scan images.

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