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Digital Image Fusion using Adaptive Neuro-Fuzzy Inference System

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***Abstract*— Image fusion is a process that combines information from multiple images of the same scene and resultant image retains the most desirable information and characteristics of input images. Image fusion can extend the range of operation, reduced uncertainty and increased reliability. In the medical imaging field, different images of the same part of the same patient with different imaging devices, and the information provided by a variety of imaging modes is often complementary each others . The fused image provides additional information that can be utilized for more precise localization of abnormalities. This paper presents study on digital image fusion , proposed model for fusion of images using ANFIS , implement and evaluate performance. This proposed model is for medical images (CT and MRI) as well as color images.**

***Index Terms*— Fuzzy, ANFIS , Image Fusion, Medical Image, Color image.**

I. INTRODUCTION

Image Fusion is a process of combining the relevant information from a set of image into a single image such that the resultant fused image will be more informative and complete than any of the input images. Image fusion techniques can improve the quality and increase the application of these data Important applications of the fusion of images include medical imaging, microscopic imaging, remote sensing, computer vision, and robotics[3][5].The aim of image fusion, apart from reducing the amount of data, is to create new images that are more suitable for the purposes of human/machine perception, and for further image-processing tasks such as segmentation, object detection or target recognition in applications such as remote sensing and medical imaging. For example, infrared and visible-band images may be fused to aid pilots landing aircraft in poor visibility.

Generally images are divided into three types: binary (black and white), color image and gray-scale image. In case of binary image, image contains only two colors, black or white. The value of black color is represented as “0” whereas white color is represented as “1”. Gray-scale image is a range of shades from black to white. Color images are a digital image that includes real-world information for each pixel. Brightness information for each color is represented by 3 channel red (R), green (G) and blue (B).

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Computerized tomography (CT) (shown in figure 1.4)is a medical imaging technique that has made a prominent impact on medical diagnosis and assessments. CT images well suited for bone , lung and chest imaging and cancer detection. CT scans are widely used in emergency rooms because the scan takes fewer than 5 minutes. MRI image is suited for viewing soft tissue in ligament and tendon injuries, spinal cord injuries, brain tumors . An MRI can take up to 30 minutes. An MRI typically costs more than a CT scan.

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II. COMMON IMAGE FUSION TECHNIQUES

a) SIMPLE AVERAGE: -. The value of the pixel P (i, j) of both images is taken and added. This sum is then divided by 2 to obtain the average. The average value is assigned to the corresponding pixel of the fused image (output image)[3].

b) SELECT MAXIMUM: -. The value of the pixel P (i, j) of both image is taken and compared to each other and selecting the greatest value for each pixel[3]

c) PCA based Image Fusion: The Principal Component Analysis based image fusion technique is to improve resolution of the images in which two images to be fused are firstly decomposed into sub-images with different frequency and then the information fusion is performed and finally these sub-images are reconstructed into a result image with plentiful information. [21]. The PCA image fusion method simply uses the pixel values of all source images at each pixel location, adds a weight factor to each pixel value, and takes an average of the weighted pixel values to produce the result for the fused image at the same pixel location. The PCA technique is useful for image encoding, image data compression, image enhancement, and pattern recognition and image fusion. It is a statistical technique that transforms a multivariate data set of inter-correlated variable into a data set of new uncorrelated linear combinations of the original variables. It generates a new set of axes which is orthogonal. By using this method, the redundancy of the image data can be decreased.[5]

d) Domain Knowledge based method: - In medical imaging, there are several instances where the medical practitioner’s knowledge can be used in designing segmentation, labeling and registration of the images. The knowledge based systems can used in combination with other methods such as pixel intensity. [4] These approaches place a significant amount of trust in the medical expert in labeling and identifying the domain knowledge relevant to

the fusion task.

e) Fuzzy based image Fusion :- Harpreet Singh. Jyoti Raj. Gulsheen Kaur [10] provide algorithm for gray image fusion based on Fuzzy and Neuro-Fuzzy.

III. METHODOLOGY

The implemented model for image fusion is shown in figure 1.

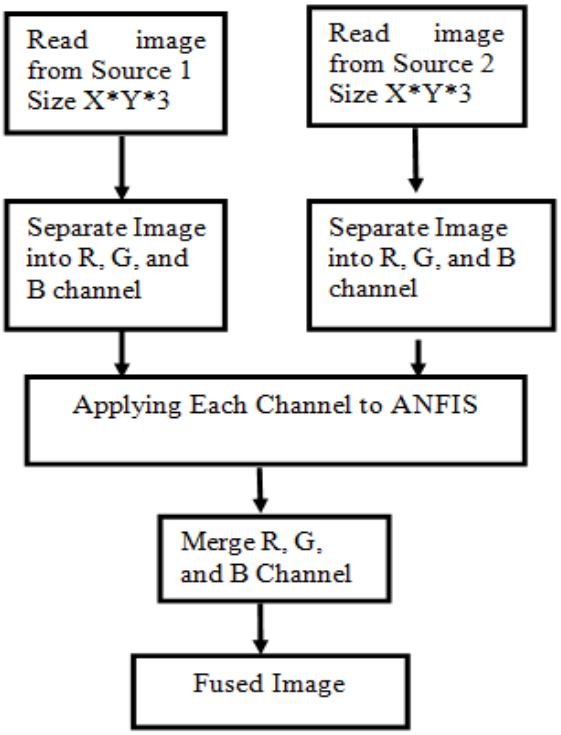

Figure 1 Image Fusion using Adaptive Neuro Fuzzy

Here first read 2input image: Image1 and Image2 . Second separate each input image into R(Red), G(Green) and B(Blue) channel. In simple Image1 separate into (R1,G1 and B1) and Image2 separate into (R2,G2 and B2).Convert each channel in column vector. Then merge R1 vector with R2 vector , G1vector with G2 vector , B1vector and B2 vector. And applying to FIS (Fuzzy Inference System) and got three separate vector corresponding to R ,G and B channel. Finally merge all three resultant channel to form final fused image. For fusion of CT and MRI image no need to separate image into color channel.

ANFIS structure: Anfis structure shown in figure 2 consist of two input and one output and number of member function is five.

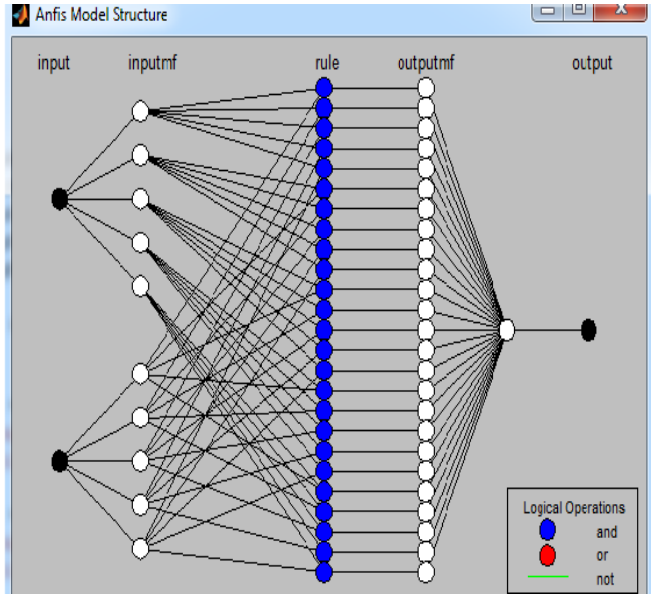

Figure 2. ANFIS structure

ANFIS rules : Here total 25 rules are generated . rule editor shown in figure 3

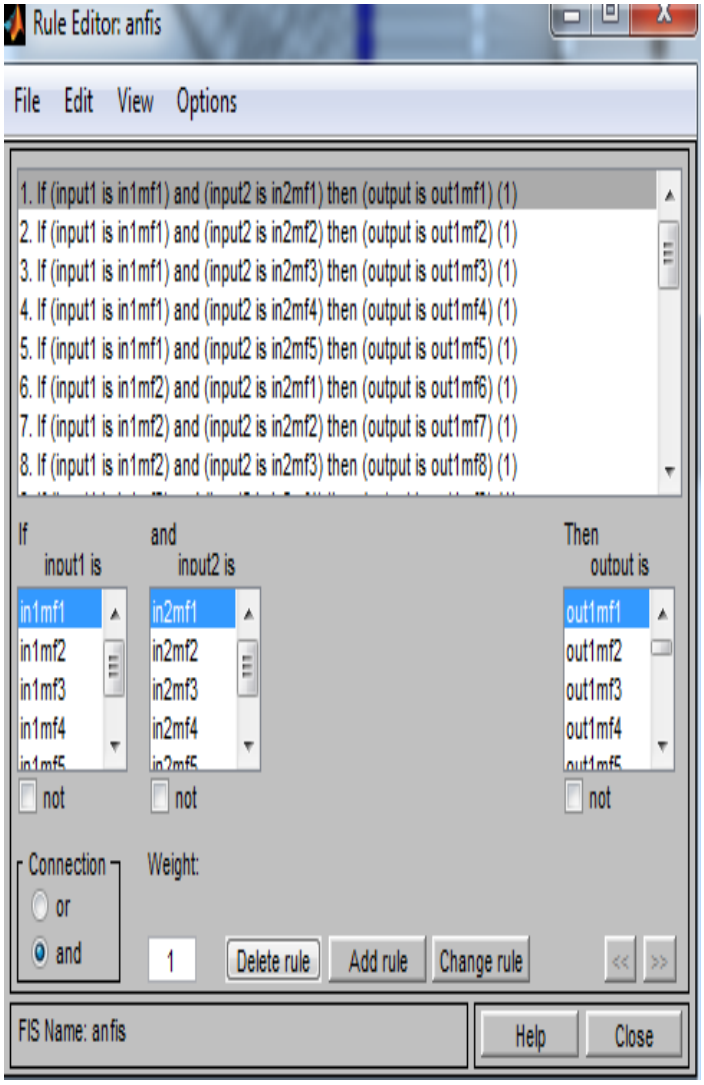

Figure 3: Anfis rule editor

IV. SIMULATION RESULT

Matlab used to implement this model. Figure 4 show color image fusion and figure 5 show CT and MRI image fusion.

Figure 4 Color image fusion

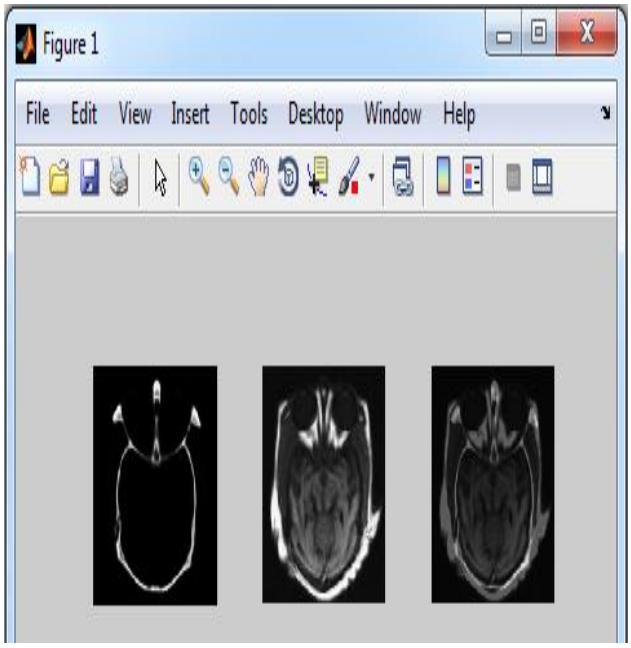

Figure 5 CT and MRI image fusion

Quality of fused image measured in term of image texture features (entropy and mean). Test medical images have collected from Internet [10] .

Table 1. Mean and Entropy values of Medical image and color images

Experiment set	Images	Mean	Entropy
Pair 1	med_img1	9.9346	1.9247
	med_img2	54.2295	6.6325
	Fused_image(fused_med_img.jpg)	56.2677	6.6424
	PCA	51.7376	4.1160
	ANFIS	31.0090	5.9541
Pair 2	p27a	57.4428	5.9577
	P27b	90.4375	7.4750
	Fused_image	99.6184	7.0998
	PCA (pca_fused_p27.jpg)	73.7856	5.3044
	ANFIS(AN_fused_p30.jpg)	72.3977	7.2537

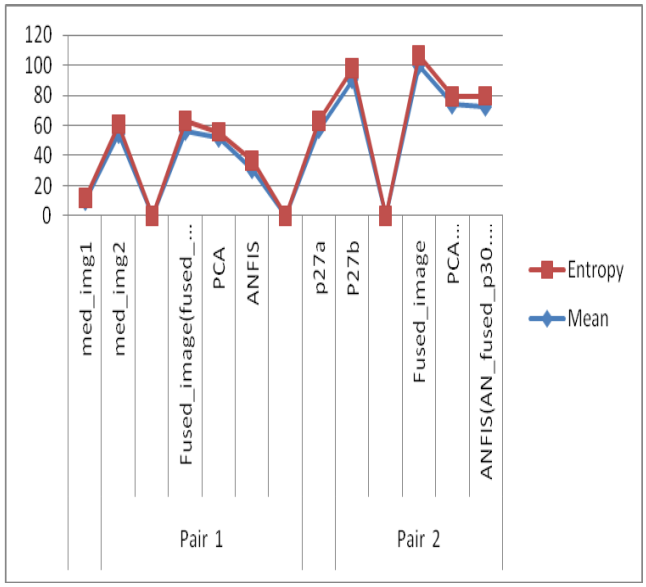

Figure 6. Performace measurement of PCA and ANFIS in Medical image and color image

V. CONCLUSION

In this paper, hybrid optimization based ANFIS was successfully used to fuse the medical images CT and MRI. Model also work on color image. Visual perspective and

image texture features of resultant fused images were satisfactory.

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