A Hybrid Fuzzy Pixel Approach for Image Fusion and Enhancement of Medical Image

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Abstract – Image fusion is the process of combining the features of two or more partially visible or damaged images to generate a new effective image. The proposed algorithm is about to improve the quality of CT image by using the concept of image fusion. In this work, an effective image analysis is done using multiple parameters. The parameters that will be considered in this work entropy analysis, MSE, PSNR, Fusion Time. . The proposed algorithm Begins with fusion of images using pixel level approach. These images will be analyzed using multiple parameters defined above. To perform the effective pixel area selection, the fuzzy logic will be applied. In this work, a two stepwise work will take place. The first step includes image fusion using pixel level method and second one includes enhancement of image using parametric fuzzy logic approach. The presented work is defined on the basis of multiple parameters to get more effective results from the defined approach. The work will be implemented using MATLAB environment. The obtained results shows the effective fused image formation. The analysis of work is done under different parameters to improve the visibility of generated image.

Index Terms – Image fusion, Computed Tomography, RMSE, PSNR, Pixel, Fuzzy approach.

1. INTRODUCTION

In today's modern Era image processing is one of the widely used concept almost in every field such as Engineering, Medical and scientific etc. Image processing is the processing of image using mathematical operations by using any form of signal processing for which input is an image, the output of image processing may be either an image or the parameters related to image. The visual information system is one of the basic need to represent the information in image form. This visual information is required to gain the information for decision making. The similarity analysis over the visual information is performed to extract the image feature. But the images are having the problems related to its visibility. The images sometimes are not fully visible because of problems like bad light, hardware problems etc. which are to be improved to gain qualitative information.

This paper deals with pixel level image fusion. An image called fused image is generated two medical images in this paper and membership functions are used for fusion in best manner.

1.1. Digital Image Processing

Computer algorithms to perform Image processing on digital images. The Digital image is a numeric representation of a two-dimensional image. Digital image processing has many advantages over analog image processing. It allows much wider range of algorithms to be applied to inputs data and can avoid problems such as the build-up of noise and signal distortion during processing. It includes image processing in various steps like Image Acquisition Image Enhancement, Color image processing, Image restoration, Compression, segmentation, Representation description, object recognition and the knowledge base.

1.2. Image Fusion

It is basically the process of combining the features of more than two images to generate the new image containing combined features of the input images to get output image. There are different types of image fusion. Image fusion is the term is used when multiple images are merged to get additional information. These images are in different formats. In medical field, images are of many types such as MRI, CT etc .These images are taken from hardware devices and sometimes suffers from problems like less visibility due to camera, light, focusing problems etc. so it became necessary to enhance these images to get useful information lacked due to visibility problems. Enhancement of image can be done using different approaches.

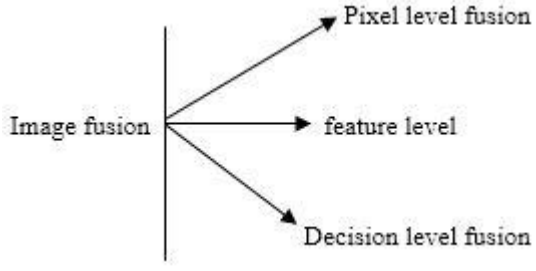

Fig 1. Types of image fusion

Signal level image fusion, also known as pixel-level image fusion, represents fusion at the lowest level, where a number of

raw input image signals are combined to produce a single fused image signal. Object level image fusion, also called feature level image fusion, fuses feature and object labels and property descriptor information that have already been extracted from individual input images. Finally, the highest level, decision or symbol level image fusion represents fusion of probabilistic decision information obtained by local decision makers operating on the results of feature level processing on image data produced from individual sensors. The goal of pixel-level image fusion can broadly be defined as: to represent the visual information present in any number of input images, in a single fused image without the introduction of distortion or loss of information. Another important consideration in pixel-level fusion is the number of input images and the colour characteristics of the input and output images. In this method the enhancement of image is done by pixel contribution for each input image for fusion. This paper also deals with the pixel level method and enhancement of image is done with the fuzzy functions use.

1.3. Image Enhancement

Image Enhancement is basically the further processing of images in terms of contrast; visibility etc to improve the image quality .It is widely used in image processing. The different images of the same form are enhanced using fuzzy based technique and different methods are used to enhance fused image. . The reduction of noise over the image, blurring and the contrast improvement actually improves the image quality and provides the improvement in image under the intensity values. Enhancement of image is done using fuzzy functions known as membership functions. Fuzzy logic is widely used for this process. FL is problem-solving control system methodology that leads itself to implementation in the system ranging from simple, small, embedded micro-controllers to large, networked, multi-channel PC or workstation-based data acquisition and control systems. It can be implemented in hardware, software, or a combination of both.

2. RELATED WORK

In this section the overview of existing work and entry points to the literature is discussed.

Arjun Nelikanti in 2014[Ref. 4], performed a work on image fusion. And the paper provides a combination of two concepts, image fusion by DWT and digital image processing techniques. The enhanced image is validated using two parameters and this paper is implemented in MATLAB. The parameters used are histogram representation and the peak signal-to noise Ratio.

In this paper a method is proposed for image enhancement by fusion of two images. By taking CT and MRI images of brain and decomposed the images into single level separately and then fused them before applying inverse DWT. Now we get a single image. Image enhancement algorithms offer a wide variety of approaches for modifying images to achieve visually acceptable images. The choice of such techniques is a function of the specific task, image content, observer characteristics, and viewing conditions. In this paper a set of image processing techniques are used for image enhancement. The validations are also done by calculating histogram, PSNR and entropy values

Ch.Bhanusree[Ref. 8], in 2013 performed a work. In medical diagnosis, Computed Tomography (CT) provides the best information on denser tissue with less distortion. Magnetic Resonance Image (MRI) provides better information on soft tissue with more distortion..This paper analyzes the characteristics of the Second Generation Wavelet Transform and put forward an image fusion algorithm based on Wavelet Transform and the Second Generation Curve let Transform. We looked at the selection principles about low and high frequency coefficients according to different frequency domain after wavelet. In choosing the low-frequency coefficients, the concept of local area variance was chosen to measuring criteria. In choosing the high frequency coefficients, the window property and local characteristics of pixels were analyzed. Finally, the proposed algorithm in this article was applied to experiments of multi-focus image fusion and complementary image fusion. In this paper, a hardware implementation of a real-time fusion system is proposed. The system is based on an Xilinx Spartan 3EDK FPGA and implements a configurable linear pixel level algorithm which is able to result in colour fused images using System C language

Sonali Mane [Ref.10] , in 2014performed work for image fusion. For medical imaging, the decomposed coefficient of DWT is applied with the PCA to get fused information. Choose decomposed coefficients by fusion rule and using inverse DWT to get the fused image of two modalities CT (computed Tomography) and MRI (Magnetic Resonance Imaging). The PSNR analysis shows better improvement on results. For the proposed fusion enhancement technique to implement on the processor based kit. The fusion of CT and MRI of two modality images improves the view of the images and adds information of both in one image, the fused image

Shivdeep kaur [Ref. 7]in 2014 performed a work and a survey on the different image fusion techniques is presented. Image fusion is a method to combine the related information from a set of images into a single image where the resultant fused image will be having more information in image. The algorithm introduces an efficient approach for fusion of multi-focus images based on variance evaluated in discrete cosine transform domain. In the paper, he has proposed another method which will integrate the PCA, Max-DCT and dynamic histogram equalization to improve the outcome further. The implementation of the proposed algorithm is done in MATLAB using image processing toolbox. From the experimental results, it is proved that the proposed algorithm outperforms over the accessible methods.

Sudeb Das,Malyakumarkundu [Ref.5] ,performed a work and in the paper the novel approach to the multi sensor, multimodal medical image fusion (MIF) problem, employing multi scale geometric analysis of non-sub sampled contour let transform and fuzzy-adaptive reduced pulse-coupled neural network(RPCNN). The linking strengths of the RPCNNs' neurons are adaptively set by modelling them as the fuzzy membership values, representing their significance in the corresponding source image. Use of RPCNN with less complex structure and having less number of parameters, leads to computational efficiency, an important requirement of point-of-care (POC) health care technologies. The proposed scheme is free from the common shortcomings of the state-of-the-art MIF techniques: contrast reduction, loss of image fine details and unwanted image degradations etc. Subjective and objective evaluations show better performance of this new approach compared to existing techniques.

3. PROPOSED MODEL

In this present work, an effective work image reconstruction approach is defined using image fusion approach. The work is here applied on medical images. To perform the effective fusion, the stage wise analysis is performed over the images under multiple parameters. Once the images are extracted, the next work is to identify the effective blocks where the reconstruction is required. Once the blocks identified, the next work is to perform pixel level fusion using fuzzy approach. The fuzzy rules are suggested in this work to perform image fusion. The input images in this leads to the formation of output image.

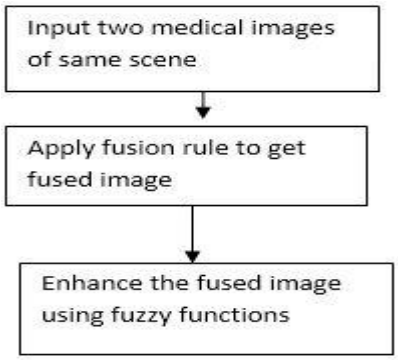

Fig . 2 Research Design

Steps of Algorithm:-

1. Inputting and reading of Background Image.
2. Inputting and reading of Foreground Image.
3. Defining of Alpha Factor i.e. 0 <= alpha factor =< 1 i.e. this factor will decide the percentage contribution of each pixel for both images. 50 % pixel contribution of each Pixel has been decided in this algorithm.
4. Comparison of size of both images.
5. Comparison of size of both images for proper fusion.
6. Fusion of both images using pixel level fusion method.
7. Multiplication of alpha factor to foreground image so as to calculate percentage.
8. Contribution of each pixel for foreground image.
9. Multiplication of negative alpha factor to foreground image so as to calculate percentage.
10. Contribution of each pixel for background image.
11. Addition of both updated image pixel matrix.
12. Pixel level mixing of images using alpha factor.
13. Reading of saved fused image.
14. Calculation of size of fused image.

Parameters used are as follows:-

PSNR

The mostly used vector for the image improvement analysis is PSNR value based analysis. It is peak signal-to noise ratio.

It is calculated using gray levels in the image and the root mean square error.

Entropy (H)

Entropy is a measure of randomness that can be used to characterize the texture of the input image.

If the Entropy value is higher the work is considered good quality image.

Root Mean Square Error

It measures the amount of change per pixel due to processing and is the RMSE value for image.

4. RESULTS AND DISCUSSIONS

Two images of the same scene are needed to implement the proposed work. Image 1 is taken as foreground image and image 2 as background image.

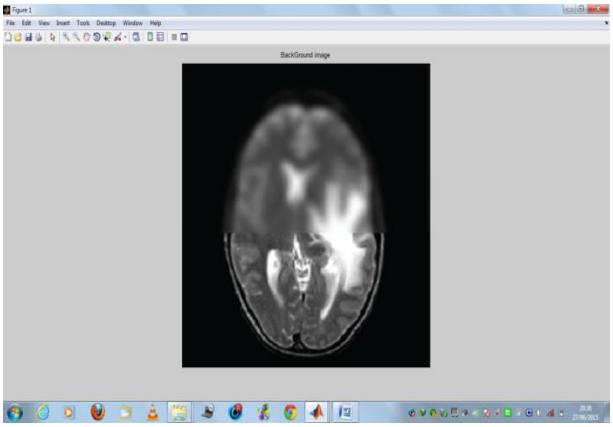

Figure 4.1 : Input Image 1

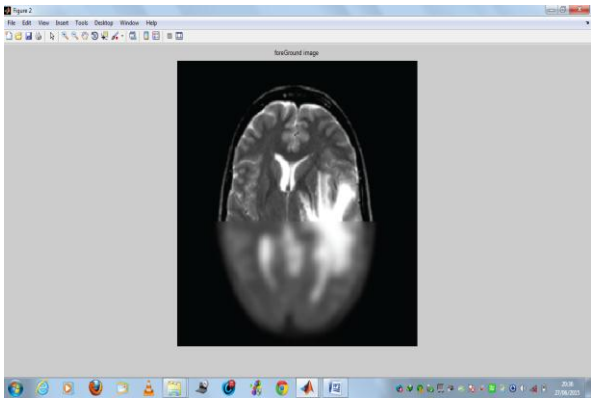

Figure 4.2 : Input Image 2

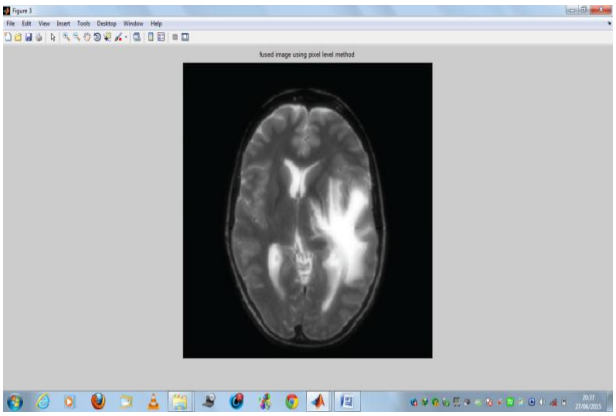

Figure 4.3: Result Image

4.1. For enhancement of fused image

For enhancement some constant is defined to form membership function Fd , Fe and (Xmax) are defined to implement proposed work. Generation of membership function using countdown fuzzy factor (Fd), exponent fuzzy factor (Fe) and maximum grayscale value of fused image (Xmax). Membership functions are then updated to form enhanced image.

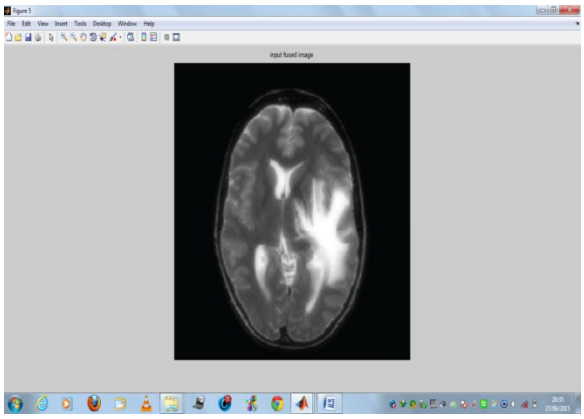

Figure 4.4 Input fused image

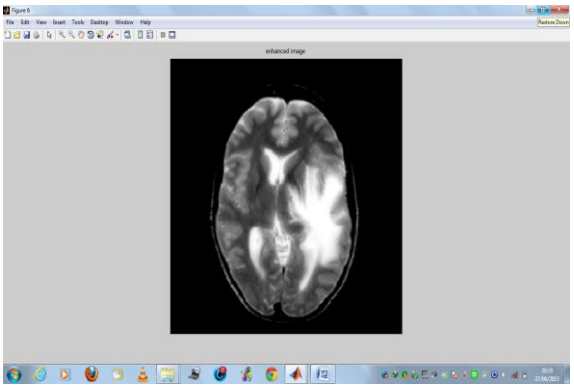

Figure 4.6: Result Image (Enhanced)

4.2. Calculations:

Entropy for foreground image	**4.9358**
Entropy for Background image	**5.0663**
Entropy for fused image	**5.2447**
Root Mean square error(RMSE)	**0.0244**
Peak signal to noise ratio(PSNR)	**69.6307**
Total time for fusion(in sec)	**0.8125**

Table 1 Calculations

5. CONCLUSION

Fuzzy pixel method is discussed to enhance medical images. Pixel contribution for image fusion leads to improvement in the quality of image to get best results in terms of enhancement. Enhancing approach for medical images is beneficial in retrieval and gathering of information from different images obtained by fusion of images. Parametric calculations leads to better result analysis for various images.

The results shows that the proposed approach has significantly improve the image. The work is presented with the help of fuzzy logic using membership functions. If the Entropy value is higher, the image is considered as good quality image this work can also be extended as further:-

1. We can also use a set of images to form a new improved Image.
2. We can use some other classification algorithm such as neural network to derive the better result.
3. As to get result more accurate other new parameters are also derived using more membership functions.

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