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Medical Image Fusion with Extended Fuzzy Switching Median Filter

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***Abstract*—The main objective of this paper is to detect and filter the impulse noises in digital images of any kind like SAR-Images, Medical-Images and natural-Images. Various standalone filters, combined filters and user defined filters are discussed in the earlier studies for impulse noise removal. In the existing system FSMF is applied for removing impulse noises. The basic functionality of the existing system used the single-threshold as well as two-threshold values of the image for fuzzy computation. Since, it is concentrating mainly on the corrupted pixels it is not possible to remove the noise completely. To overcome this problem and make accuracy in noise removal the existing system is extended and introduced** EFSMF-**[Extended Fuzzy Switching Median Filter]by including speckle noise removal after (Set Portioning Hierarchical Tree (SPHIT) division on the image. The noise removal and image correction made two times in an image. The performance evaluation of EFSMF is obtained and verified with comparing the results with the FSMF results.**

Keywords: Median Filter, Noise Removal, Image Enhancement, Fuzzy.

I. INTRODUCTION

Image processing is guiding human to take perfect decision about the human body, natural disasters, satellite reports etc. Various image processing techniques are available for different image processing methods like edge detection, cropping image, image acquisition, energy point detection, image comparison, image segmentation and so on. Before start the image processing methods, it is necessary to clean the image and enhance the image.

One of the main methods for cleaning the image is noise removal. In this study some of the literatures are reviewed for image processing methods. Krishnan Nallaperumal et al. [2] utilized multi-scale morphological method combined with watershed method for image segmentation. Watershed segmentation method generally intakes image gradient values as input parameters for segmentation. Kalpana Saini et al. [3] proposed a three step procedure for segmenting an ultrasound images such as general, clinical application based and ultra-sound image based segmentation. S.Saheb basha et al. [4] applied morphological operations with fuzzy 'c' algorithm to detect breast cancer in mammogram images automatically. Kimmi Verma et al. [5] discussed briefly about the information about MRI brain tumor detection and segmentation. M.Joseph Prakash et al. [6] enhanced the texture of the image and then segmented the image. Waseem Khan et al. [7] discussed about image retrieval by comparing the segmented objects from the database images. Mrs.Sujatha.K et al [8] proposed Fuzzy-C-Means combined with Binary operations for image clustering and segmenting. Leela G A et al [9] applied morphological techniques for segmenting MRI brain tumor. Walita narkbuakaew et al. [10] discussed about various segmentation methods for CT-liver images.

The main contribution of our work is to

- Divide the image using SPIHT
- Apply fuzzification
- Remove noise using Speckle noise removal method.

In Existing system FSMF [1] carryout a step of procedures such dividing image into 5 x 5, compute the impulse noises in each pixels by neighborhood analysis and finally apply weighted median filter for removing the noise with fuzzy logic. Dividing the image as 5 x 5 in small size image accurately is difficult in 256 x 256 sized images and large size image.

Impulsive Noise is one of the noises occurs in images is Impulsive noise affect the image at the time of image-acquisition, image-transmission and image-storage. The image containing impulse noise is represented as:

$$x_{i,j} = \begin{Bmatrix} N_{i,j}, & \text{with } p \\ Y_{i,j}, & \text{with } 1-p \end{Bmatrix} \quad (1)$$

Where Y_{ij} and N_{ij} indicates the gray level of the original image and noise substituting for the original gray scale value at pixel location (i,j) respectively.

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There are two kinds of impulse noises, one is random-valued impulse noise and the other is fixed –valued impulse noise. Salt-and-pepper is the fixed-value impulse noise and the corrupted pixels values occur in fixed a range. The value of the corrupted pixel values is available as a random value from 0 to 255. In the existing system fixed-valued impulse noise was adopted as the sample noise model to test the system. But in EFSMF both the fixed-valued, random-valued impulse noise is adopted as the noise model and tests the performance.

II.PROPOSED SYSTEM

A. MFSMF – [Modified Fuzzy Switching Median Filter Input Image

Any image can be taken as an input image such as SAR, Medical and Natural Images in .JPEG, .PNG, .GIF and .BMP format. Also the size of the image is also not limited. To provide accurate noise removal and improving the quality of the image, the entire input image is resized into 516 x 516 after read from the database. Resizing the image makes EFSMF to improve its performance on any sized and kind of images quickly and accurately.

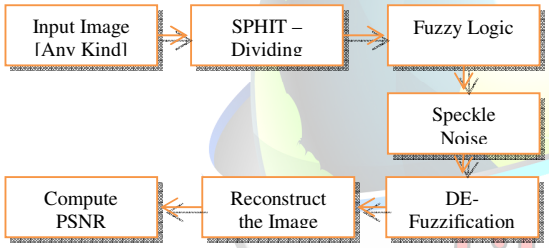

Fig.1: System Model for EFMSF

B. SPIHT

The input image is divided using SPHIT method and it divides the image from 516 x 516 into 2 x 2. SPIHT uses the basics of DCT, DWT wavelet transformations. SPHIT functions on spatial data structure with space-orientation trees which is given below. Since SPIHT has wavelet transformations it also does noise removal.

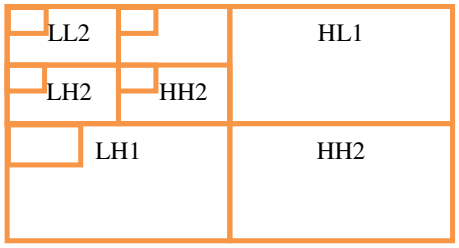

Fig.2**:** SPIHT – Image Division

SPIHT algorithms searches the list of significant bits from 2 x 2 to 516 x 516 sized image. Each time it analyzes the various thresholds on the pixels and repair the currupted pixels with the help of the nearest significant pixels' threshold value. Hence the first time the image quality is improved by correcting the currupted pixles.

C.Fuzzyfication

The input image I of 2 x 2 to 516 x 516 dimensions is taken into account for fuzzy singletons. The very first function of fuzzy logic is the entire pixels are member denoting a gray value of the image. The pixels and the gray value of the pixels are analyzed and computed from 2 x 2 sizes. The contrast values of the image are enhanced to process the input image to that the output image is more suitable than the original input image for pattern recognition. Secondly, each member will be altered as a new member by enhancing the contrast value by applying transformation on contrast values. All the contrast pixels are highlighted and grouped. Enhancing the contrast level on the fuzzy image is applied repeatedly. Once the input image is processed using intensity contrast repeatedly, it is will become more suitable for patter recognition and classification. Means the objects on the image will be separated clearly for further image processing.

D. Speckle Noise Removal

One of the main challenging tasks in medical image processing is noise reduction. Various approaches were discussed in the earlier studies for noise reduction. Commonly speckle noise is basically found in medical images. In this study multiple filtering methods are proposed for removing speckle noise from the all images. Any imaging technique is typically used as an analytical tool for present medicine. Medical image is used to do visualizing internal organs, size, structure of nerves, and injuries. In medical imaging speckle noise indicates its occurrence at the time of visualization process. Speckle noise is the negative impact on the medical images. The common model of the speckle noise can be represented as:

It is assumed that n, m varies from 2×2 to 516×516 sequentially.

$$g(n,m) = f(n,m) * u(n,m) + \xi(n,m) \qquad (2)$$

Where g(n,m) the input image observed from medical images, u(n,m) is the multiplicative and $\xi(n,m)$ is the additive component of the speckle noise. N, m denotes the both axis of the image samples. Noise can be removed by ignoring the additive component of the noise and can be written as:

$$g(n,m) = f(n,m) \times u(n,m) + \xi(n,m) - \xi(n,m) \qquad (3)$$

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$$g(n,m) = f(n,m) * u(n,m) \quad (4)$$

is the noise removed image.

Basically the enhanced, noise removed image will be applied for successful image processing tasks. The above steps fuzzy based object embossing, SPIHT based image division and pixels corrected and speckle noise removal is applied on the input image and de-Fuzzyification will be applied. After completion of noise removal the image is reconstructed after de-Fuzzyification. This approach is suitable for all kind of images with any kind of frequency. Reducing noise from the medical images, a satellite image etc. is a challenge for the researchers in digital image processing. Several approaches are there for noise reduction. Generally speckle noise is commonly found in synthetic aperture radar images, satellite images and medical images.

The above algorithm can be implemented in any computer programming language and the performance of EFSMF can be investigated.

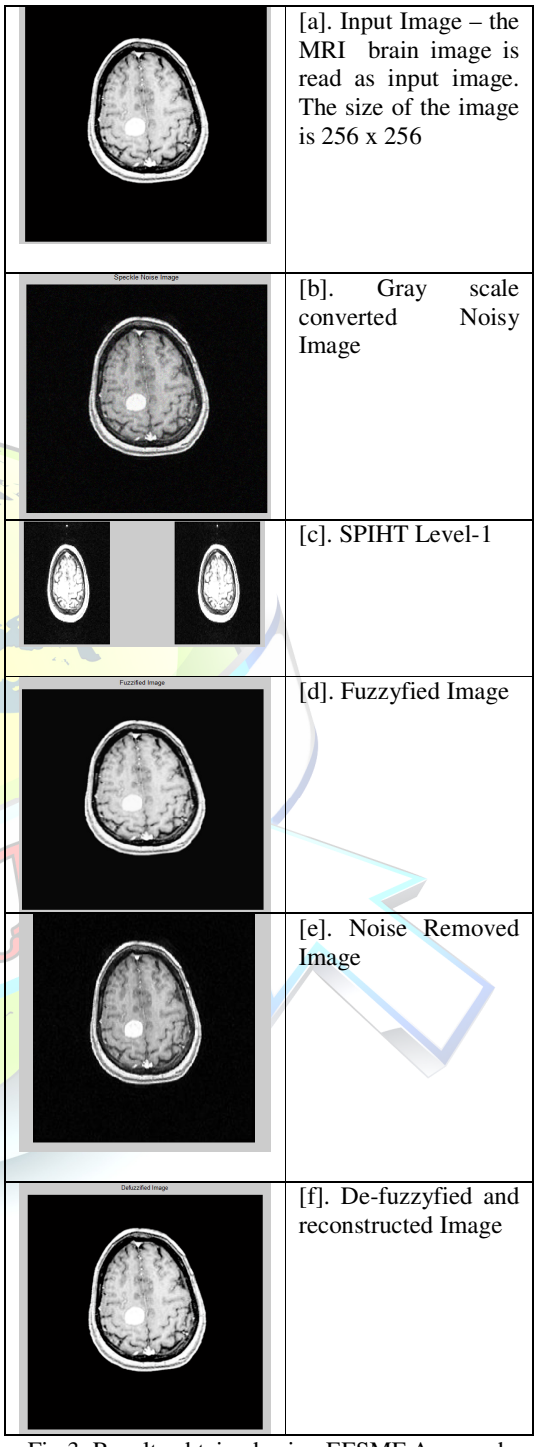
III .RESULTS AND DISCUSSIONS

EFSMF is experimented using MATLAB-2012a software with various input images. The size of the image is also varies with the different format of the image such as .jpeg, .png, .tif etc. The performance of the image is evaluated by comparing EFSMF results with the existing approach results. The performance of the proposed approach is computed using the metrics MSE, PSNR of the image.PSNR and IEF are the metrics to measure the image quality and it is represented mathematically using the following formulas as:

$$f(I1,I2) = PSNR(db) = 10 * \log_{10}\left(\frac{255^2}{\frac{1}{M*N}\sum_{m,n}[I1m,n - I2m,n]^2}\right)$$

$$IEF(I1,I2,I3) = \frac{\sum_{m,n}[I1m,n - I3m,n]^2}{\sum_{m,n}[I1m,n - I2m,n]^2}$$

Where I1, I2, I3 are original, enhanced and corrupted images respectively. The stage wise results obtained on a medical image are depicted in Fig.3. In Fig.3, [a] shows the original input image read from the database and shown in figure window. [b] shows that the image is converted into gray scale image.



[a]. Input Image – the MRI brain image is read as input image. The size of the image is 256 x 256

[b]. Gray scale converted Noisy Image

[c]. SPIHT Level-1

[d]. Fuzzyfied Image

[e]. Noise Removed Image

[f]. De-fuzzyfied and reconstructed Image

Fig.3: Results obtained using EFSMF Approach

[c]. shows that the level of SPIHT method, since it has different levels. [d]. depicts the fuzzyfied image. [e].

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depicts the real output that is noise removed image and finally [f]. depicts the de-fuzzyfied, reconstructed image.

TABLE I: COMPARISON OF PSNR (DB) AND IEF FOR BARBARA IMAGE

Performance metrics	FBDA	FSMF	EFSMF
PSNR	29.5	31.23	38.63
IEF	165.13	149.5	136.87

The obtained PSNR, IEF values among the proposed, existing methods for Barbara image is depicted in table-1 and in Fig.3. The proposed approach performs very well comparing with the existing approaches in terms of PSNR and IEF. PSNR, IEF obtained by FBDA method was 29.5, 165.13 respectively, IEF obtained by FSMF method was 31.3, 149.5 respectively whereas EFSMF is obtained PSNR, IEF are 38.63, 136.87 respectively. For single image the performance metrics are computed and given in Table-1 and in Fig.4.

From Fig.5 and Fig.6, it is clear that any type of image in terms of format, size can be processed by the EFSMF approach.

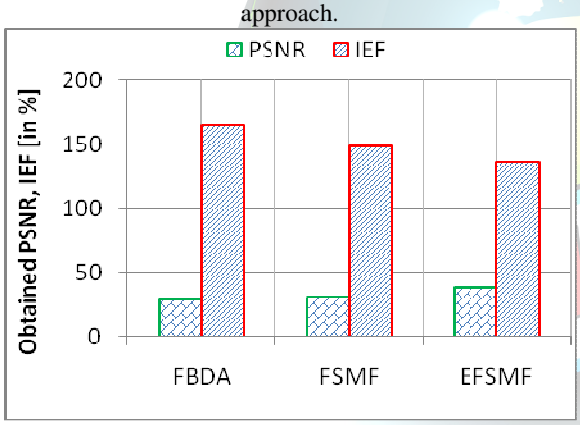

Fig.4: Comparison of PSNR (dB) and IEF for Barbara image

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The various images taken as input and each image has various level of noises. The noise level may be from 0% to 99% depends on the image sources. In this study the input images taken from MATLAB benchmark dataset and their basic noise level is only up to 30%. The PSNR, IEF computed for various images provides a better result comparing with the existing systems. The results obtained based on the system model of EFSMF [fig.-1] is given below.

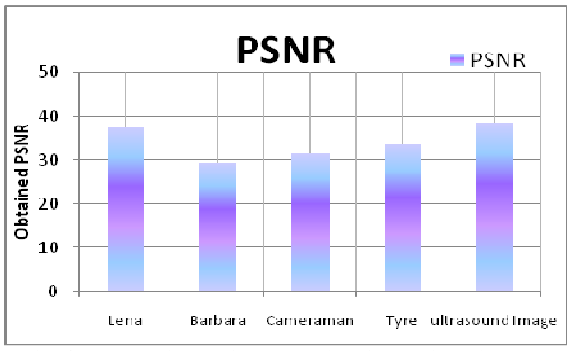

Fig.5: Comparison of PSNR (dB) for various images

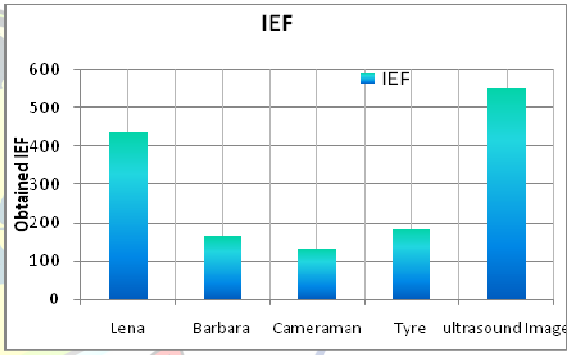

Fig.6: Comparison of IEF for various images

IV.CONCLUSION

In this paper EFSMF used fuzzy, SPIHT, Speckle noise removal algorithms sequentially for removing the noise and improving the quality of the image. All the images are corrupted in their pixels in some extend in terms of impulse noise occurrences. EFSMF removed the noise in the first phase while dividing the image through SPIHT, then speckle noise removal method. The speckle noise removal method consists of various in-built filters can remove various kinds of noises in different images of different sizes. The performance of the proposed approach is compared with the existing approaches and EFSMF proved that it is a better method than the existing methods

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