ISSN: 2278 – 1323
International Journal of Advanced Research in Computer Engineering & Technology (IJARCET)
Volume 5, Issue 4, April 2016

DETECTING AND TRACKING DIS-FORMALITIES IN MEDICAL IMAGES THROUGH WIENER FILTER BASED IMAGE ENHANCEMENT

Ms. Kanchan S. Ghute, Dr. S. S. Dhande

Abstract-
The processing on an image in order to make it more appropriate for certain applications is called as Image enhancement. It plays very important role in the field of medical image analysis, since most of the diseases are diagnosed on the basis medical images which are taken with the help of different imaging techniques like X-rays, CT scans, MRI, etc. In last few years, the quality of medical images can be enhanced by applying pre-processing method, which is first basic step in medical image processing, especially for segmentation and feature extraction. But still after applying this technique, the results are not that much accurate which are required for medical applications.

The proposed algorithm is developed to enhance the quality of medical image so that very minute details should be clearly visible for correct diagnosis and treatment of disease. This is achieved first by applying gray scale method then Histogram Equalization and at last Wiener Filter, this combination is giving very proper results i.e. minimizing the MSE with higher PSNR value. Further the algorithm successfully works in detecting the abnormalities in this medical image and later on tracking these abnormalities correctly on it.

Keywords: - Image Processing, Image Enhancement, Gray Scale, Wiener Filter, Histogram Equalization.

I. INTRODUCTION

Image Processing:

Image processing techniques have been used widely in a variety of applications to improve the quality of raw image data. As for example, in medical imaging, it has been accepted as an effective tool to help the doctors for fast checkups and further treatments. The importance of good image processing techniques in medical applications is to produce better image quality, to sharpen the details of the image and to measure the features and structures of the images [13].

Medical image processing allows the doctors to see fine details of the images that are difficult to detect or distinguish just by using naked eyes. There are several medical image modalities, for instance magnetic resonance image (MRI), x-ray images [4], computed tomography image (CT scan), position emission tomography (PET), single photon emission computed tomography (SPECT) and digital radiography.

X-ray image which is taken photographic is one of the most widely used techniques in medical diagnosis. X-ray image is a very useful modality for the physicians and doctors to determine and analyze the affected part which is an important symptom used for diagnosis [15].

Suppose for example, when there is a small bone fracture and the x-ray image quality is not good then it goes undetected. So, the medical X-ray image enhancement becomes one of the important topics in the medical image processing.

Image Enhancement:

Image enhancement is one of the important techniques in digital image processing, which plays very important role in many fields, such as medical image analysis, hyper spectral image processing, industrial X-ray image processing [4], remote sensing, high definition television (HDTV), microscopic imaging etc [7].

It is mainly utilized to enhance the clarity of the image and to improve the visual effects, or to make the original image more conducive for computer to process. Image enhancement techniques can be categorized as: frequency domain methods and spatial domain methods. Unfortunately, when it comes to human perception, there is no general theory for determining what "good" image enhancement is. If it looks good, it is good [11].

Contrast Enhancement:

The contrast enhancement is one of the commonly used image enhancement methods. Many methods for image contrast enhancement have been proposed, among those the histogram modification technique has been widely utilized because of its simplicity and explicitness in which the histogram equalization (HE) is one of the most widely used techniques [10] [11].

The fundamental principle of HE is to make the histogram of the enhanced image approximate to a uniform distribution so that the dynamic range of the image can be fully exploited.

II. LITERATURE REVIEW

i. An advanced noise reduction techniques use adaptive filters. This type of filters steers the filter strength according to a noise estimate and causes less smoothing in regions where noise is low, i.e., the X-ray intensity is less attenuated [1]. For instance, an adaptive filter for reducing noise induced streak artifacts in very strongly attenuated data.

ii. X-ray mammography is the most common technique used by radiologists in the screening and diagnosis of breast cancer. The Enhancing and Denoising of these images is required in order to have accurate results. The dyadic wavelet transform pioneered by Mallat and Zhong was precisely introduced to achieve this [2][3].

iii. Many kinds of medical image enhancement methods have been proposed. One of the extraordinary methods is partial differential equation (PDE) method which was first proposed by Perona Malik [4][5][6]. The main advantage of this method is that it can smooth the regions of image while preserving edges, which means that it can be used to enhance the images. Although this model has been used widely, in some experiments of the image enhancement with the noisy image show that some edges cannot preserve well [7][8].

iv. To overcome this drawback an improved method was proposed from Perona-Malik anisotropic diffusion to enhance the image quality of X-ray image.

v. Lina Septiana and Kang-Ping Lin had proposed a modified anisotropic diffusion method to enhance the X-ray image contrast of the original image which makes the image become more reliable and easier to be interpreted with the help of histogram equalization and weighted K-means clustering [9].

vi. In previous study [10], various methods have been proposed for the pre-processing module to enhance the quality of the image. Two common domains used in image contrast are spatial domain (SD) and frequency domain (FD). The FD utilizes Fourier transform technique while SD focuses on modifying the pixel values based on neighboring pixels with a unique frequency range [11][13].

vii. According to Mustapha et al., saturation occurred because of the negative aspect of image contrast enhancement [12]. Thus, they have proposed the GC approach and a non-linear contrast image enhancement process which are independent to neighborhood pixels and can be performed directly to each individual pixel. This approach is applied to improve the localization of the cervical vertebrae and its features [10]. Besides, HE has also been applied for x-ray image enhancement [13]. The information from the HE not only can be used in image enhancement, it can be applied to image segmentation and compression [11]. Apart from that, CLAHE is a popular image enhancement technique that modifies the grey-level value based on some characteristics to improve the contrast and minimize the noise [13].

viii. A fracture is a crack or break in the bone. This can be easily detected by taking an X-ray in that area [14]. But sometimes these images lack sufficient brightness. In order to overcome this, N. R. S. Parveen and M. M. Sathik proposed a method i.e. Contrast Limited Adaptive Histogram Equalization, to increase the brightness of such images which helps in taking accurate decisions in medical applications [13].

III. PROPOSED WORK

The main purpose of this proposed work is to enhance the quality of medical images for easy diagnosis of diseases. In order to improve the image quality the series of methods are combined and applied on an input image, thus, forming an algorithm whose data flow diagram is shown below:

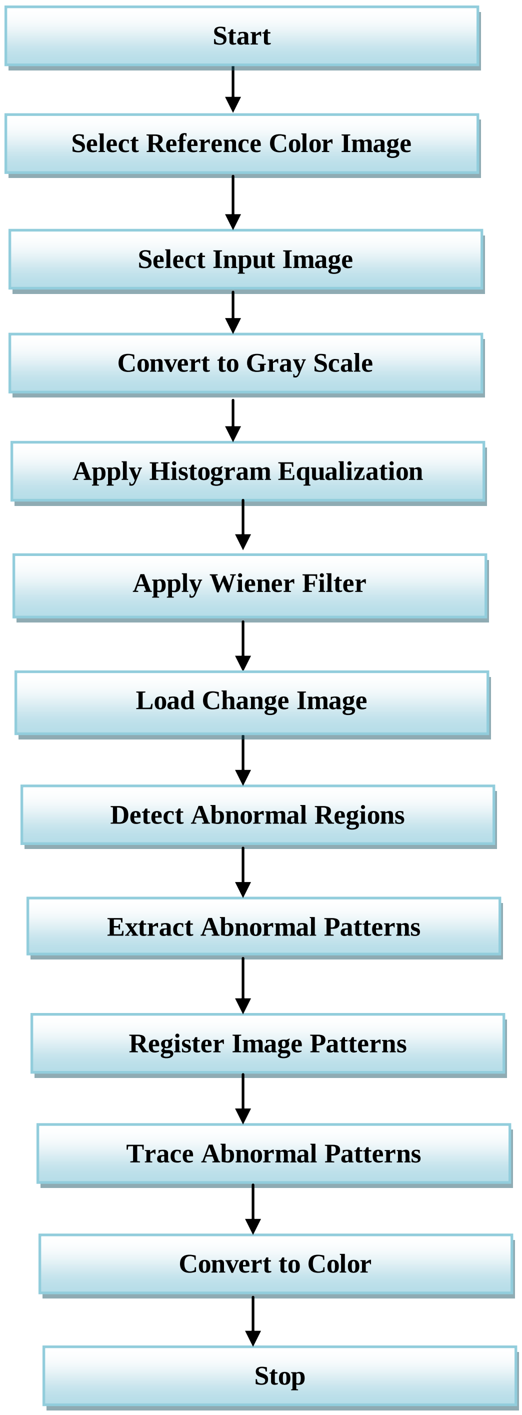

Fig (1) Flowchart of Proposed Algorithm

Algorithm:

1. Select reference color image.
2. Select medical image (X-Ray, MRI, CT-Scan) which is required to enhance.
3. Convert the input image into gray scale.
4. Then apply histogram equalization on it.
5. At last apply Wiener filter and then load change image.
6. In order to detect abnormalities in this image, first detect abnormal patterns in it.
7. Then extract abnormal regions from it and add it to the database.
8. Register these patterns in an input image and then trace these abnormal patterns.

Description

Select one color reference medical image; this will be used only for the color recovery purpose i.e. its RGB component will be preserved and then at last will be copied to our enhanced or output image. Now, select input image which may be of type X-ray, MRI or CT scan which is required to enhance using proposed method.

Then convert this image into gray scale, in this step the color of an input image is removed i.e. the average of the values of its R, G and B component is calculated and then that value is set as its pixel value thus removing color from it.

Histogram Equalization

Further in Histogram Equalization step these pixel values are observed and compared in the group of five such that if it is found that any of the value is exceeding the decided threshold value then the average of remaining values is calculated and it is set as the new value for that pixel which is below threshold. The following description shows how actually the comparison is done among the pixels in a group,

Calculate the difference between the two adjacent pixels and check whether it is greater than the decided threshold value.

$$|p_i - p_{i+1}| > th$$

If the difference is greater than the threshold value, then apply following condition,

If ($p_i > p_{i+1}$)

Then odd pixel = p_i

Else odd pixel = p_{i+1}

After finding the odd pixel from the group it is required to reset its value in order to maintain its range. The new value is calculate by taking the average of all the pixels in that group,

Average = $\sum_{i=1}^{n}(p_i + p_{i+1} + \ldots p_{i+n})$/n …… (Where n=no. of pixels in a group)

Set odd pixel = Average

After this continue above steps till then there should not be any odd pixel in that group in order to improve the quality.

Wiener Filter

But sometimes it is observed that after histogram equalization there are some noisy pixels present in it i.e. the noisy pixels are those which are either extremely white or those which are extremely white. All such pixels are identified and then adjusted such that they should match with adjacent pixels this is done with the help of wiener filter. Thus after adjusting these pixels the overall image get enhance.

Next is the abnormality detection section, in this part first of all the abnormalities in an inputted medical image is detected and then these abnormalities are extracted and added to the database.

Image Registration

After that the extracted patterns are registered into an input image, this is done such that as the detection of abnormality is already done then the work is to locate this in actual image because the extracted image consists of only abnormal region with white part all other section is shown dark.

For this purpose the pixel by pixel comparison is done between the abnormalities located image and the input image. The size of both these images is same and both are single channel images. If the pixel value in first image is found to be 255 then the same position pixel value in a second image is set to 255 otherwise there is no change in the pixel values of second image, it is shown below

If Ip(x, y) = = 255

Then

Set Op(x, y) = 255

End

Where Ip(x, y) is pixel of abnormality located image and Op(x, y) is pixel from input image

Then at last the abnormal patterns are traced with the help of some marking on an image as an output.

IV RESULT ANALYSIS

Mean Intensity (MI): This is used to count the brightness of an image; this should be maintained in a particular range so as to enhance it because extra brightness makes it invisible i.e. degrading the image quality

This is calculated using following formula

MI = $\sum_{i=1}^{n}(p_i + p_{i+1} + \ldots p_{i+n})$/n …..(Where n=no. of pixels in an image)

Mean Square Error (MSE) and Peak Signal to Noise Ratio (PSNR)

MSE is given by,

$$MSE = \frac{\sum_{i=1}^{M}\sum_{j=1}^{N}(f(i,j) - F(i,j))^2}{M*N}$$

PSNR is given by,

$$PSNR = 10 * \log_{10}\left(\frac{255*255}{MSE}\right)$$

Sr. No.	Image Name	Image Dimensions	Mean Intensity				
			Input Image	Wiener Filter	Gabor Filter	Wavelet db Filter	Gaussian Filter
1	1.jpg	213*236	0.28	0.55	0.10	508.42	327.19
2	2.jpg	337*297	0.4	0.54	0.09	700.92	616.44
3	3.jpeg	232*217	0.23	0.62	0.03	264.60	211.79
4	4.jpg	276*182	0.35	0.60	0.01	138.38	140.14
5	5.jpg	203*248	0.26	0.42	0.02	230.77	219.57

Table (1) Calculated values of image metrics like Mean Intensity

ISSN: 2278 – 1323
International Journal of Advanced Research in Computer Engineering & Technology (IJARCET)
Volume 5, Issue 4, April 2016

Sr. No.	Image Name	Image Dimensions	PSNR			
			Wiener Filter	Gabor Filter	Wavelet db Filter	Gaussian Filter
1	1.jpg	213*236	11.00	10.65	10.18	10.86
2	2.jpg	337*297	15.14	14.92	13.20	13.43
3	3.jpeg	232*217	6.20	5.91	5.92	6.14
4	4.jpg	276*182	12.51	12.45	12.22	12.52
5	5.jpg	203*248	6.70	6.40	6.47	6.69

Table (2) Calculated values of image metrics like PSNR

Sr. No.	Image Name	Image Dimensions	Time required for enhancement (in seconds)			
			Wiener Filter	Gabor Filter	Wavelet db Filter	Gaussian Filter
1	1.jpg	213*236	3.05	4.35	5.13	3.38
2	2.jpg	337*297	2.05	4.07	2.67	3.99
3	3.jpeg	232*217	2.75	5.43	3.20	3.35
4	4.jpg	276*182	3.19	4.62	3.43	5.49
5	5.jpg	203*248	2.82	7.12	3.05	3.19

Table (3) Calculated values like time required for enhancement

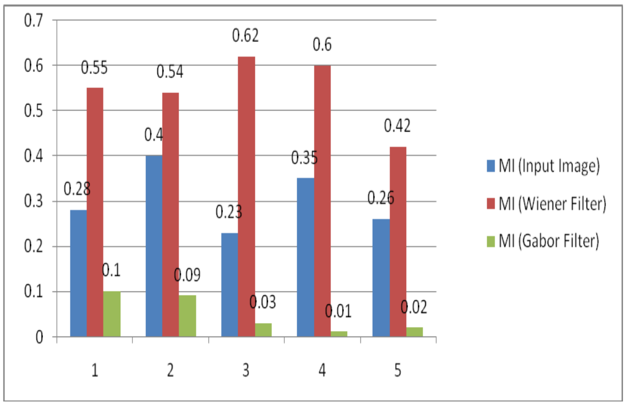

Fig (2) Graphical representation of Mean Intensity results

The above Fig (2) shows the graphical representation of Mean Intensity for input image, Wiener filtered image and the Gabor filtered image. It is observed that the MI is highest for the Wiener filter i.e. it is brighter than the other two which shows that it gets enhanced and improve its visibility. But as we observed the calculated values for wavelet db and Gaussian Filter from table (1) they are much higher than the wiener filtered values which mean the brightness is so high that most of the things in those images are not clearly visible through our naked eye.

The graphical representation of PSNR values for different methods is shown in fig (3), in that, it is observed that the PSNR is maximum for wiener filter as compared to others. And hence it can be said that the image enhanced using wiener filter is having a very good quality with maintained brightness which is required to observe the minute details in it for medical diagnosis purpose.

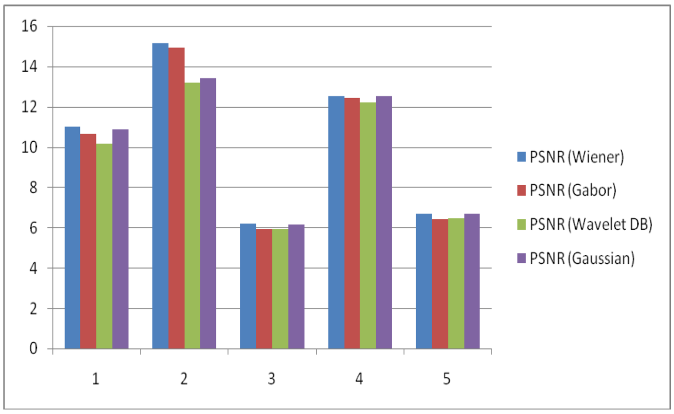

Fig (3) Graphical representation of PSNR results for various filters

The graphical representation fig (4) shows comparison between the different filters time required for enhancement.

From this it is observed that the time requirement for wiener filter is the least as compared to the other filters. This shows that the wiener filter is most time effective method among the comparison.

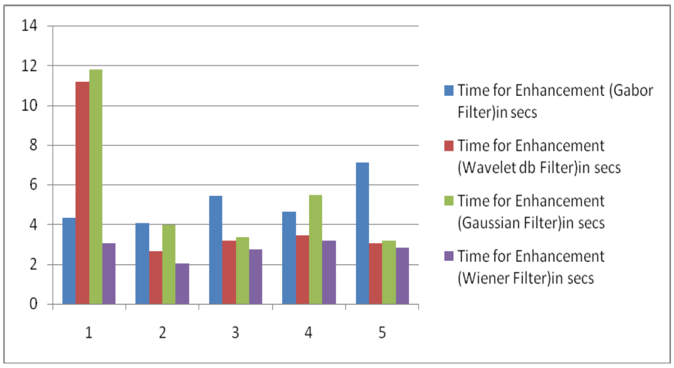

Fig (4) Graphical representation of time required for enhancement for different filters

CONCLUSION

In this study we try to enhance the quality of medical images by applying the combination of Gray Scale, Histogram Equalization and then Wiener Filter in order to improve the quality of image so that minute details should get clearly visible and performance of this method id compared with existing techniques in terms of PSNR, Mean Intensity and time required for enhancement. It has been observed that combination of this method does perform better than the existing techniques. In addition to this after enhancing the medical image we are successful in detecting and tracking the abnormalities from these medical images, which will help in easy diagnosis of diseases.

Acknowledgment

I would like to thank my guide Dr. S. S. Dhande for fulfilling my research work on Twitter. Moreover I thank for the facilities provided by Sipna College of Engineering and Technology, Amravati for providing me necessary article for completing my study on this topic.

V. REFERENCES

[1] J. Hsieh, "Adaptive streak artifact reduction in computed tomography resulting from excessive x-ray photon noise," Med. Phys., vol. 25, no.11, pp. 2139–2147, 1998.

[2] S. Mallat and S. Zhong, "Characterization of signals from multiscale edges." IEEE Trans. Pattern Anal. Mach. Intell., vol. 14, no. 7, pp. 710–732, Jul. 1992.

[3] S. Mallat, A Wavelet Tour of Signal Processing. San Diego, CA: Academic, 1998.

[4] L. F. Zhao, Q. W. Gao, D. X. Zhang, and Y.X. Lu, "Medical X-Ray Image Enhancement Based on Kramer's PDE Model," Journal of Electronic Science and Technology of Chine, vol. 5, no. 2, pp. 187–190, Jun. 2007.

[5] P. Perona and J. Malik, "Scale-space and edge detection using anisotropic diffusion." IEEE Trans. Pattern Anal. Mach. Intell., PAMI-12:629–639, 1990.

[6] P. Perona and J. Malik, "Scale space and edge detection using anisotropic diffusion," in Proc. IEEE Computer Society Workshop on Computer Vision, Miami FL, 1987, pp. 16-27.

[7] M. Nitzberg and T. Shiota, "Nonlinear image filtering with edge and corner enhancement," IEEE Trans. Pattern Anal. Machine Intell., vol. 14, no. 8, pp. 826-833, Aug. 1992.

[8] F. Catte, P. L. Lions, J. M. Morel, et al., "Image selective smoothing and edge detection by nonlinear diffusion," SIAM J. Numerical Analysis, vol. 29, no. 1, pp. 182-193, Feb. 1992.

[9] Lina Septiana and Kang-Ping Lin, "X-ray Image Enhancement using a modified Anisotropic Diffusion", IEEE International Symposium on Bioelectronics and Bioinformatics, 2014.

[10] A. Mustapha, A. Hussain, and S. A. Samad, "A new approach for noise reduction in spine radiograph images using a non-linear contrast adjustment scheme based adaptive factor," Sci. Res. Essays, vol. 6, no. 20, 2011, pp. 4246–4258.

[11] C. Chaudhary and M. K. Patil, "Review of image enhancement techniques using histogram," Int. J. Appl. Or Innov. Eng. Manag., vol. 2, no. 5,2013, pp. 343–349.

[12] Ada. and R. Kaur, "Feature extraction and principal component analysis for lung cancer detection in ct scan images," Int. J. Adv. Res. Comput. Sci. Softw. Eng., vol. 3, no. 3, 2013, pp. 187–190.

[13] N. R. S. Parveen and M. M. Sathik, "Enhancement of bone fracture images by equalization methods," in 2009

International Conference on Computer Technology and Development, 2009, vol. 2, pp. 391–394.

[14] S. K. Mahendran and S. S. Baboo, “An enhanced tibia fracture detection tool using image processing and classification fusion techniques in x-ray images,” Glob. J. Comput. Sci. Technol., vol. 11, no. 14, 2011, pp. 22–28.

[15] R. Ramani, N. S. Vanitha, and S. Valarmathy, “The pre-processing techniques for breast cancer detection in mammography images,” Int. J. Image, Graph. Signal Process., vol. 5, no. 5, 2013, pp. 47–54.

Kanchan S. Ghute perceiving Master of Engineering in Computer Science and Engineering from Sipna College of Engineering and Technology, Amravati. Completed the graduation in Information Technology (India)
(Contact No: +9403242954)

Dr. S. S. Dhande, Associate Professor, Department of Information Technology at Sipna College of Engineering and Technology, Amravati. (India)