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A Hybrid Medical Image De-Noising Approach Using Gabor, NN and MDA

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Abstract: Medicinal imaging innovation is turning into an imperative segment of expansive quantities of utilizations nowaday. Different medical images (X-ray, CT scan, MRI, ultrasound and echocardiography, etc.) have minute data about heart, nerves and cerebrums which are be more exact and free from twisting or commotion. Noise reduction has emerged as a significant area of research in recent past. Different image enhancement techniques and approaches are developed in the literature based on LDA, NN, wavelets and filtering, etc. In spite of the fact that these sorts of techniques created better results yet have a large scope in enhancing image quality through noise reduction. In this study, a hybrid approach is developed using neural Network (NN), Gabor filter and MDA for enhancing the quality of medical images. First, Gabor filter is apply on the image then neural network are used as the learning calculation which takes after the managed learning after that Gabor filter is characterized for its viability in edge-safeguarded image de-noising. Further, MDA are applied on the processed image and final results are evaluated using PSNR, MSE, mean SSIM, etc. and produces better results comparative to previous one. This approach helps in decision making for diagnosis of different critical diseases.

Key words: De-noising, medical images, NN, Gabor filter, MDA, diagnosis

INTRODUCTION

Medical images like Computerized Tomography (CT) scan, X-Radiation (X-Ray), Magnetic Resonance Imaging (MRI), Positron Emission Tomography (PET) and Single Photon Emission Computed Tomography (SPECT), ultrasound and echocardiography are widely used nowaday for identify different diseases. These technology are easily diagnose the diseases which are might be in human body. The proposed approach can be used in multimodal biometric system (Selwal and Jangra, 2017; Kaushik and Jangra, 2017; Selwal and Gupta, 2017; Kumar *et al*., 2017; Selwal and Gupta, 2016a, b; Selwal *et al*., 2016; Sangwan *et al*., 2017; Selwal and Gupta, 2015) for improving the quality of different biometric images.

Images are characterized as 2 dimensional capacity of two genuine factors. Image f(x, y) where f is plentifulness to any combine of co-ordinates (x and y) are the spatial directions known as pixels, image components and image values. In image handling the image is changed over into the advanced shape. The digitization includes testing of a images and quantization of examined qualities. After then changing over of image into bit data the handling is performed (Rani, 2013; Kaur and Verma, 2014). Images are prepared in two ways.

Spatial space: Spatial area is characterized as to upgrade the image plane itself: it depends on the immediate controls of the pixels in the image. These strategies are chipped away at the dark level mapping where mapping is utilized to upgrade the image.

Recurrence space: Till now, every one of the areas in which we have investigate the flag. Be that as it may in the recurrence area, we don't investigate motion regarding time, however with deference of recurrence. Image is handled or arranged/decayed in type of sub groups. Numerous type's changes are connected in recurrence space as DWT, DFT and so on (Fig. 1).

Noise: There are different types of noises available in the image as under.

Enhancer and Gaussian noise: Enhance voice have common standard model of intensifier commotion is Gaussian, added substance, independent at all pixel level. In shading cameras are used for intensification and amplifier commotion is the significant part of the "read clamor" of an image sensor amid securing. Gaussian commotion is the measurable clamor that has claim

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(a)

(b)

Fig. 1: Medical images; a) X-ray and b) MRI

likelihood thickness work equivalent to that the typical dispersion which is likewise called as the Gaussian dissemination.

Salt and pepper noise: A image containing salt and pepper clamor will have dim pixels in the brilliant locales and splendid pixels in dim areas. That kind of commotion can be brought about by dead pixels amid simple to advanced converter, transmission bit. That can be decreases or dispensed with in vast part by utilizing dull casing subtraction and by inserting around splendid/dim pixels. This clamor is named for the salt and pepper appearance of a image interpretation of in the wake of being corrupts by this sort of commotion.

Spot noise: That sort of clamor is granular commotion that characteristically exists in and corrupts the nature of the dynamic radar and SAR (Synthetic gap Radar) images. Spot commotion is the routine radar comes about because of irregular vacillations consequently motion from a question that is no greater than a solitary image handling component. It is expands the mean dim level of neighborhood. Dot commotion is brought about by signs from the gravity-slender swells, underneath, image of the ocean waves, basic scatters and shows as a platform image.

De-noising: The aim of image de-noising is remove noise from an image without destroying object boundaries. There are mainly two noise models: additive Gaussian noise and impulsive noise which can represent the most of noises captured (Jangra *et al*., 2015, 2016). As mobile phone camera is widely applied in actual life because of its convenience, people's requirement of it is becoming higher and higher. Image de-noising algorithm has always been a hotspot in the field of image processing. To improve the quality of mobile image, the edge of the image shouldn't be blurred while de-noising (Jangra *et al*., 2015).

Literature review: Different research studies identified with restorative image de-noising are considered and examined in this segment. Restorative image de-noising are generally utilized as a part of today era's. These innovation are effortlessly analyze the ailments which are may be in human body. Taking after are the past study which is speaks to the distinctive strategies for therapeutic image de-noising. By Dubey *et al*. (2012), a hybrid based method on multi-scale wavelet edge detection was used for achieving a better de-noising quality. PSNR was set to achieve the target and visual quality. By Riji *et al*. (2015), an iterative respective channel for separating the Rician commotion in MR images based approach is developed. This channel the de-noising proficiency and jam the edge highlight and fine structures in the images. It likewise evacuates the inclination because of rician commotion. In this study, PSNR and mean auxiliary comparability record network used to upgrade and better nature of MR images. By Dubey *et al*. (2012), researcher proposed "A crossover technique for image de-noising in light of wavelet thresholding and RBF arrange" in which a half and half construct strategy with respect to multi scale wavelet edge discovery was utilized for accomplishing a superior de-noising quality and PSNR set to accomplish the objective and visual quality. Here, by Bhadouria *et al*. (2014) another approach for high thickness soaked motivation commotion evacuation utilizing choice based coupled window middle channel has been proposed for expulsion the defiled pixels in the image. Further, DWT (Leavline *et al*., 2011), LDA (Rai and Sontakke, 2011) and Fuzzy logic (Oshiro and Nishimura, 2009), NN (Kumar *et al*., 2017) based de-noising techniques are developed. This calculation has been observed to have the capacity to expel the salt and pepper commotion. The calculation discovered better PSNR, image enhancement,

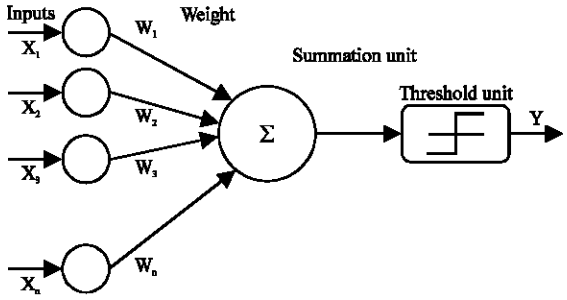

Fig. 2: Neural network architecture

SSIM. In study, Vishwa and Sharma (2012) researchers proposed a new technique which is based on wavelet thresholding and adaptive filters. In this study various synthetic images were taken like MRI, CT, ultrasound-ray and shows better results in terms of PSNR and MSE.

In this study, a hybrid de-noising model is generated through the process of hybridization and the accuracy of its functioning and performance is tested on different types of medical images. Comparison of the results is drawn along with other methods using different parameters. It has been observed that proposed approach is the best amongst in terms of PSNR and MSE.

Neural network, Gabor and MDA

Neural network: An Artificial Neural Network (ANN) is a mathematical model whose functioning is similar to biological neural networks. A number of artificial neurons are linked together to form the network. The main idea behind the neural network is the transformation of the inputs into significant outputs. ANN structure signifies the input-output mapping. The basic model of ANN model has been presented in Fig. 2.

Figure 2 shows $\{x_1, x_2, ..., x_n\}$ inputs. The strength with these inputs gets fired to summation units is referred as the weights. In this study $\{w_1, w_2, \ldots, w_n\}$ presents the weights sets. The weights and inputs are multiplied and sent to summation unit. From here their sum is further sent to threshold unit which carries threshold value say. Here, their corresponding difference is calculated through threshold function (sigmoid function, piecewise linear function, etc.). If the strength input sum is greater than threshold value then output Y will be 1 otherwise output will be 0.

Gabor filter: Dennis Gabor is the father of Gabor filter which is widely used to filter or de-noising the 2D images (CT images). Due to the optimal spatial and frequency domain characteristics and localization Gabor filter are highly suitable for computer vision and image processing, specifically for texture analysis. This has linear filter

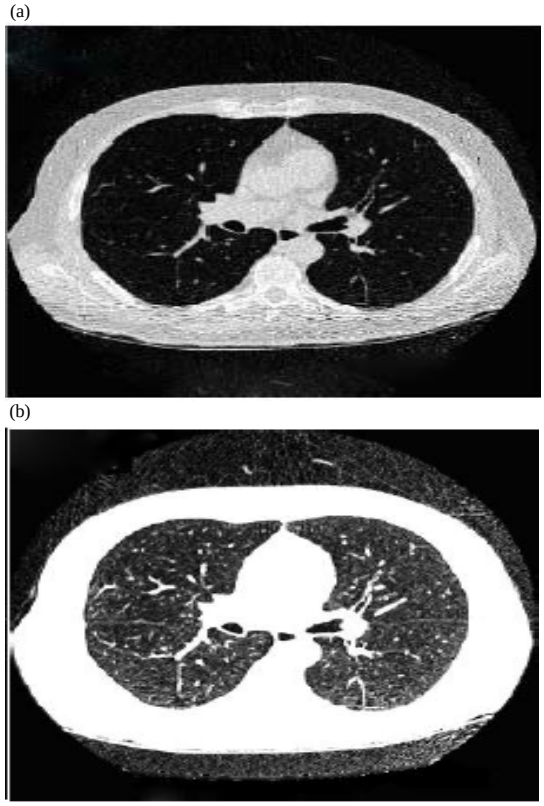

Fig. 3: a) Original image and b) Image after using Gabor filter

whose impulse output is well defined through multiplying Gaussian function with harmonic function (Yang *et al*., 2003) and further Fourier transform are applied. Figure shows the enhancement of image after applying Gabor filter (Fig. 3).

Two-sided separating is a method to smooth images while protecting edges. The utilization of two-sided separating has become quickly and is presently it is utilized as a part of image preparing applications, for example, image de-noising, image improvement and so on. A few characteristics of respective channel are enrolled beneath which clarifies its prosperity:

- It is easy to detail it. Every pixel is supplanted by a weighted normal of its neighbors
- It depends just on two parameters that show the size and complexity of the components to protect
- It is a non-iterative technique. This makes the parameters simple to set since their impact is not total more than a few cycles

Multi-linear Discriminant Analysis (MDA): MDA is an outstanding plan for feature extraction and measurement

decrease. It has been utilized numerous a greater amount of utilizations including high-dimensional information, for example, confront acknowledgment and image retrieval. Multi-linear Discriminant Analysis (MDA) is a systems utilized for information characterization and dimensionality decrease. This can be used for facial biometric system to recognize a person automatically. It reduces the number of feature points before cataloguing and produces a templet (Jangra *et al*., 2015). Further, MDA can be used in medical science for analysing and identifying different diseases. It first makes the groups of patients as per the disease and conduct the test for each group. At last results are analyzed and studied based upon different parameter in order to reveal the dieses.

MATERIALS AND METHODS

Proposed approach: In this proposition, another technique is proposed for better nature of medical image. The proposed research depends on Gabor channel, MDA and neural network method and developed using MATLAB R2012a. There are many phases are as following (Fig. 4):

Stage 1: The info image is stacking from the database of the MATLAB. This is accomplished for getting the info image pixel esteem in the workspace of the MATLAB.

Stage 2: After getting noised image, the two-sided channel is applied to diminish the rician commotion. The two-sided channel is characterized for its viability in edge-safeguarded image de-noising. Neural system is utilized to lessen the MSE and increment the estimation of PSNR or mean SSIM.

Stage 3: MDA is Multi-linear Discriminant Analysis is notable plan for highlight extraction and measurement diminishment. This is utilized to analyze the outcomes amongst proposed and past research.

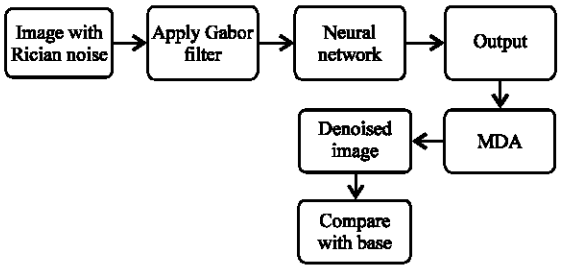

Fig. 4: Flow chart of proposed hybrid approach

RESULTS AND DISCUSSION

In this stage, display results are better and significant of the tests to verify the achievements of the proposed demonstrate on the behalf of PSNR, MSE and SSIN with the comparison of previous research (Fig. 5) (Riji *et al*., 2015).

PSNR: The accompanying figure demonstrates the PSNR by Riji *et al*. (2015) and proposed research. This is utilized to lessen the commotion and increment the nature of image (Fig. 6):

$$PSNR = 10\log_{10}\left(\frac{R^2}{MSE}\right)$$

where, R is the mean square error in the input image data type.

MSE: The MSE represents the cumulative squared error between the reconstructed and the original image. The working of MSE is lower the value of MSE, the lower the error:

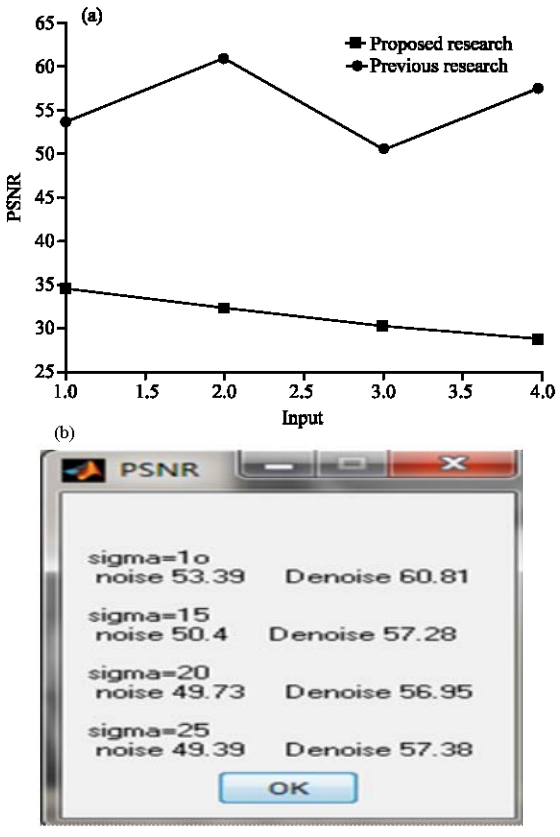

Fig. 5: a) PSNR comparison between proposed and b) PSNR value noise and denoise of proposed approach (Riji *et al*., 2015)

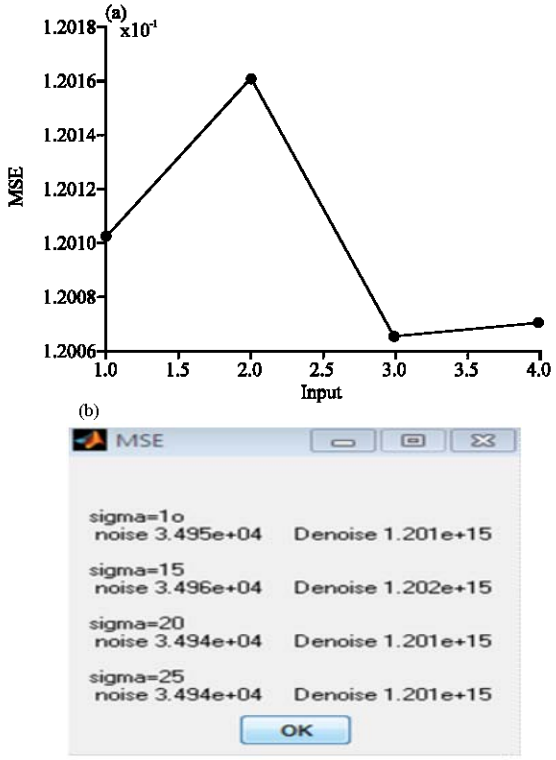

Fig. 6: a, b) MSE of proposed work

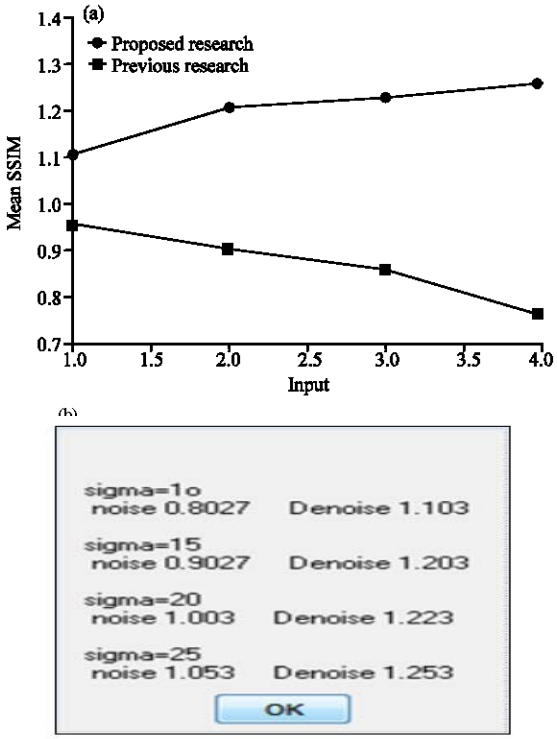

Fig. 7: a) Comparison of mean SSIM and b) Values of mean SSIM

$$MSE = \frac{\sum_{M,N}\left[I_1(m, n)-I_2(m, n)\right]^2}{M\times N}$$

where, M and N are the number of rows and columns in the input images, respectively.

Mean SSIM: The Structural Similarity (SSIM) Index is a method for measuring the similarity between two images. The structural similarity image quality method is based on the acquired that the image is an highly adapted for extracting structural information from the image and after then, measure of structural similarity can provide a good approximation to perceived image quality (Fig. 7).

CONCLUSION

Different types of medical images like X-ray, CT scan, MRI, ultrasound and echocardiography, etc. have proved boon for the medical fraternity as they help in diagnosing the disorders in the living body. This process of diagnosis has transformed the functioning of the medical fraternity and has brought accuracy in terms of identifying various diseases. In this proposed research, the hybrid medical image de-noising approach has been developed in order to enhance the quality and clarity of the image. After applying the proposed approach on medical images results are evaluated using PSNR, MSE and mean SSIM and produces better results comparative to previous one. The proposed hybrid approach helps in the reduction of the noises and enhancing the quality of medical images for diagnosis of different diseases.

RECOMMENDATION

Further it also used broadly where quality of images is matters for human identifications like biometric, etc. The system is developed using MATLAB R2012a.

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