Improvement in NLM Filtering to De-noise MRI Images

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Abstract - The process in which data required for the generation of images is sampled in the spatial frequency domain in direct manner is known as Magnetic resonance imaging (MRI). In order to sample the 3D spatial frequency volume, several models are used. One of these paradigms has become the route of various 3D radial spokes which is analogous to a kooshball. The NLM is the efficient approach which is applied to denoise MRI images. To improve efficiency of NLM filter, the PNLM filter is designed in this research work. The PNLM filter is further improved in this work using GLCM algorithm. The NLM, PNLM and proposed methods are implemented in MATLAB. It is analyzed that proposed method performs well in terms of PSNR, MSE and other parameters are compared to NLM , PNLM

Keywords - NLM, PNLM, GLCM,PSNR, MSE

I. INTRODUCTION

The process which is used for image enhancement or for the extraction of some important features by executing some operations on it is known as image processing. The image processing is a kind of signal dispensation. In this approach, pictures or video frames are applied as input. The output may be in the form of picture or some features related to that picture. The image processing is of two types i.e. analog image processing and digital image processing. When digital images are manipulated by means of computers, then this process is called digital image processing. In image processing, three fundamental processes are performed such as Pre-processing, enhancement and information extraction. In order to capture images from several sources, some fundamental tools such as Cameras, video cards, and scanners are used. The process in which data required for the generation of images is sampled in the spatial frequency domain in direct manner is known as Magnetic resonance imaging (MRI). In order to sample the 3D spatial frequency volume, several models are used. One of these paradigms has become the route of various 3D radial spokes which is analogous to a kooshball. The main advantage of this phenomenon is the presence of important undersampling. This undersampling can be executed devoid of aliasing artifacts in comparison with the minimal sampling density recommended by the Shannon-Nyquist sampling theorem. As compared to all the other earlier medical modalities, the MRI approach has proved most effectual and the minimal risky for patients. Mainly the soft tissues of brain and muscles can be sighted in accurate manner using MRI. With the help of MRI, a number of unusual states such as cancer, internal damages, sarcoma etc. can be diagnosed through scanning. It is considered as non-invasive approach as it does not need ionizing radiation. The MRI technique provides excellent contrast between the usual and unhealthy tissues.The nonexistence of ionizing radiation in MRI scans is one of the main reasons due to which the patients and children choose them. In MRI, high contrast of soft tissue remains available in the brain and some kind of deformities might occur because of the high sensitivity of this area. In the imaging plane, the MRI scanning is performed without causing any physical damage to the patient during the procedure. Moreover, the possibility of the occurrence of a lethal allergic reaction is less in MRI in comparison with other techniques. The images obtained as output from a MRI scan help in assessing the configuration of masked objects from the bone.

Image denoising can be described as a procedure which is used for the removal of noise from a picture. The noise corrupts all the features of a picture during the acquisition procedure or transmission. The image denoising process maintains the quality of a picture. This procedure is the sub branch of digital image processing. In the medical field, timely recognition of disease is necessary. The medical images can be analyzed using most common tool called MRI. The random noise affects the quality of images during image acquisition step. This results in unwanted outcomes and bad optical quality of a picture which lowers the visibility of low contrast objects. The extraction of concealed details, image data and recovery of fine details is essential for the removal of noise in the applications of medical imaging. These noise corrupted MR images influence the medical diagnosis procedure. In general, various techniques are used for eliminating noise from an image and this is major area for the researchers as well. In the denoised MR images, different used tools are proposed earlier. Though, the noise suppression process should not affect the quality of an image. This process should not deteriorate the useful features of an image as well [15]. In the MR images, the boundaries are very important;

therefore the preservation of boundaries is necessary for balancing the denoising process.

Acquisition based and post acquisition based noise reduction techniques are the two classes of the Denoising techniques in MRI. During the image acquisition process, an increase in acquisition time or lessening in the spatial resolution can be seen which in turn improves the SNR. Patient comfort and system throughput are the factors which limits acquisition time. On the attained MRI information there is logical limitation on the SNR in the acquisition based technique. As a result, post acquisition image denoising technique is considered a cost-effective and competent technique. Lessening of noise strength is the major purpose of post processing MRI denoising algorithm. This algorithm maintains the authenticity of features within MR images. Filtering, transform domain and statistical approach are three classes of the post acquisition MRI denoising techniques. Filtering and transform are the two types of MRI denoising process.

II. LITERATURE SURVEY

Paul Bao, et.al (2003) stated that an extensive development was seen in the edge-preserving denoising technique in the field of medical image processing. For minimizing the effect of noise in the magnetic resonance images, a wavelet-based multi-scale products thresholding scheme was proposed in this study. In this study, a canny edge detector-like dyadic wavelet transform was implemented. Degradation in noise was seen along with the important features of image developing with high magnitude across wavelet scales. While following the process of weakening noise, the adjacent wavelet sub-bands were multiplied to improve boundary structures, in order to generate the wavelet inter-scale dependence [21]. The noise from the edges could be removed in effective manner in case of multi-scale products. So, this study, the adaptive threshold was computed to implement it on products instead on the wavelet coefficients for the recognition of indispensable features. Several tests were performed and demonstrated the efficiency of the proposed approach in suppression of noise and preservation of edges in comparison with other methods.

A. G. Motaal, et.al (2008) stated that heart disease was a deadly disease. The timely recognition of this disease was necessary for the proper treatment. (MRI) was an emerging technology which had been used extensively. With the help of this approach, the recognition of this disease could be done by imaging the heart structure and its function. In order to increase the contrast-to-noise ratio (CNR) between myocardium and background, several techniques were proposed in this study. In this study, a novel technique was also proposed which used cine cardiac images along with black-blood contrast [22]. The capabilities of CNR were limited because it suffered from elevated noise. On the other hand, cine sequence of high contrast was produced by this approach. In order to eliminate the backdrop noise, the Bayes classifier was applied before the detailed analysis of performance and efficiency of this technique. For the verification of proposed method, the Real MRI data was utilized. The proposed and existing approaches were compared to evaluate of the performance of each one of them.

Xiaofeng Yang, et.al (2011) proposed a wavelet multiscaledenoising approach for the MR images on the basis of the Radon transform. With the help of this approach, Rician nature of MR data was recognized. The Radon transform was implemented in the authentic MR images on the basis of noise information. For the processing of MR sinogram image, the Gaussian noise model was utilized. For the disintegration of above stated MR image into multiscales, they implemented a translation invariant wavelet transform was implemented in this study by means of which noise from an image was eliminate successfully. The noise variance was estimated in different scales on the basis of Rician noise. In this study, Radon transform was applied for the reconstruction of actual MR images and for the elimination of noise from a picture [23]. The proposed technique was verified through the usage of the human brain and its MRI image information. As per the performed experiments, it was concluded that proposed technique was more effective in comparison with other methods. Therefore, a reduction in the Rician noise was seen due to this proposed method using which key image details and features of the image were maintained. Thus, there was inclusive range of applications of wavelet denoising in MRI.

YogeshBahendwar, et.al (2012) stated that a development was seen in the Magnetic Resonance Imaging (MRI) approach with the growth of technology. The Magnetic Resonance Imaging (MRI) technology was used in various applications of medical imaging and played an essential role. There was occurrence of conventional problem in the different regions for example image processing due the occurrence of noise caused de-noising of picture. In this study, the simple threshold methods were proposed in order to eliminate the additive random noise [24]. In this study, a medical image denoising algorithm was also proposed in which basics of discrete wavelet transform (DWT) were utilized. On the basis of conducted tests, it was concluded that higher peak signal to noise ratio (PSNR) was obtained by the algorithm. In this study, wavelet based denoising algorithm was used for MR images tainted with random noise.

Ahmed Faisal, et.al (2012) stated that medical image processing had two most challenging fields. These fields were recognized as image denoising and segmentation. In the process of medical diagnosis, there was regression in the

visual quality and the accuracies of the segmentations due to occurrence of noise. In this study, an improved approach was proposed for the recognition of tumor from 2-D magnetic resonance brain images and to eliminate the denoising and segmentation from it. In order to eliminate the MRI noises, the fourth order partial differential equation was applied on the basis of technique [25]. Thus, the automatic seeded region growing algorithm was used for the execution of segmentation using which brain cancer was detected automatically. Therefore, to store the necessary information at the boundaries, the compass operator was used in this study for its automatic saving. In order to eliminate the skull from the brain MRI image, a novel morphological technique was proposed using which tumor could be detected precisely. In this study, various experiments were performed for the evaluation of the proposed method for numerous real brain MRI images. The achieved outcomes concluded the efficiency of proposed approach method in the automatic detection of brain tumor.

Samir BARA, et.al (2012) stated that a development was seen in the field of Nuclear Magnetic Resonance Imaging (MRI) also called as the noninvasive imaging techniques. In the field of clinical diagnosis, the MRI techniques had become the extensively utilized technologies by means of which different type of disease could be diagnosed without difficulty [26]. Therefore, for the correction, denoising, and segmentation of the MRI images, a novel method was proposed in this study. Therefore, with the help of coupled system of linear and nonlinear diffusion reaction equations, a correction was identified in the faced issues. Therefore, the equations used for the denoising of magnetic resonance images were tested using which segmentation could be implemented without difficulty in medical images.

NivithaVarghees. va, et.al (2012) presented an automated, adaptive image denoising approach in this study using which Rician noise from MRI images could be eliminated effortlessly. The proposed approach integrated certain methods and techniques to provide enhancement in these noisy images [27]. On the basis of denoising method, the regularization parameter was applied to handle the standard deviation of noise within these noisy images. The proposed method was evaluated by applying on those images which contained Rician noise within them. On the basis of noise standard divergence, the performance of proposed approach was evaluated. A denoised image was achieved whose quality was evaluated by performing some tests and calculating some quality metrics. On the basis of attained simulation outcomes, it was concluded that there was noteworthy improvement in the edges conservation and also in the removal of Rician noise from a MR image because of this proposed method. Thus, it was concluded that proposed method showed better results in comparison with previously used techniques.

Skimpy Garg, et.al (2013) stated that an essential role was played by the medical science image segmentation in the medical field. Therefore, cautious analysis was required for the medical images so that their quality could not hamper. It became a chief task of recognizing the minor issue in the body part of human. Therefore, to remove all these issues and to makes the procedure of medical diagnosis simple, the image segmentation was utilized. With the help of this technique, image was divided into different number of parts and after this analysis was performed on it [28]. Due to the grey scale images, it was difficult to scrutinize the brain images as there was extremely small alteration in the brightness between the pixels of these pictures. In this study, the interpolation median filter (IMF) was utilized in order to remove noise. The proposed method was used to improve the attained simulation results. This technique of IMF removed the noise but retained the image details. In this study, the ADTVFCM method was applied as well for the segmentation process which provided accuracy and also enhanced the results.

III. RESEARCH METHODOLOGY

A filtering technique named NLM is used for the de-noising of MRI images. The attributes of MRI images are very much affected by the occurrence of raisin inside the images. The PNLM is the advanced form of NLM algorithm. This algorithm processes the parallel pixels by de-noising the images for a better experience. Moreover, one more algorithm is proposed for having enhanced and reasonable performance is the GLCM algorithm. This approach is utilized to find out the Peak signal-to-Noise Relation (PSNR), Mean Square Error (MSE) and Mean Structural Similarity Index (MSSIM). In this study, GLCM is termed as Grey level Co-occurrence Matrix and also identified as Grey Tone Spatial Dependency Matrix. In this algorithm, the number of rows is equal to the number of columns to the total number of grey levels existing within the images. This algorithm is in the table form and find outs brightness value of different combinations falling in any image. The foremost aim of GLCM is the extraction of statistical surface parameters such as Inverse Difference Moment, Entropy, Angular Second Moment and Correlation. The second order statistical information is one more part of the GLCM algorithm which combines the pixels of the images. This second order statistical information pays attention to the execution of GLCM in VERILOG language. GLCM is also utilized in the assessment procedure of grey co-matrix in the scaled set-up. Let us assume that 'I' is the binary image in grey co-matrix scaled format and if 'I' is the intensity image which divides the image into eight grey-levels. The numbers of these grey levels are described by the 'Numlevels' and gray co-matrix divides the different values through the usage of 'Graylimits' parametric values.

Pseudo Code of GLCM Algorithm

1. Number of pixels is computed for the storing of data.

2. The calculated pixels are stored in the matrix P[I,j].

3. The resemblance is demonstrated by applying the histogram method.

4. The contrast factor is computed through the expression given below:

$$g = \exp[\frac{mean(I) - minimum(I)}{maximum(I) - mean(I)}]$$

5. The values of g are normalized by dividing them through number of pixels.

$$g = \begin{bmatrix} 0.8\ if g < 0.8 \\ 1.2\ if g > 1.2 \\ g otherwise \end{bmatrix}$$

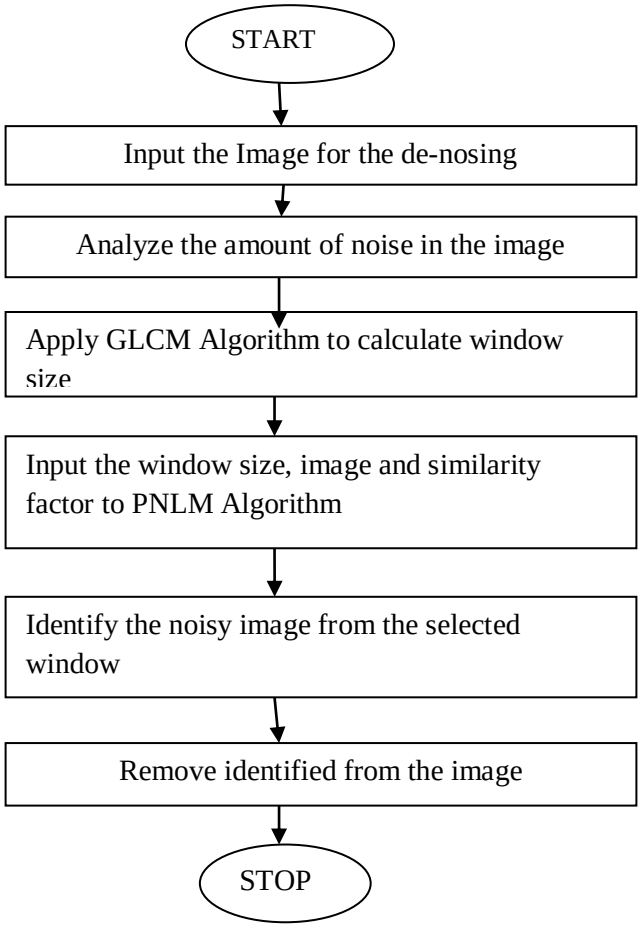

Figure 1: Proposed Flowchart

IV. RESULT AND DISCUSSION

The MRI images are used to perform experiments. These images are obtained from the http://nist.mni.mcgill.ca/?page_id=672.This respective website has various MRI images. These images are gathered from the Neuro images and Surgical Technologies Lab. These images are MRI images having B-mode image pre and post – reactions. A dataset is used to evaluate the performance of existing PNLM algorithm and advanced PNLM algorithm. The images gathered from the provided link are the Brain MRI images taken from different angles.

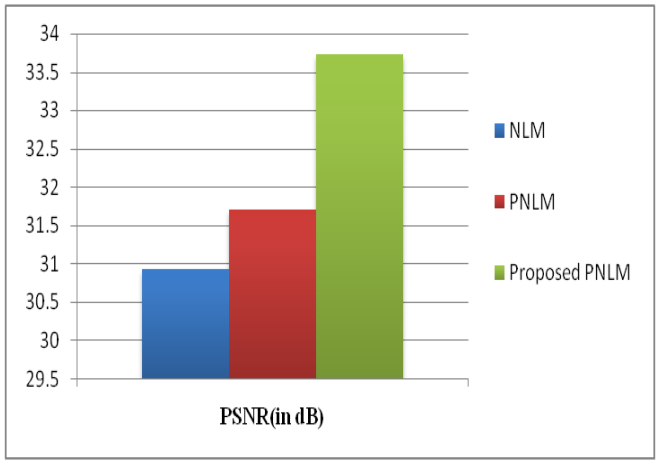

Figure 2: PSNR Comparison

The NLM, PNLM and Proposed algorithm are compared in terms of standard PSNR value for the analysis of their performances as depicted by figure 2 . It is scrutinized that the proposed algorithm has maximum PSNR value in comparison with NLM and PNLM algorithm.

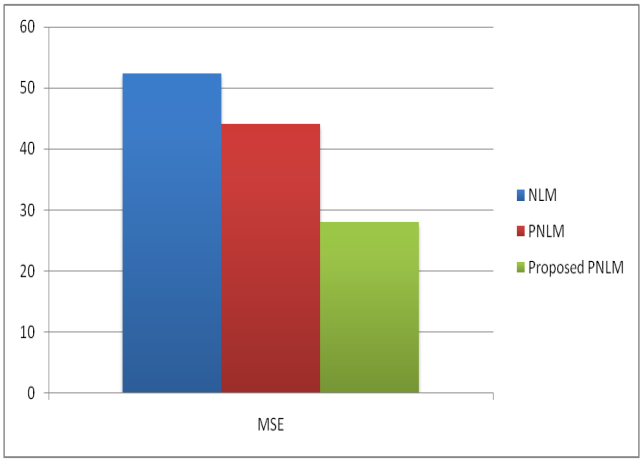

Figure 3: MSE Comparisons

The NLM, PNLM and Proposed algorithm are compared in terms of MSE value for the analysis of their performances as depicted by the figure 5.4. It is scrutinized that the proposed algorithm has least MSE value in comparison with NLM and PNLM algorithm.

V. CONCLUSION

Different filtering techniques are compared in the proposed study. The newest aproch is proposed for the denoising of the MRI images. These images contain raisin noises. The improved version of NLM called PNLM is used in this study. In the other step of this research, PNLM algorithm is proposed and implemented for multiple windows having input images to reduce the execution time and for improving the quality of images by maintaining the PSNR, MSE and MSSIM values. In the third step of the work, the NLM algorithm is improved by using GLCM approach. This GLCM algorithm is introduced to analyze some textual characteristics such as entropy, homogeneity and so on. The single value is returned in PSNR with the help of this GLCM algorithm. This single value is used as input in NLM approach. In these two steps, the size of window is altered according to the input provided by the GLCM algorithm. The results are analyzed on the basis of PSNR, MSE and MSSIM values. The results of NLM, PNLM and two step algorithms are compared on different images. It is observed that the two step algorithm shows good performance and enlightens the noises from the pixels which in turn enhance the value of remains.

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