Image Denoising in MR Images Using Wavelet based Canonical Correlation

Aarthi K[1], Dr.B.S.E.Zoraida[2]
[1, 2] School of Computer Science Engineering and Applications, Bharathidasan University, Trichy -23, Tamil Nadu, India.

Abstract*- Image denoising has been evolving as an essential process in medical imaging especially the Magnetic Resonance Imaging (MRI). The MR images are processed to improve visual appearance to the viewers. Noise can degrade the image at acquisition time or during transmission. Most of the researchers using wavelet denoising technique for signal de-noising, because wavelet provides an appropriate basis for separating noisy signal from the image signal. In this work, wavelet based canonical correlation algorithms under different conditions to achieve better performance and improving MR image quality. Because the wavelet transform has good accuracy, therefore, it has been widely applied in image processing tools. This proposed work gives better performance and Experimental results show the validity of the new algorithm and also the proposed work compared with filtering approach*.

Keywords- MR Images, Wavelet, Denoising, CCA, Median filter, Thresholding.

I. INTRODUCTION

A powerful and widely used clinical imaging modality (MR) Magnetic Resonance is able to visualize internal structures of the human body. MR images are vulnerable to artifacts compared with other imaging modality, it degrades the quality of images. It may cause inefficient or inaccurate diagnosis, may impact the visual search efficiency of the clinical specialists, and as such, may affect their workflow. To minimize or eliminate these artifacts, many correction procedures have been developed. This paper proposes a wavelet based denoising technique with canonical correlation algorithm to remove salt and pepper noise from corrupted images.

Noise is any undesired information that contaminates an image. The Salt and Pepper type noise is typically caused by malfunctioning of the pixel elements in the camera sensors, faulty memory locations, or timing errors in the digitization process. To denoised image there is a filtering approach called median filtering technique. The working procedure of the existing median filtering technique is very simple. This filtering technique, is calculated by first sorting all the pixel values from the surrounding neighborhood into numerical order and then replacing the pixel being considered with the middle pixel value. The PSNR of the filtered images obtained by this filtering technique are actually lower than that of the corrupted images. So these techniques actually decrease the quality of the noisy images rather than improving the quality. Hence the proposed system is used to improve the quality of MR Images.

II. WAVELET DENOISING

In Recent years, many noise reduction techniques have been developed for removing noise and preserving edge details. The primary aim of noise reduction is to remove the noise without losing much information contained in an image. To achieve this goal, we can use mathematical function that analyzes the data according to scale or resolution called as the wavelet transform to localize an image into different frequency components or useful sub bands and effectively reduce the noise in the sub bands according to the local statistics within the bands. The main advantage of the wavelet transform is to calculate wavelet coefficients. The wavelet de-noising sets threshold value to the wavelet coefficients arising from the wavelet transform. The wavelet transform yields a large number of small coefficients and a small number of large coefficients. Applications of wavelets have been used in compression, detection and denoising.

III. WAVELET BASED CANONICAL CORRELATION ALGORITHM

Canonical correlation analysis (CCA) is a technique of measuring the linear relationship between two multidimensional variables widely used in economics, meteorology, image processing fields.CCA was developed by H. Hotelling as a way of measuring the linear relationship between two multidimensional sets of variables and was later extended to several data sets [2]. The proposed algorithms first perform CCA and continuous wavelet transform of the canonical components to generate a number of features which include component autocorrelation values and wavelet coefficient magnitude values to get in MR images. A subset of the most important features is subsequently selected using threshold and labeled observations or input image constructed from the original observations. The proposed algorithms are evaluated using realistic implemented image as well as find nearest pixel analysis in original MR Images. We assessed the performance of the proposed algorithms using band separation performance and goodness-of-fit values for noisy and noise-free signal windows. In the implementation, where the ground truth was known, the proposed algorithms yielded almost perfect performance. In the case of input image, where expert marking was performed, the results suggest that both the noise affected image in wavelet and CC algorithm versions were able to remove artifacts without affecting noise-free channels considerably, outperforming standard CCA.

We propose the CCA in wavelet for better performance in image quality. The noisy input MR image is given to the input of this techniques first analysis the band separation the input Image. Band separation is input image is divided in to 4 bands (LL, LH, HL, and HH). The 3 bands (LH, HL, HH) is high frequency range. Noise can occur in LL only, so again LL band separate in 4 bands until minimum noise removal process. The noise removal maximum error level set and removes the noise with the help of CCA. The CCA is analyses and exactly remove the noise with the help of nearest pixel value. Nevertheless, many survey researchers use correlations with rating scales, because the results usually reflect the real world.

IV. WAVELET THRESHOLDING

Wavelet thresholding is a signal estimation technique that manipulates the capabilities of wavelet transform for signal denoising. It removes noise by killing coefficients that are insignificant relative to some threshold, and turns out to be simple and effective, depends heavily on the choice of a thresholding parameter and the choice of this threshold determines, to a great extent the efficacy of denoising. Threshold Selection: As one may observe, threshold selection is an important question when denoising. A small threshold may yield a result close to the input, but the result may still be noisy. A large threshold produces a signal with a large zero coefficients. This leads to a smooth signal. By increasing too much attention to smoothness, it may affect small details and in image processing may cause blur and artifacts. Thresholding Method: Some of thresholding methods are: (i) Hard thresholding, (ii) Soft thresholding. In this algorithm , soft thresholding method is used to analyze the performance of denoising system for different levels of DWT decomposition[4], since soft thresholding results in better denoising performance than other denoising methods. Soft thresholding brings less distortion when compared to other thresholding methods. Several approaches have been suggested for setting the threshold for each band of the wavelet decomposition.

V. DENOISING PROCEDURE

- Apply wavelet transform to the noisy signal to create the noisy wavelet coefficients
- These wavelet coefficients which are small in value are typically noise.
- Select appropriate threshold limit at each level and threshold method (hard or soft thresholding) to best remove the noises.
- For noise removal, we use the canonical correlation algorithm which is calculate the noise image pixel value
- Then it analyses the maximum error level by set thresholds value can remove the noise pixel.
- Then reconstruct the data using inverse wavelet transform.

VI. MEDIAN FILTER

Median filtering is a nonlinear filtering method which is used to remove noise especially ‘salt and pepper ‘noise from MR images. It is widely used method and also it is very effective at removing noise while preserving edges. The working of median filter is to running through the image pixel by pixel, replacing each value with the median value by comparing neighbor pixels. The pattern of neighbor’s pixel is called the "window", which slides, pixel by pixel over the entire image, The median value is calculated by sorting all the pixel values from single window and arranged them into ascending numerical order, and then replacing the each pixel by considering the middle (median) pixel value[7]

123	125	126	130	140
122	124	126	127	135
118	120	150	125	134
119	115	119	123	133
111	116	110	120	130

Figure 1.

Neighbourhood values:

115, 119, 120, 123, 124,
125, 126, 127, 150

Median value: 124

Figure 2.

The basics of the median filter are to check through the signal pixel by pixel, replacing each pixel with the median of neighboring pixel. For 1D signals, the window is followed just the first few preceding and following entries, For 2D (or higher-dimensional) signals such as images, possibility of complex window patterns may arised. In case of odd number entries in a window, then the median value is calculated by middle value is taken after all the entries in the window which are sorted numerically ascending.

VII. RESULT

Performance of proposed algorithms is measured using quantitative performance measures such as peak signal-to-noise ratio (PSNR) as well as visual quality of the images. The experiments are conducted on several MR images and also PSNR value is compared with median filter algorithm.

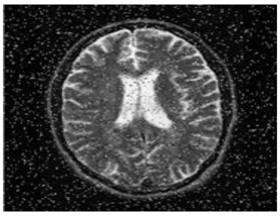

Figure 3. Noisy Image

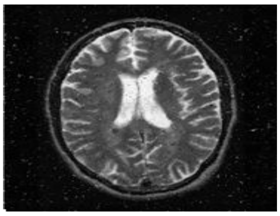

Figure 4. Filtered Image

Table 1. PSNR VALUE

Image	Peak Signal To Noise Ratio in db	
	Median Filter	**Wavelet**
MRI 1	9.95	20.72
MRI 2	10.55	21.05
MRI 3	11.61	21.04

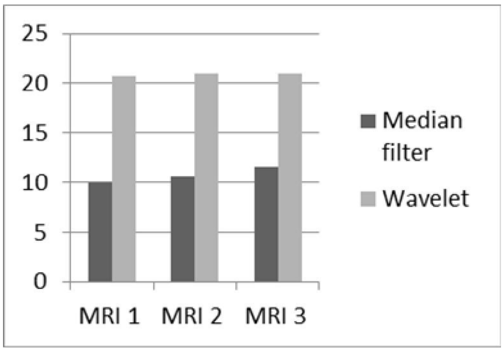

Figure 5.

VIII. CONCLUSION

Based on the implementation the wavelet based denoising method improves the quality of MR images. This denoising algorithm uses soft thresholding to provide smoothness and better edge preservation at the same time. The above algorithm is also compared with median filtering approach. The results obtained for improving the quality of the MR Images.

REFERENCES

[1] D. L. Donoho, “Denoising by soft-thresholding,” IEEE Trans. Inf. Theory, vol. 41, no. 3, pp. 613–627, Mar. 1995.

[2] Magnus Borga ,” Canonical Correlation a Tutorial” January 12, 2001

[3] D. L. Donoho and I. M. Johnstone, “Adapting to unknown smoothness via wavelet shrinkage,” J. Amer. Statist. Assoc., vol. 90, no. 432, pp. 1200–1224, 1995

[4] D.L. Donoho, “De-Noising by Soft Thresholding”, IEEE Trans. Info. Theory 43, pp. 933-936, 1993.

[5] S. Grace Chang, Bin Yu and M. Vattereli, “Wavelet Thresholding for Multiple Noisy Image” Copies, IEEE Trans. Image Processing, vol. 9, pp.1631- 1635, Sept.2000

[6] Savita Gupta and Lakhwinder kaur,” Wavelet Based Image Compression using Daubechies Filters”, In proc. 8th National conference on communications, I.I.T. Bombay, NCC-2002.

[7] James C. Church, Yixin Chen, and Stephen V. Rice Department of Computer and Information Science, University of Mississippi, “A Spatial Median Filter for Noise Removal in Digital Images”, IEEE, page(s): 618-

623, 2008.

[8] D. L. Donoho and I. M. Johnstone,”Threshold selection for wavelet shrinkage of Noisy Data,” Proc16th Annual International conference of IEEE Engg in Medicine and biology Society .Vol1,Page A24-A25 Baltimore, Maryland, 1994.

[9] R. D. Nowak. Wavelet-based Rician noise removal for magnetic resonance imaging. IEEE Trans Image Process 1999;8:10:1408–1419.

[10] A. Pizurica, A. M. Wink, E. Vansteenkiste, W. Philips, and J. B. T. M. Roerdink. A review of wavelet denoising in MRI and ultrasound brain imaging. Current Med Imag Rev 2006;2:2:247– 260.