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Removal of Noise from MRI using Spectral Subtraction

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Abstract

Magnetic resonance imaging (MRI) is a medical imaging technique used in radiology to visualize internal structures of the body in detail. MRI can create more detailed images of the human body than are possible with X-rays. Magnetic resonance (MR) images are normally corrupted by random noise which makes the automatic feature extraction and analysis of clinical data complicated. Here a new denoising method based on spectral subtraction is applied to MRI image. The spectral subtraction method is a simple and effective method of noise reduction.

Keywords: Magnetic resonance imaging (MRI), Histogram equalization, segmentation, Spectral subtraction, DICOM images

1. Introduction

Several denoising methods have been proposed to enhance the SNR of images acquired using parallel MRI techniques. One method, anisotropic diffusion filtering (ADF) [1], effectively improves SNR while preserving edges by averaging the pixels in the direction orthogonal to the local image signal gradient. ADF can potentially remove small features and alter the image statistics, although adaptively accounting for MRI's spatially varying noise characteristics can offer improvements, this is practically challenged by the unavailability of the image noise matrix [2].Wavelet-based filters have also been applied to MRI. These are prone to produce edge and blurring artifacts.

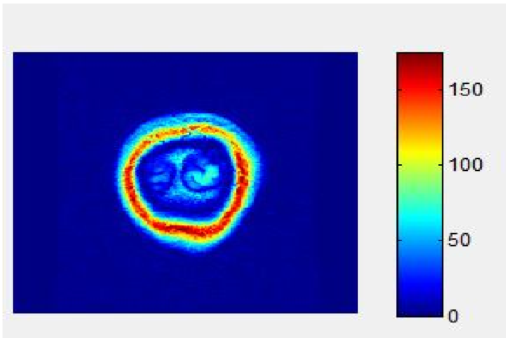
Recently, denoising methods employing nonlocal means (NLM) [3] were applied to increase the MRI SNR by reducing variations among pixels in the image with close similarity indices[4] . The robustness of the determination of pixel similarities enhanced by comparing small image regions centred at each pixel, rather than pixel-by-pixel comparisons. While adaptive NLM denoising offers improved performance NLM can still affect image statistics and its computational burden is high compared to other approaches. A bilateral filter is a non-linear, edge-preserving and noise-reducing smoothing filter for images. The intensity value at each pixel in an image is replaced by a weighted average of intensity values from nearby pixels. This preserves sharp edges by systematically looping through each pixel and adjusting weights to the adjacent pixels accordingly. But alters the original MRI image.

In this study, we introduce a new, time efficient, image denoising method by applying spectral subtraction directly to MRI image. Spectral subtraction is well established for the suppression of additive Gaussian noise (AGN)[5] and is commonly used in speech processing[6]. We test spectral subtraction method on matlab version of MRI image.

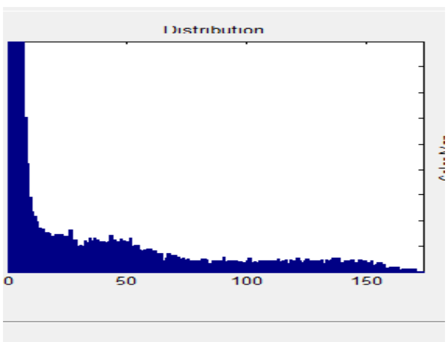
2. Basic Principles

Colormap: A colormap is a matrix that can have any number of rows,but must have three columns.

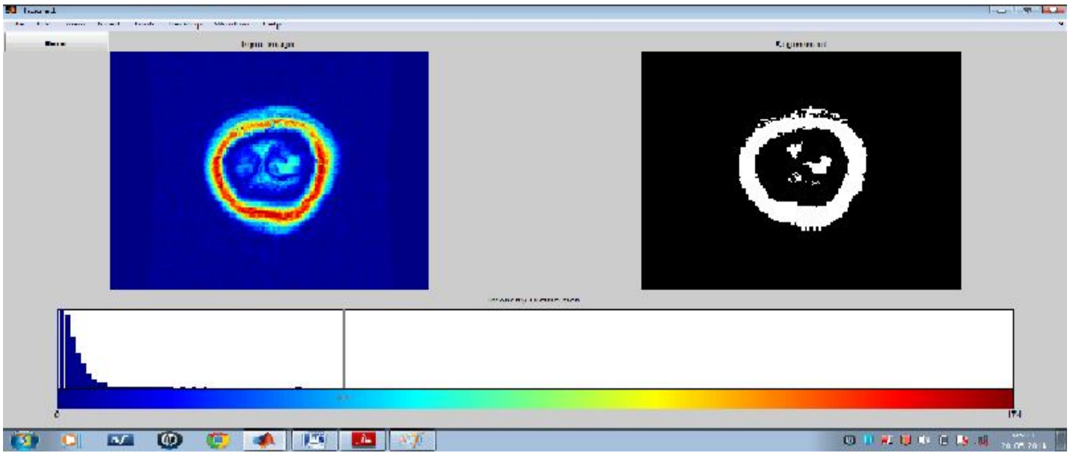
Each row in the colormap is interpreted as a color, with the first element specifying the intensity of red , the second is green and the third is blue.

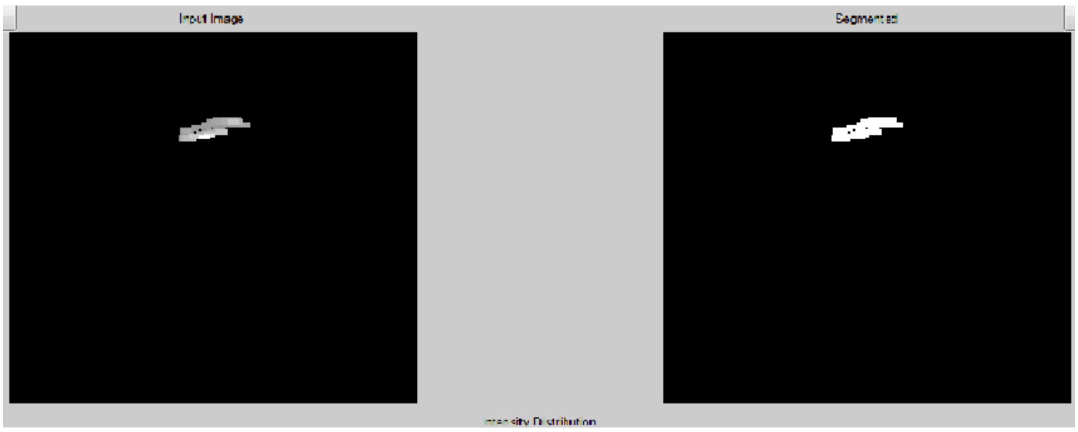


Histogram equalization: It is a method in image processing of contrast adjustment using the image's histogram. This method usually increases the global contrast of MRI images, especially when the usable data of the image is represented by close contrast values. Through this adjustment, the intensities can be better distributed on the histogram. This allows for areas of lower local contrast to gain a higher contrast. Histogram equalization accomplishes this by effectively spreading out the most frequent intensity values. The method is useful in images with backgrounds and foregrounds that are both bright or both dark. In particular, the method can lead to better views of bone structure in MRI, X-ray images.



Segmentation: It is the process of partitioning a digital image into multiple segments. The goal of segmentation is to simplify or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain visual characteristics. The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image. Each of the pixels in a region are similar with respect to some characteristic or computed property, such as color, intensity, or texture. Adjacent regions are significantly different with respect to the same characteristic.





3. Spectral Subtraction

Spectral subtraction is performed by subtracting an estimate of the noise spectrum from the noisy spectrum to estimate the enhanced spectrum. Let (n) be the noise corrupted input image which is composed of the clean image (n) and the additive noise image $d(n)$. We can write noisy input image in time domain and Fourier domain as in equation (1) and (2) respectively

$$y(n) = x(n) + d(n) \ldots \quad \ldots\ldots (1)$$
$$Y[w] = x[w] + D[w] \ldots \quad \ldots\ldots (2)$$

$[\omega]$ Can be expressed in terms of magnitude spectrum and phase spectra as

$$Y[w] = |Y[w]|\ ej\theta$$

Here $|[w]|$ is the magnitude spectrum and θ is the phase spectra of the corrupted noisy image similarly $D[w]$ that is noise spectrum in terms of magnitude and phase

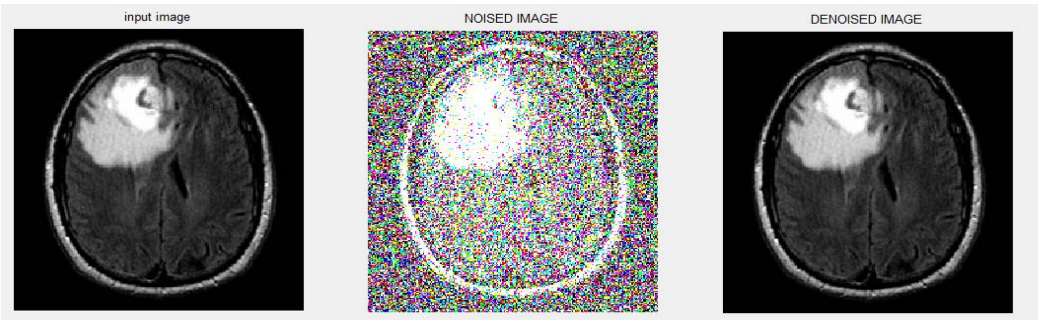
$$D[w] = |d[w]|\ ej\theta$$

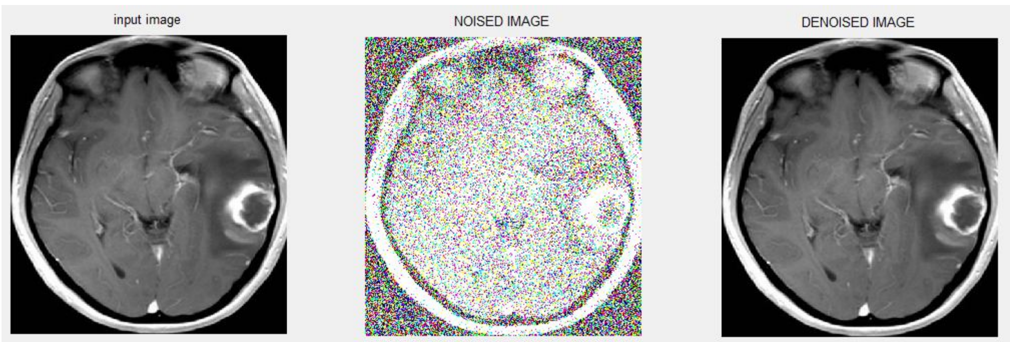
4. Algorithm:

Step1: Read the MRI image.
Step2: Allocating memory for output image.
Step3: Putting the pixel values into a single array.
Step4: Computing power spectral density of original image and noisy image.
Step5: Compute the mean value of noise.
Step6: Create a single sided spectrum for denoised image.
Step7: Reconstructing denoised image using remaining coefficients.

5. Results

Original MRI image is added by additive Gaussian noise i.e sigma=2.





Spectral subtraction(SS) technique remove noise from MRI image. It is well established for the suppression of additive Gaussian noise (AGN). Application of SS to phantom, human heart, and brain MRI is useful in medical field.

References

[1] P. Perona and J.Malik, "Scale-space and edge-detection using anisotropic diffusion," *IEEE Trans. Pattern Anal.Mach. Intell.*, vol. 12, no. 7, pp. 629–639, Jul. 1990.

[2] A.A. Samsonov and C. R. Johnson, "Noise-adaptive nonlinear diffusion filtering of MR images with spatially varying noise levels," *Magn. Resonance Med.*, vol. 52, no. 4, pp. 798–806, Oct. 2004.

[3] A. Buades, B. Coll, and J. M. Morel, "A non-local algorithm for image denoising," in *Proc. IEEE Comput. Soc. Conf. Comput. Vis. Pattern Recognit.*, 2005, vol. 2, pp. 60–65.

[4] J. V. Manjon, J. Carbonell-Caballero, J. J. Lull, G. Garcia-Marti, L. Marti-Bonmati, and M. Robles, "MRI denoising using non-local means," *Med. Image Anal.*, vol. 12, no. 4, pp. 514–523, Aug. 2008.

[5] S. V. Vaseghi, *Advanced Digital Signal Processing and Noise Reduction*, 2nd ed. New York, USA: Wiley, 2000.

[6] S.F. Boll, "Suppression of acoustic noise in speech using spectral subtraction," *IEEE Trans. Acoust., Speech, Signal Process.*, vol. ASSP-27, no. 2, pp. 113–120, Apr. 1979.