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Emerging Technology Based on Adaptive Filtering Algorithm for MRI Scans.

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ABSTRACT

Tensor based orientation adaptive filtering, an overt method for anisotropic filtering, constitute a supple structure for medical image enrichment. The aim of noise filtering is to eliminate noise and its effects on the original image. Adaptive algorithm proposed in this paper could efficiently reduce noise even in highly corrupted image .In this paper the technique is applied to magnetic resonance angiography and T2-weighted MRI.

Keywords: MRI, adaptive filtering, tensor based, computed tomography

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INTRODUCTION

In most medical imaging, improving the image quality requires the collection of more image data .In computed tomography (CT), this goal can in general accomplish only if the radiation dose is increased, with undesirable side effects to the patient .In magnetic resonance imaging (MRI) a similar trade-off exists between acquisition time and image quality .Reconstruction of image is used for filtering .The filtering is carried out in 2-D.The Adaptive filtering algorithm is used in this paper, because it have high accuracy, high speed and user interaction. The image system consists of

1. Computer
2. Display System
3. Control Console

The computer system collects the nuclear magnetic resonant signal after A/D conversion. High speed data are sent from the system controller to the computer. A/D converters are used to convert analog signal into desired digital signal. Algorithm like fast Fourier transformation (FET) is used to convert the digitized time domain data to image data. Two dimensional images are typically displayed as 256 x 256 or 512 x 512 pixel arrays.

The next stage is the display system. The reconstructed image data are transmitted to the display console by a high capacity image memory disk. This can be used as an independent image processing. This unit in an interactive system .The images are displayed on the TV monitor in gray scale or colors. A multiform at camera is used for making hard copies of the image. The image reconstruction software is used to rebuild an image, register images, display and position scanned image processing and registers patients.

The control console comprises of

*System control section
*Display section
* Operation section

In the system control section, a microcomputer controls the gradient magnetic field, the high frequency pulse train (RF pulses) and the timing of A/D conversion of the signal received
The display section includes the high resolution monitor, keyboard, image memory and microcomputer for processing the image.

It has various panel indicators to monitor the system condition

The below figure shows the sample MRI images obtained in the imager system.

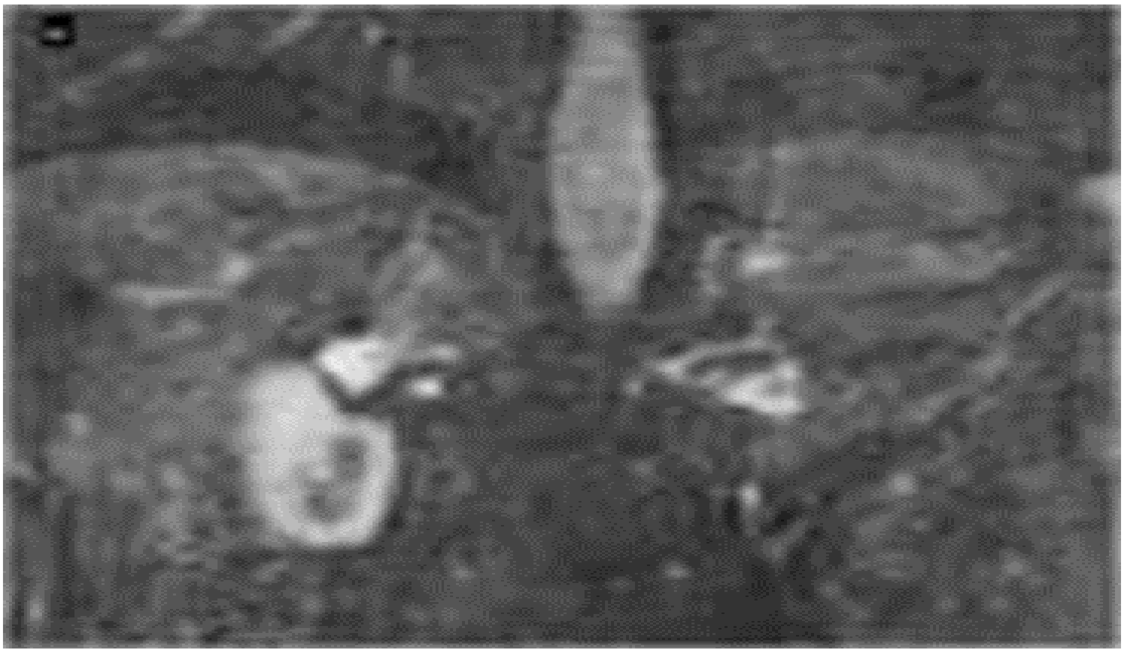

Figure 1: Sample MRI images obtained in the imager system

Adaptive filtering algorithm

This algorithm is split into two parts,

- Noise detection (ND)
- Adaptive filter

Architecture of the noise-detection processor system

$F'_{i-1, j-1} + f'_{i-1, j} + f'_{i-1, j+1} + f'_{i, j-1} = DM_{ij}$(1)

Where DM_{ij} -The local mean of the done filtered
F_{ij} – the currently processed pixel
$f'_{i, j-1}$ – current scanning line that have been filtered.

Another parameter representing the mean of the pixels that have not yet been processed can be expressed as

$F_{i, j+1} + f_{i+1, j-1} + f_{i+1, j} + f_{i+1, j+1} = Ym_{ij}$—(2)

Where,
$F_{i, j+1}$, $f_{i,j+m}$ – not yet processed pixel in the current scanning line the following one respectively.

The noise detection ND is given by

iff_{ij} ⍰ $(DM_{ij} + YM_{ij}) > Th$, f_{ij} is corrupted pixel

Otherwise f_{ij} is a noise pixel ----------(3)

Th – noise threshold

The eq3 decides whether the currently processed data is a corrupted pixel.

If it is then a non linear procedure is used to eradicate noise, which is given by

$f'_{i,j}$ = DM_{ij}, as f_{ij} is a corrupted pixel
f'_{ij} = f_{ij} , as f_{ij} is a noise free pixel

The processing window is a 3 x 3 window and the first window (window1) is having the central pixel f_{ij}

The DM and YM values are obtained from eq (1) &eq (2)

The difference between the old sample and the new one is computed and this differential value is accumulated to DM and YM values of window1 to obtain the respective values for window2

To compute DM value in window2, two differential values can be calculated

$D1 = f_{i-1,j+2} – f_{i-1,j-1}$
$D2 = f_{ij} – f_{i,j-1}$

The DM value for window 2 is expressed as $(DM)_{window2} = (DM)_{window1} + D1+D2$

Similarly, the Ym value can be obtained using the same computing method

$D3 = f_{i+1,j+2} – f_{i+1,j-1}$ and
$D4 = f_{i,j+2} – f_{i,j+1}$

The YM value for window 2 is expressed as $(YM)_{window2} = (YM)_{window1} + D3+D4$

This method possibly blurs image edges.

Hence adoption of edge detection (ED) in threshold adoption improves on filtering quality.
To avoid inclusion of noisy pixels, the parameter of horizontal ED is computed by

$$ED = \sum_{m=4}^{1} f'_{i-1,j-m} \; ? \; f'_{i,j-m}$$

Where $f1_{i-1,j-m}$ & $f1_{i,j-m}$ – have been filtered

Based on ED value, the noise threshold TH can be dynamically adjusted to reduce edge distortion.

The filtering power should be enhanced in a high noise condition, so the threshold is lowered

The noise ration NR can be computed by using a noise counter

The NC increased by one if a noisy pixel is found from 9.

The edge parameter has to be computed accurately to achieve better filtering performance.

From ED and NC parameter, the adaptive function for the noise threshold can be given by

$Th= K1+k2+ED – K3 \times NC_{t-1}$

Where NC_{t-1} the NC result that is estimated from the previous frame for computing the noise threshold of the current process pixel.
K1, K2 & K3 – constant

Assuming the

K1 = 30, K2 = 0.25 and K3 = 1/12---(12) by trial error method

Noise reduction ability with the method proposed adaptive filter could achieve much better quality than the median filter.

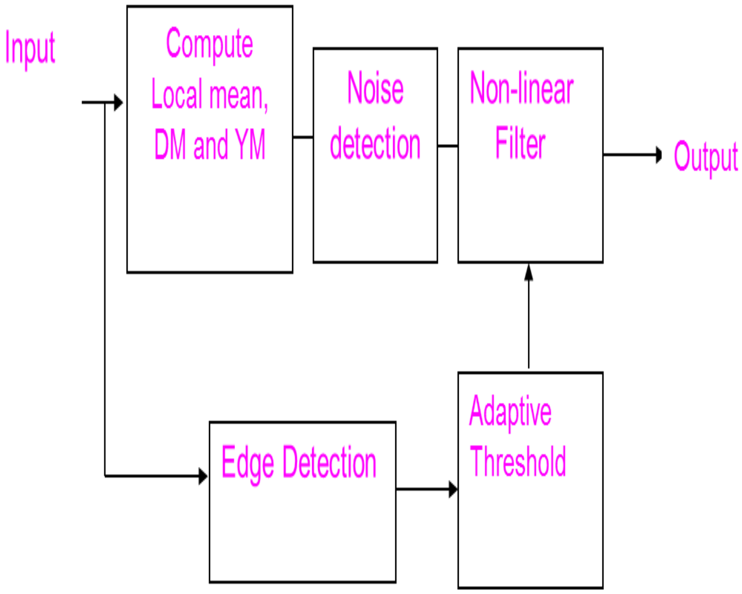

Fig 2: Block diagram of noise detection using adaptive filter

Sample results

Some sample results which can be obtained with the existing and proposed methods.

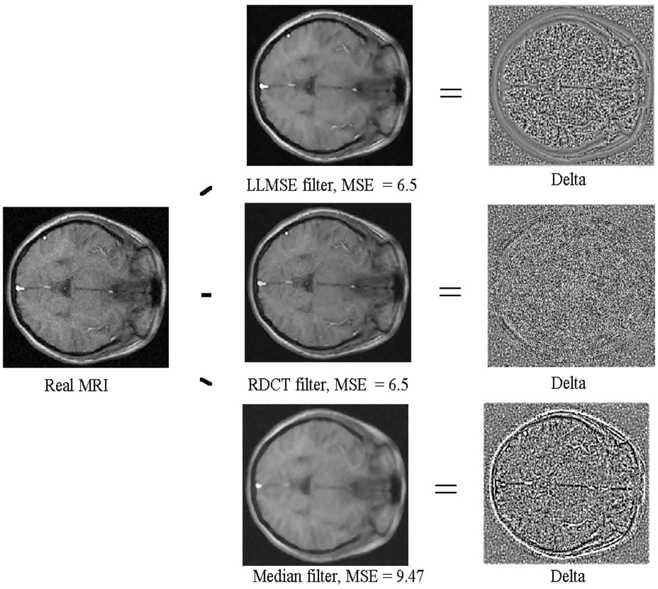

Fig 3: Sample results of MRI

Advantages

It provides unprecedented visualization of internal organs and structures without using X-rays.

Selectively enhances MRI spin signals in solution without irradiating organisms at microwave frequencies.

Allows for high speed protocols.

It is good looking at soft tissues of the body

Applications

Distinguishing between chemical species in living organisms.

Eg. Blood, proteins, lipids.

MRI studies on soft tissue anatomy, physiology and pathology.

CONCLUSION

Adaptive filtering technique can be applied to low-dose CT images, magnetic resonance angiography and T2 weighted MRI.

The maximum intensity projection (MIP) was used to visualize the volume by projecting the maximum intensity of the signal along every projection ray.

High performance algorithm has been used for noise removal.

The chip complexity is very low; a system-on-chip design for noise reduction can be efficiently implemented by integrating the proposed chip with other interface components.

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