International Journal of Advanced Computer and Mathematical Sciences ISSN 2230-9624.
Vol 2, Issue 2, June-2011, pp 105-110 http://bipublication.com

TWO DIMENSIONAL MRI IMAGE ANALYSIS BY USING OVERSAMPLED FIR FILTER BANK FOR PERFECT RECONSTRUCTION

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ABSTRACT
In this paper we propose oversampled three channels FIR filter banks [FB]. Channels are selected likewise which gives the result near perfect reconstruction filter bank. The inband aliasing is significantly reduced by selecting proper frequency spectrum and design of filters of filter banks. This design gives the result of oversampled FIR filter bank for two dimensional MRI image with peak signal to noise ratio and histogram of images. By applying wavelet transform energy is preserved at output of oversampled filter banks. By using local thresholding segmentation, major components of images are exposed, which detect abnormality i.e. occurrence of cancer tissues in image.

I] INTRODUCTION:

Biomedical images are of significant interest because they can be a useful tool when diagnosing and analyzing functions and diseases of the brain, as well as other body parts can be examined for example the kidneys. So how is it that the body can be analysed by magnetic resonance? Well, the biological tissue contains a lot of hydrogen atoms which are possible to detect. Nuclear magnetic resonance is a technique in which a electromagnetic .field is applied to the sample, in this case the brain. The nuclei of the hydrogen atoms in the biological tissue align themselves to the magnetic field, after this a radiomagnetic pulse will raise their energy level further, when the pulse ends they will relax and during the relaxation this energy will be transmitted from the atoms. The transmitted signal will be detected by the equipment and processed further into the pixels that make up the biomedical image. This paper is more focused on MR images, but in fact the methods described here can be applied to any kind of image.

During recent years ,the efficiency of image coding algorithm is improved significantly. Typically signal decomposition is performed by using discrete FIR filter bank. Uniform FIR filter bank have variety of applications in speech processing, image processing, and signal processing. Applications of oversampled and nonuniform filter banks can be found in those area of signal processing where one is interested in making modification in signal processing to signals in certain frequency bands. Recently perfect reconstruction condition for oversampled and nonuniform filter bank has been derived. Because of real valued subband signals, these filter banks are more suitable for spectral modification.[1].

Basic goal of this paper is Image de-noising and decomposition using selected filtering methods. Good algorithms for de-noising are of the essence when it comes to handling MR images. FIR filters are used to decompose and de-noise the image using filter bank.

The design of three channel oversampled FIR two dimensional filter bank is implemented, which satisfies all the properties of perfect reconstruction of filter bank. This filter bank passes all the frequency components without any loss and as well as to filter all noise with each channel and finally de-noised image without inband aliasing produced at the output of filter bank. To detect cancer tissue in the 2D MRI image, denoised image is applied for image segmentation using thresholding of image.

For image segmentation we have been appling thresholding i.e.local thresholding and global thresholding. Basic goal of this paper is to design proposed three channel oversampled filter bank which is applied for two dimensional MRI image to filter out all the noise and inband aliasing in channels and give output near perfect reconstruction of filter bank. The de-noised image which is obtained from FIR filter bank applied for segmentation and thresholding which are able to enhance feature of MRI image. The aim of our study was to assess the accuracy of thin-section MRI performed with a phased-array coil as a technique for the preoperative evaluation of pelvic anatomy and tumor extent in patients with rectal cancer[2].

With the discussion with radiologist comparison of normal MRI image and MRI with tumor images are selected for analysis. This technique is suitable for any 2-D image analysis. In section II filter bank description is explained. Section III shows design procedure for FIR filter bank . Section IV gives details about image segmentation.

II] Oversampled three channel Filter Bank:

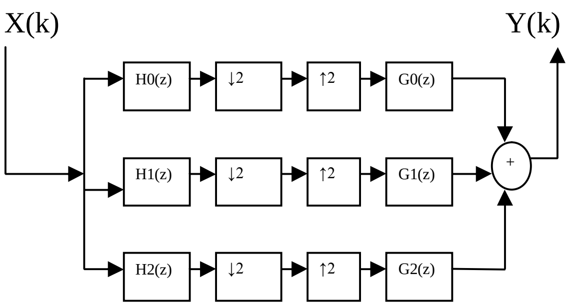

Figure.1: Three Channel filter bank

The main problem of subband adaptive filtering is the"inband" alias which occure if a real valued analysis filters Hi(z), whose channel is subsampled by Si, contains normalized frequency points

2лl/Si, l=1,….Si – 1 Ref [3]. Therefore to avoid inband alias, all the analysis filters need to have spectral nulls at these frequencies, if the same subsampling ratio Si is to used for all channels. So filterbank proposed is to remove inband aliasing by choosing different subsampling ratio Si for different channel[4] . We proposed three channel oversampled filter bank with same subsampling ratio as shown in Figure [1].Here every analysis filter has to be placed in the frequency domain such that the resulting signal does not violate the sampling when subsampled by a factor Si and that the analysis filters have to be placed such that all frequencies are covered by at least once to filter in order to allow reconstruction.

This filter bank is simplest possible filter bank that uses different subsampling ratios. This filter bank preserves the property of alias free output of two dimensional image . In this design H0(z) is lowpass filter and H2(z) is highpass filter which covers all frequency components of input signal except frequency pi*1/2 i.e.0.5 normalised frequency which is shown in Fig.1[1]. H1(z) is selected as a band pass filter of passband normalized frequency range shown in Fig2. H0(z), H1(z) and H2(z) are downsampled by 2. All frequencies must be covered by at least one filter. To fill the spectral gap between H0(z) and H2(z), one bandpass filter H1(z) is selected. Frequency spectrum of above figure is shown in Fig.2. Design of this filer bank using 1D direct form-II transposed structure FIR filter design technique which is transformed into two dimensional FIR filter using frequency transformation technique. .

Requirement for filter bank is that it yields the perfect or near-perfect reconstruction property, i.e.y(k) = x(k-Δ), where Δ is a fixed and delay chosen a priori, and therefore common zeros in all analysis filters Hi(z) are ruled out as information is lost at these frequencies. One possible solution to overcome these two contradicting requirement is to use a filterbank with different subsampling ratios in each channel Ref [1,5,6].

III] Design procedure for filter bank: General equation of filter bank for analysis and synthesis filter bank is shown below in equation (1).

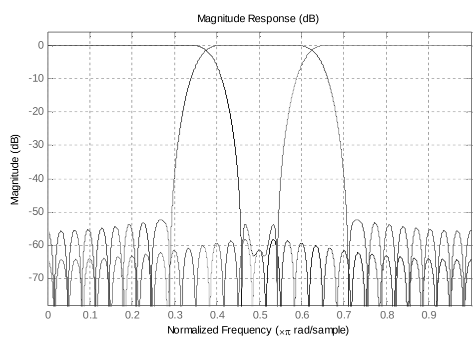

Figure.2: Frequency spectrum of three channel filter bank

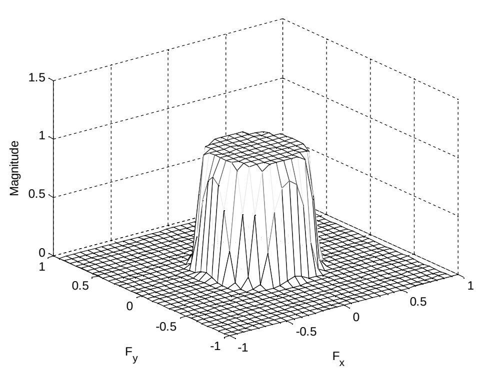

Figure3: Frequency response for two dimensional filter

$$Y[z]=\sum_{l=0}^{L-1}\sum_{m=0}^{S_l-1} Sl^{*}\, G_l(z)_l(zW_{Sl}^{m})\, X(zW_{Sl}^{m}) \qquad (1)$$

Y[z], $G_l(z)$, $H_l(z)$ and $X_l(z)$ are Z-transform of Y[k], $G_l(k)$, $H_l(k)$ and $X_l(k)$ respectively. Design of analysis and synthesis filters is basic task in the filter bank. We have used the method to design filters using 1D FIR filter design , which is transformed into two dfimensional FIR filter using frequency transformation technique for two dimensional image. Design of uniform filter bank shows inband aliasing to avoid this we are selecting proposed three and eight channels (shown in section FIR filter banks which shows the output near perfect reconstruction filter bank.

$H_2(z)$ is bandpass filter which shows passband near the cutoff frequencies of $H_0(z)$ and $H_1(z)$.To design FIR filters for 3-channels FIR filter bank, linear-phase FIR digital filter design technique is used. It designs filters in standard lowpass, highpass, bandpass, configurations. The output filter coefficients, b, are ordered in descending powers of z as shown in equation[3].

$$B(z) = b(1)+b(2)+\ldots\ldots+b(n+1)z^{-n} \qquad (2)$$

Order of filter is selected equal to 60 to design filters for proposed filter banks . Linear phase FIR filter is designed in 1-D form, then it is transformed into 2-D form using frequency transformation technique . frequency response for two dimensional filter is shown in Fig3. Fig.4 shows histogram of input and output image. An image histogram is a chart that shows the distribution of intensities in an indexed or grayscale image.

The aim of our study was to assess the accuracy of thin-section MRI performed with a phased-array coil as a technique for the preoperative evaluation of pelvic anatomy and tumor extent in patients with rectal cancer[2]. Therefore MRI filtered image is applied for segmentation to detect cancer on image.

IV] Image Segmentation :

Segementation subdivides an image into its constituent regions or objects. The level to which the subdivision is carried depends on the problem being solved. That is, segmentation should stop when the objects of interest in an application have been solved. For example, in the automated inspection of electronics assemblies, interest lies in analyzing images of the products with the objective of determining the presence or absence of specific anomalies, such as missing components or broken connection paths.

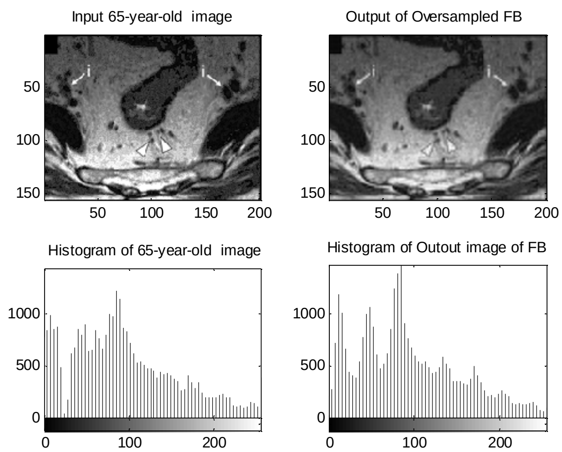

Figure 4:a]Input MRI image of pelvic anatomy b]Output image of FB c] Histogram of input image d] Histogram of output image.

Segmentation algorithms for monochrome images generally are based on one of two basic properties of image intensity values: discontinuity and similarity. In the first category partition an image based on abrupt changes in intensity, such as edges in an image. The principal approaches in the second category are based on portioning an image into regions that are similar according to a set of predefined criteria. We used thresholding segmentation which produce closed, well-defined regions.

Because of its intuitive and simplicity of implementation, image thresholding enjoys a central position in application of image segmentation..Two techniques are used for thresholding i.e. global thresholding and local thresholding. In global thresholding select an initial estimate for T(threshold value). Then segment the image using T. This will produce two groups of pixels:G1 consisting of all pixels with intensity values $\geq$T, and G2, consisting of pixels with values $<$ T. Compute the average intensity values $\mu 1$ and $\mu 2$ for the pixels in the region G1 and G2. Compute new threshold value :$T = \frac{1}{2}(\mu 1 + \mu 2)$.

In local thresholding technique objective of segmentation is to partition an image into regions. These statistics can characterize the texture of an image because they provide information about the local variability of the intensity values of pixels in an image. For example, in areas with smooth texture, the range of values in the neighborhood around a pixel will be a small value; in areas of rough texture, the range will be larger. Similarly, calculating the standard deviation of pixels in a neighborhood can indicate the degree of variability of pixel values in that region. By using local thresholding segmentation major components of images are exposed, which detect any abnormalities occuring in image.

Figure 5 to 8 shows different segmentation methods applied for image and we have tried to find out cancer tissues in the image . Here basically local thresholding is used which is shown in figure 5 to expose or to highlight cancer tissues. Similarly figure 6 and 7 shows Global thresholding techniques using Iterative and Otsu's methods [using image processing toolbox] of segementation to check whether cancer tissues are exposed or not. But from above two segmentation techniques we are able to expose cancer tissues by using local thresholding segementation . Figure 5 apply for image cropping, which is used to separate out cancer effected area and resultant is shown in figure 8.

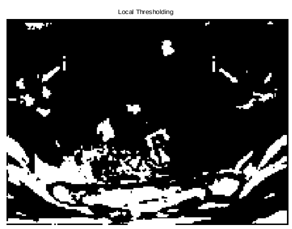

Figure 5: Local thresholding image

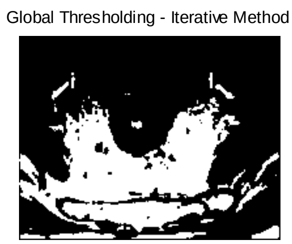

Figure 6: Global thresholding using Iterative method

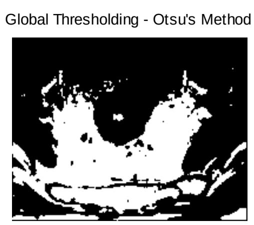

Figure 7: Global thresholding using Otsu's method

Figure 8: Cancer tissues after image cropping of local thresholding image

V] RESULTS:

The computer simulations, carried out with the MATLAB version 7.1.using digital signal processing and image processing toolboxes. Output image of proposed filter bank is shown with histogram which gives information in terms of intensity values of input and output images. Similarly to find out peak signal to noise ratio of input output images of filter banks [7]. PSNR=[$10\log_{10}(255^2/$ mse)]dB. PSNR for filter banks is 24.4414 dB.

. By using wavelet transform we are decomposes outputs of filter banks and calculate wavelet coefficients. Also output images are compressed by using wavelet sym4. then energy of compressed images is calculated which is compared with energy of input image. It shows that input image energy is preserved at output. Energy of input MRI image is equal to 95.2331 and output of filterbank energy of image is 97.8084.Which indicates that input image filtered without loss of information of image. Figure 5 shows local thresholding output, it indicates that white spots are of cancer tissue [2]. Figure 6 and 7 shows global thresholding using Iterative and Otsu's methods respectly. Figure 8 shows white areas are cancer tissues in image.

VI] Conclusion :

In this paper we presented a proposed real valued FIR filter bank i.e. three channel oversampled filter bank. This filter bank shows output without "inband aliasing" and it removes noise. By using image segmentation i.e. local thresholding cancer tissues are detected . As per the discussion with radiologist in figure 5 arrow indicate white portion which is detected as cancer tissues.

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