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Energy Preservation By Using Wavelet Transform For Analysis Of Oversampled Filter Banks For 2-D Image

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Abstract: Wavelet transforms and other multi-scale analysis functions have been used for compact signal and image representations in de-noising, compression and feature detection processing problems for about twenty years. Here proposed oversampled filter banks are analyzed by using wavelet transform. In this paper oversampled nonuniform three and eight channels FIR filter banks [FB] are designed for analysis of 2D images. Filter bank channels are selected likewise which gives the result near perfect reconstruction of input image. The inband aliasing is significantly reduced by selecting proper frequency spectrum and design of filters of filter bank. By applying wavelet transform energy of input image is preserved at output of oversampled filter bank.

Key words: FIR Filter bank, Oversampled filter bank, FIR, Multirate FIR filter bank.

I. INTRODUCTION

Oversampled filter banks have found use in a variety of applications in recent years. In particular, they have found commercial applications in low-power audio signal processing for devices such as hearing aids [1]. 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 filter banks can be found in those areas of signal processing where one interested in making modification in signal processing to signals in certain frequency bands. Recently perfect reconstruction condition for oversampled filter bank has been derived. Because of real valued subband signals, these filter banks are more suitable for spectral modification.

In this paper input image is decomposes into different subbands of nonuniform[frequency bands of different size] spectrums and subsampled by factor two. For nonuniform and oversampled frequency spectrum filter banks are designed for three and eight channels. Channels are distributed into nonuniform frequency bands. In design of uniform non overlapping filter bank some frequency components are lost at the transition gap, to overcome this problem the design of these two oversampled filter banks are proposed. As per the designer interest one can modify number of channels. For three channels two filters are subsampled by two and one filter is sampled by four. Three channels are selected for oversampled filter bank, middle channel is bandpass filter[2] with subsampling rate is equal to three, but to maintain perfect reconstruction and PSNR [as per the knowledge of perfect reconstruction filter bank] selection of sampling factor equal to four. For eight channels oversampled FIR filter bank, seven channels are bandpass filters and one channel is highpass filter [2,3,4]are used. Section II highlights design of oversampled three channel

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FIR filter bank. Section III discusses design of eight channel oversampled filter bank.

II. OVERSAMPLED THREE HANNEL FILTER BANK

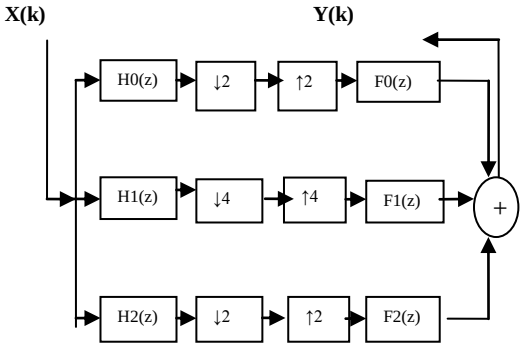

Fig.1: Three Channel filter bank

This filter bank uses different subsampling factors . 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 normalized frequency which is shown in fig.1. H1(z) is selected as a band pass filter of passband normalized frequency range of 0.45 to 0.55. H0(z) and H2(z) are subsampled by 2 and H1(z) bandpass filter subsampled by 4 . 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-I FIR filter design technique which is transformed into two dimensional FIR filter using frequency transformation technique .The phase response of three channel filter bank is shown in Fig.3.

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[2,3,4].

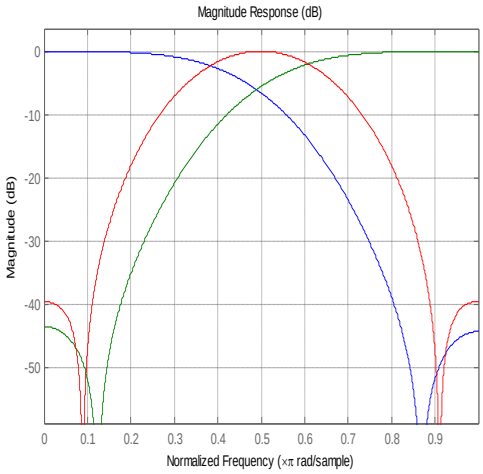

Fig.2: Frequency spectrum of three channel filter bank

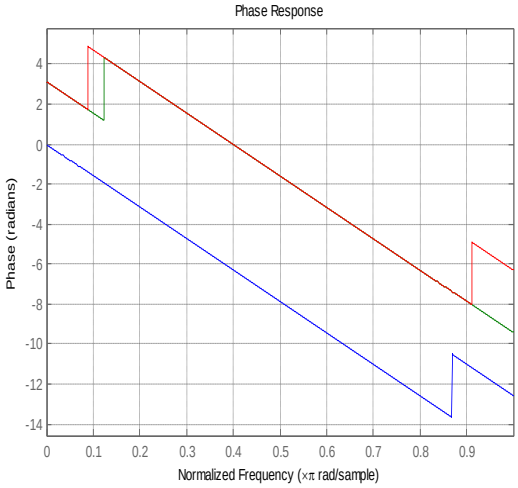

Fig.3: Phase response of three channel filter bank

For two dimensional image analysis we used 1D FIR filter design which transformed into two dimensional filter design and analysis of oversampled FIR filter banks are carried out. For 2D image the transformation is as below,

$H(w1,w2)=B(W)\,|\,cosw=T(w1,w2)$

B(W) is the Fourier transform of the one dimensional filter .

$$B(W) = \sum_{n=-N}^{N} b(n)\, e^{-jwn}$$

and

$$T(w1,w2) = \sum_{n1} \sum_{n2} t(n1,n2)\, e^{-jw1n1}\, e^{-jw2n2}$$

The returned filter h is the inverse Fourier transform of

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H(w1,w2).

III. EIGHT-CHANNELOVERSAMPLED FIR FILTER BANK

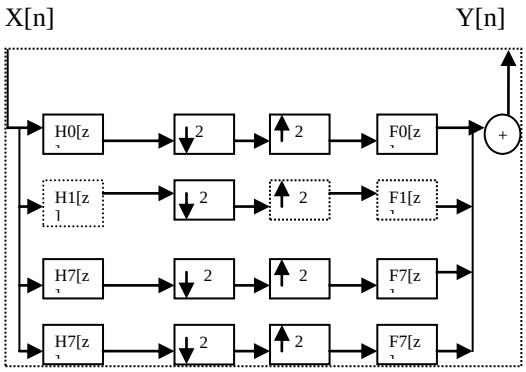

Fig 4: Eight-Channel oversampled nonuniform FIR filter bank

The analysis of two dimensional image near perfect reconstruction of filter bank is performed by using oversampled nonuniform filter bank.

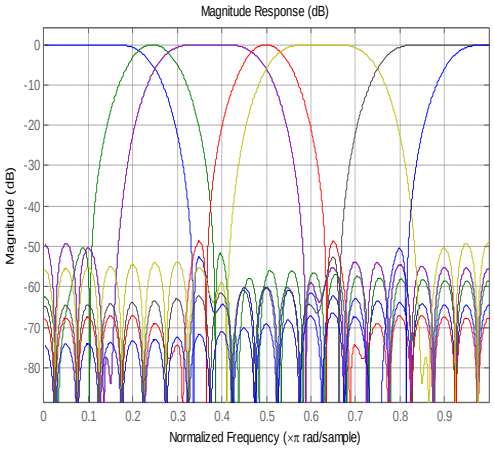

Fig.5 : Frequency spectrum of eight channel filter bank.

This filter bank is designed using seven bandpass FIR filters and one highpass FIR filter .The design of all filters using one dimensional FIR filter transformed into 2-D FIR filters technique which is explained in section II. For oversampled FB downsampled factor for each channel is selected as N < M . Where N is downsampling rate and M is no. of channels for analysis bank. For synthesis bank upsampling factor is equal to downsampling factor which is shown in Fig.3. and upsampled data processed by using proper selection of frequency spectrum FIR filters. Proper selection of frequency spectrum of oversampled nonuniform FIR filter bank is carried out means all possible frequency components i.e. frequency components at transition gap which is not passed in uniform FB which are passed through this filters . Fig.5 shows frequency spectrum of oversampled nonuniform FIR filter bank for seven bandpass and one high pass filter.

For near perfect reconstruction of filter bank peak signal to noise ratio [PSNR] for all output images are estimated which is acceptable as per the knowledge and study of filter banks. This oversampled nonuniform FIR filter bank is applied for two dimensional images. By using image processing and signal processing techniques these filter banks are designed.

IV. DESIGN ALGORITHM

The computer simulations, carried out with the MATLAB version 7.1. Grayscale images are applied for the .design of the subband filters for different subband frequencies. The input images are applied for three and eight channels oversampled nonuniform filter banks. Filter banks shows two stages one is analysis stage and other is synthesis stage. In analysis stage input signal is divided into subbands for respective oversampled nonuniform filter banks. Subbands are in the range from 0 to 1 rad. using lowpass, bandpass and highpass filters with filter order 40. Direct form –II FIR filters are used for filter banks.for three channel FB, H0(z) is lowpass filter with cutoff frequency 0.49 and H2(z) is high pass filter with cutoff frequency 0.51. Here band pass filter H1[z] is designed properly which passes all remaining frequency components, which were not passed through the lowpass and high pass filters .The resultant of output image in terms of histogram and output image shown in fig.6 .

For oversampled Non-uniform eight channel

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filter bank, down sampling factor is 2 which is shown in Fig.2. The resultant of output image in terms of histogram and output image shown in fig.7 Peak signal to noise ratio (PSNR) [5] for above two techniques are shown in table1 in dB. Wavelet transform is used for calculation of energy of signal, which shows energy restoration near input image which is shown in table1. In this designs input Leena image is considered which shows energy is 99.6530. One can apply any two dimensional image for testing.

Table1

Filter Bank	**Energy of Input image**	**Energy of Output image**	**PSNR**
Oversampled three channel FB	99.6530	99.8098	24.065dB
Oversampled eight channel FB	99.6530	99.7487	24.065 dB

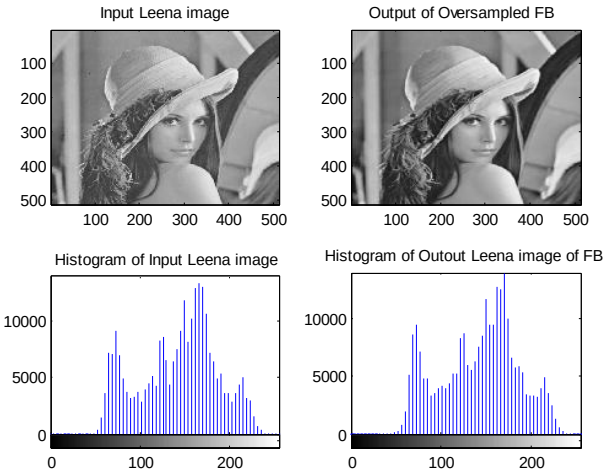

Fig.6: Input and output Leena images with Histograms for 3-channel oversampled filter bank

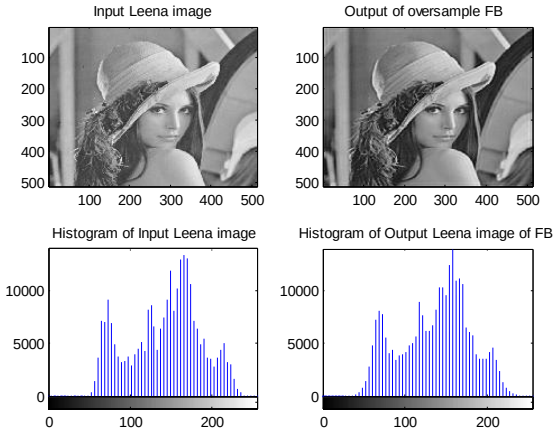

Fig.7: Input and output Leena images with Histograms for 8-channel oversampled filter bank

V. CONCLUSION

In this paper a real valued FIR filter bank of two types i.e. three channel and eight channel oversampled nonuniform filter banks for analysis of 2D image using wavelet transform . To remove aliasing which occurs in oversampled filter banks and achieve resultant near perfect reconstruction of filter bank for any two dimensional images, these two FBs are developed. By using peak signal to noise ratio[PSNR] and wavelet transform for energy restoratation of two dimensional input and output images are shown in table1. Energy of input image is preserved at output image.

VI. REFERENCES

[1] R. Brennan and T. Schneider, *"A flexible filterbank structure for extensive signal manipulations in digital hearing aids,"* in Proc. IEEE International Symposium on Circuits and Systems,May 1998, vol. 6, pp. 569– 572.

[2] Moritz Harteneck, Robert W. Stewart and J.M. Paez- Borrallo *"A filterbank design for oversampled filter banks without aliasing in the subbands",* Signal Processing division ,dept. of Electricalk & Electronics Engineering Uinversity of Strathclyde Glasgow, GI 1XW,UK.

[3] Moritz Harteneck,Stephan Weiss, and Robert W. Stewart *"An oversampled filter bank with different analysis and synthesis filters for the use with adaptive filters"* Signal Processing division ,dept. of Electricalk & Electronics Engineering Uinversity of Strathclyde Glasgow, GI 1XW,UK.

[4] Moritz Harteneck,Stephan Weiss, and Robert W. Stewart *"Design of near perfect reconstruction oversampled filter banks for subband adaptive filters"*,Signal Processing division ,dept. of Electricalk & Electronics Engineering Uinversity of Strathclyde Glasgow, GI 1XW,UK.

[5] Kutluyil Dogancayand Vikram Krishnamurthy *"Application of extreme value theory to level estimation in nonlinearly distorted hidden marko*