ISSN: 2278 – 909X
International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)
Volume 7, Issue 5, May 2018

Modified Bohman window- FIR-Filter using FrFt for ECG de-noising

K.krishnamraju[1] M.Chaitanyakumar[1] M.Balakrishna[1] P.KrishnaRao[1]
Assistantprofessor Assistantprofessor Assistantprofessor Assistantprofessor

[1] Department of Electronics and Communications Engineering, Aditya Institute of Technology y & management, Tekkali, Andhra Pradesh, India.

Abstract

A filter is a linear time invariant system, used for removing undesirable noise from desired signal. A filter has very essential role in denoising bio medical signals. One such signal is ECG[2] (Electrocardiogram) wherein contains heart functioning information. here an attempt is done to remove power line noise from ECG using FIR filter with modified Bohnman window an improvement in the filter performance is observed in terms of RSA(Relative Side lobe Attenuation) of window(Bohman) using Fractional Fourier Transform and higher order polynomial functions as windows. Simulation results are compared with FIR filters using existing windows using MATLAB.

I. Introduction

A filter is designed to pass a band of desired frequencies without any distortion called pass band of filter and to totally block a band of unwanted frequencies called stop band of filter. The digital filters are available as low pass filters, high pass filters; band pass filters and band reject filters. A low pass filter blocks all frequencies above the cut off frequency. Similarly high pass filter passes all frequencies above the specified cut off frequency. The band pass filter allows a particular band of frequencies and the band reject filter rejects the particular band of frequencies and allows the other frequencies.

II. Windowing

The window method (Fourier transform design with window functions) is developed to remedy the undesirable Gibbs's oscillations in the pass band and stop band of the designed FIR filter. Gibb's phenomenon is the phenomenon of causing oscillations in pass band and in stop band because of truncating the infinite Fourier series at n= ± ((N1/2)).While finding an FIR filter that approximates H(n). Then it is natural to seek a window function, which is symmetrical and can gradually weight the designed FIR coefficient down to zeros at both ends for the range of –M ≤ n ≤M; Applying the window sequence to the function. Filter coefficients gives h(n)=h(n).w(n), where w(n) designated the window[4].

Rectangular window:

$$w(n) = 1 \quad \text{……………………………………….. (1)}$$

Hamming window:

$$w(n) = 0.54 - 0.46\ \cos\left(\frac{2\pi n}{N-1}\right)$$

- Note that:

$$w_0(n) \stackrel{\text{def}}{=} w(n + \tfrac{N-1}{2}) = 0.54 + 0.46\ \cos\left(\frac{2\pi n}{N-1}\right) \quad \text{…. (2)}$$

Triangular windows:

With non-zero end-points:

$$w(n) = \frac{2}{N+1}\cdot\left(\frac{N+1}{2} - \left|n - \frac{N-1}{2}\right|\right) \quad \text{…….(3)}$$

Bartlett window:

Triangular window with zero-valued end-points:

$$w(n) = \frac{2}{N-1} \cdot \left(\frac{N-1}{2} - \left| n - \frac{N-1}{2} \right| \right)$$ …. (4)

Bohman window:

Bohman window function A Bohman window is the convolution of two half-duration cosine lobes. In the time domain, it is the product of a triangular window and a single cycle of a cosine with a term added to set the first derivative to zero at the boundary. Bohman windows fall off as 1/w4.

( ) = (1 − | |) cos(| |) + 1 sin(| |) -1 ≤ x ≤ 1

………….. (5)

III. ELECTRO CARDIO GRAM:

The electrocardiogram (ECG or EKG) is a diagnostic tool that measures and records the electrical activity of the heart in exquisite detail. Interpretation of these details allows diagnosis of a wide range of heart conditions. These conditions can vary from minor to life threatening.

ECG WAVE:

Figure-1 **Sample ECG**

The electrical cavity results in p, QRS, and T waves that are of different sizes and shapes. When viewed from different leads, these waves can show a wide range of abnormalities of both the electrical conduction system and the muscle tissue of the hearts 4 pumping chambers.

IV.POLYNOMIAL FUNCTIONS AS WINDOWS[1]:

$$w_m(t) = 1 - K_m \sum_{n=0}^{m} A_{m,n} |t|^{2m-n+1}, \quad -1 \leq t \leq 1. \text{..........} (1)$$

where

$$K_m = \frac{(2m+1)!(-1)^m}{(m!)^2} \qquad A_{m,n} = \frac{(-1)^n \, {}^mC_n}{2m-n+1}.$$

'M' is the order of the window

Polynomial window with zero order:

y1= (2*(1-cos(w)))./(w.^2) …………..2

Polynomial window with first order:

y2=(12*(2-2*cos(w)-w.*sin(w)))./(w.^4)……..3

Polynomial window with second order

y3=(120*(12-(w.^2)+(w.^2).*(cos(w))-6*w.*sin(w)-12*cos(w)))./(w.^6) ……………..4

Polynomial window with third order:

y4=(1680*(w.^3).*sin(w)+20160*(w.^2).*cos(w) -(w.^2).*20160-100800*w.*sin(w)-201600*cos(w)+201600)./(w.^8) ………….5

Polynomial window with fourth order:

y5=(30240*(w.^4).*cos(w)+(w.^3).*604800.*sin (w)+(w.^2).*cos(w)*5443200(w.^2)*54 43200(w.*sin(w)*25401600))cos(w)*50803200+ 50803200+30240*(w.^4))./(w.^10)…………6

ISSN: 2278 – 909X
International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)
Volume 7, Issue 5, May 2018

V. Fractional Fourier Transform:

The fractional Fourier transform (FrFT) is a family of linear transformations generalizing the Fourier transform. It can be thought of as the Fourier transform to the n-th power, where n need not be an integer thus, it can transform a function to any intermediate domain between time and frequency.

A generalization of Fourier Transform, the Fractional Fourier Transform was first introduced by Victor Namias in 1980 [5]. The Fractional Fourier Transform X, of a function x, , [4]is defined by means of the Transformationαwith an angle kernel Ka (t,u). Xa(u) can be expressed as

$$F^a\left[f(x)\right] = \int_{-\infty}^{\infty} K^a(x,x_a) f(x)dx = f^a(x_a) \qquad .....1$$

where

$$K^a(x,x_a) = \exp\left[i\pi\left(x^2 \cot\alpha - 2xx_a + x_a^2 \cot\alpha\right)\right]$$

$$and \quad \alpha = a\pi/2$$

VI. PROPOSED CONCEPT:

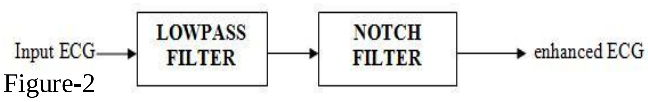

Figure-2

The noisy ECG signal is first applied to lowpass filter for removal higher level noise frequencies then applied to notch filter for removal of power line noise of 60hz.

VII PROPOSED FILTER

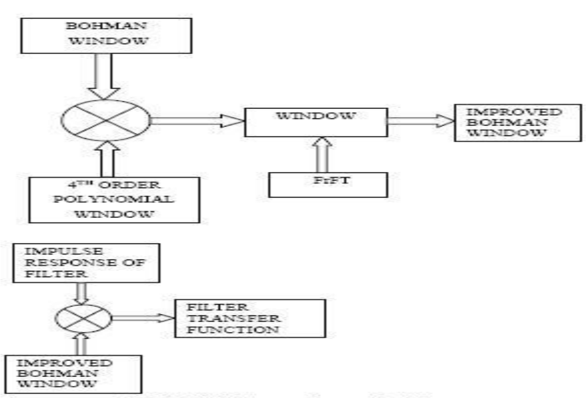

Figure-3.Block diagram of proposed filter

The required filter is designed by convolving the Bohnman window with fourth order polynomial window to the combination which fractional Fourier transform is applied in which RSA is improved. Now this modified window function is applied to impulse response of the filter to get the transfer function of the filter for which ECG with power line noise is applied for filtering it.

VIII SIMULATION RESULTS:

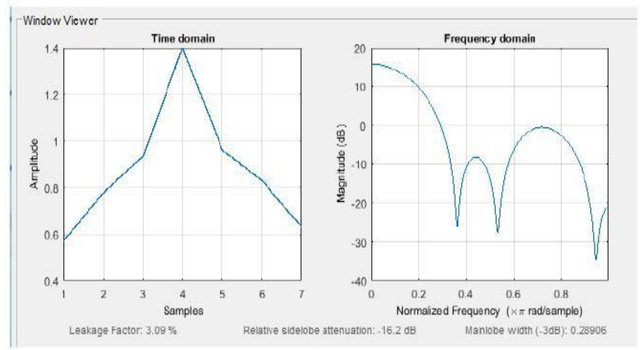

Figure-4 :Response of fourth order polynomial window

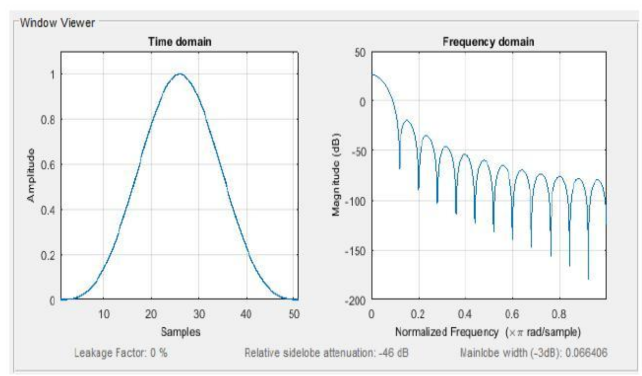

Figure-5 Response of Bohnman widow

ISSN: 2278 – 909X
International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)
Volume 7, Issue 5, May 2018

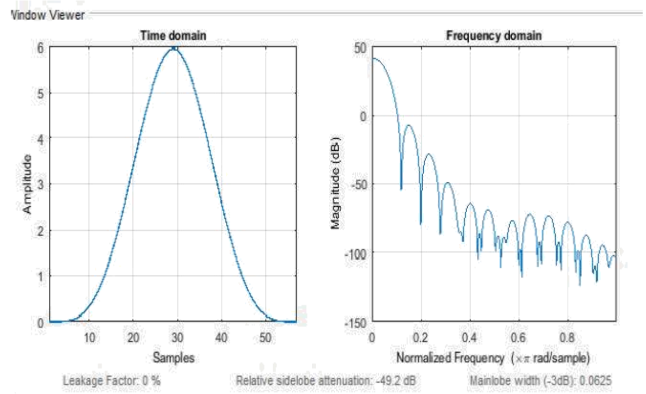

Figure -6: Combination of Bohnman window and polynomial window with order four with frft.

TABLE-1 NUMERICAL ANALYSIS OF PROPOSED WINDOWS:

Windows	Spectral characteristics					
	Without Concept			With Concept		
	RSA	SFLR	MW	RSA	SFLR	MW
BARTLETT	-26.4	29.788686	0.050781	-28.3	29.60832	0.046875
HAMMING	-42.3	48.07038	0.050781	-46.2	51.837933	0.050781
HANNING	-31.5	32.9744	0.054688	-32.7	33.435027	0.0625
BLACKMANN	-58.1	58.38869	0.0625	-61.1	62.11995	0.0625
BOHMANN	-46	51.63581	0.066406	-49.4	49.371507	0.066406

From the table it is observed that RSA of Bohman window is improved that definitely improves the filter performance by improving noise rejection level.

IX RESULTS:

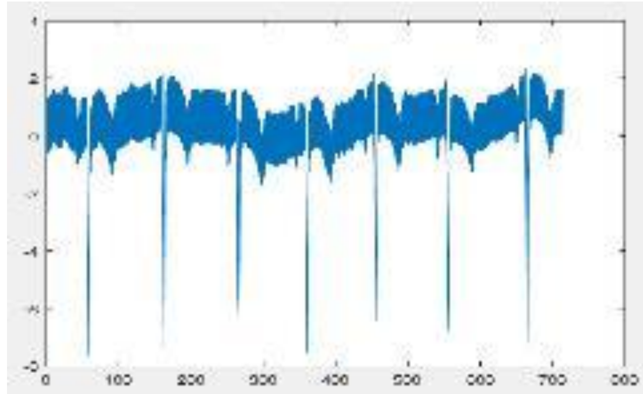

Figure-7: Noisy ECG signal

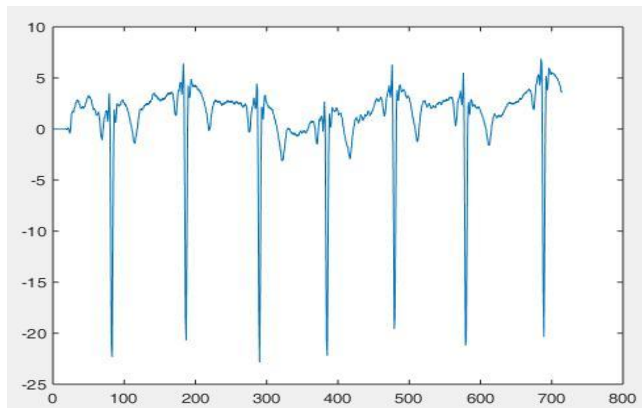

Figure-8: filtered ECG signal output from the proposed filter

CONCLUSION

In this paper we observed from the results that the designed filter using proposed technique improved the filter performance characteristics which enhanced the ECG by eliminating power line interference very effectively. In our project attempt is made only eliminate power line interference similarly many more artefacts of ECG can be removed with our proposed FIR filter which can be encouraged.

REFERENCES:

1. 'Desired Order Continuous Polynomial Time Window Functions for Harmonic Analysis' Puneet Singla, *Member*, *IEEE*, and Tarunraj Singh IEEE TRANSACTIONS ON INSTRUMENTATION AND MEASUREMENT, VOL. 59, NO. 9, SEPTEMBER 2010.

2. MIT-BIH database directory.

3. Sarkar, N. (2003): Elements of digital signal Processing: Khanna

4. J.G. Proakis and D.G. Manolakis on Digital signal processing, Prentice-Hall of India, New, Pages 360 – 365. 2006

5. Namias.V-"The FrFT and Time Frequency representation"- J.Inst.Math.Applications,Vol:25,pp.241-265,1980.

6. . S/N - ECG SIGNAL WITH HYBRID WINDOW TECHNIQUE P.V.Muralidhar , K.krishnamraju , S.K.Nayak ,P.V.S.Nirosha Devi International Journal of Science, Engineering and Technology Research (IJSETR) Volume 1, Issue 4, October 2012

7. Spectral Interpretation of Sinusoidal Wave using Fractional Fourier Transfrom Based FIR window Functions by P. V. Muralidhar, A. S. Srinivasa Rao, S. K. Nayak Vol. 4. n. 6, pp. 652-657

8. Analylsis of Polynomial Windows for FIR Filters for Better Spectral Response International Journal of Engineering Research & Technology (IJERT) Vol. 2 Issue 12, December - 2013 IJERT ISSN: 2278-0181