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Design of Lowpass Fir Filter Using Nuttall and Taylor Window Techniques

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Abstract: ***The digital filter plays major role and area of communication system. In filtering application unwanted signal provides high attenuation. For removal of attenuation from pass band and stop band region and optimal design of filter is required. In this paper represent an optimal design of low pass fir filter using Nutall and Taylor window techniques. The simulation is done by using MATLAB. The comparative analysis performs in term of magnitude and phase response of proposed filter. The Nutall window design shows better result as compare with Taylor window design.***
Keywords: DSP, Digital filter, Low pass filter, FIR filter, Taylor window, Nuttall window, frequency sampling.

I. INTRODUCTION

Digital Signal Processing (DSP) is an area of science And engineering which has evolved rapidly in the past 40 years It is said that the origin of DSP techniques By the seventeenth century can be traced when finite Difference methods numerical integration methods, and Numerical projection methods were developed Solution of physical problems involving constant variables More work This is the result of rapid development Significant progress in digital computer technology And integrated circuit construction DSP techniques are used in different areas, including Speech, radar, sonar, image etc. These techniques are Applied in spectral analysis, channel vocoders, homomorphism processing. [1][2]

type of filter and purpose

SN	Filter	Purpose
1	low pass filter	Passes low frequency band
2	high pass filter	Passes high frequency band
3	band pass filter	Passes selected range of frequency band
4	band stop filter	Stops selected range of frequency

There are two types of filters *i.e.*

A. Finite Impulse Response (FIR) filter
B. Infinite Impulse Response (IIR) filter

II. FINITE IMPULSE RESPONSE

The digital FIR filter has many favorable properties, which is why they are extremely popular in digital signals. One of these properties of processing is that they can display linear steps, which means that the signal in the pass band. There is no dispersion to disperse dispersion occurs when there is a separate delay through different frequency components of the signal a system. The simplest design method for FIR filter is Impulse Response Synchronization (IRT), but unfortunately it is undesirable Due to the event of Gibbs, frequency-domain characteristics are the second design.

III. FILTER DESIGN METHOD

There is a problem of estimate in the FIR filter design and Realization Issues Renewal Step Transfers the ceremony Part of architecture deals with choosing structure Applying the transfer function which can be in the form of Circuit diagram or as a program. There are different Methods for designing FIR filters, i.e. Equivalent, Low-Square, Window, lower-class, campus equi-rial, max flat, At least Pth-ideal, resistive counterpart, generalized Equiripple, Constr. Band Equivalent and Interpolated FIR.

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IV. WINDOW FUNCTION

In this method, a certain bandwidth is generated using a truncated ideal low-pass filter, and then we use a selected window to get certain stop-band attenuation. The filter length L can be changed in the transition band to meet a specified roll-off rate. We start with windowed, truncated low-pass filters, and then do it for other kind of filters, like band-stop, bandpass, and high-pass filters can also be achieved by several techniques.

Any finite-length of a low-pass impulse response may be considered as the product of a window function w and the infinite-length low-pass impulse response.

$$a = \frac{\sin(w_c[n-M])}{\pi[n-M]} W_L[n-M]$$

V. NUTTALL WINDOW

Between Blackman, Extract Blackman and Blackman Harris window, The Nuttall window has the most detailed main lobe and the lowest maximum lab level. The equation for the new window is:

$$\omega(n) = a_0 - a_1\cos\left(2\pi\frac{n}{N-1}\right) + a_2\cos\left(4\pi\frac{n}{N-1}\right) - a_3\cos\left(6\pi\frac{n}{N-1}\right) \ldots\ldots\ldots\ldots\ldots\ldots ()$$

Where n=0, 1, 2….N-1

The equation for the periodic Nuttall

$$\omega(n) = a_0 - a_1\cos\left(2\pi\frac{n}{N}\right) + a_2\cos\left(4\pi\frac{n}{N}\right) - a_3\cos\left(6\pi\frac{n}{N}\right) \ldots\ldots\ldots\ldots\ldots\ldots ()$$

Where n= 0, 1, 2, N-1.

The periodic window is N-periodic. [4]

The coefficients for this window are given in table:-

Coefficient of Nuttall window

a_0	0.3635819
a_1	0.4891775
a_2	0.1365995
a_3	0.0106411

VI. TAYLOR WINDOW

Taylor Loop is used in FIR filter rotation technique in MATLAB is a Taylor loop FIR filter but it is used for feedback and other math works Taylor windows are similar to the windows in the Chebyshev while one Chebyshev is the smallest possible main lobe for the window The specified sandwich level, a teller window allows you to create trade between main lobe width and side lobe level. Taylors delivery avoids the disadvantages of growth, so Taylor window side lobe decreases monotonically, Taylor Window Coefficient is not normalized Taylor windows are usually used in radar applications, such as synthetic weight aperture radar images and antenna designs. [5][6]

VII. DESIGN SIMULATION/RESULT

To design the low pass FIR filter using MATLAB Nuttall and Taylor Window the parameter specifications are:-

Table1-Parameter Specification

PARAMETER	VALUES
Sampling Frequency(F.s.)	48000 Hz
Cut off Frequency(F.s.)	10800 Hz
Order(N)	30

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Table 2 Frequency and Magnitude

FREQUENCY	WINDOW TECHNIQUES	
	NUTTALL	TAYLOR
0.1π	13.1448	-19.0891
0.2π	-12.9642	-20.0534
0.3π	-74.6998	-2.5700
0.4π	-67.9512	-39.0168
0.5π	-76.9714	-5.7209
0.6π	-71.0887	-41.4898
0.7π	-70.5848	-7.5781
0.8π	-77.3212	-36.7980
0.9π	-68.9529	-8.4281
π	-89.8437	-29.2613

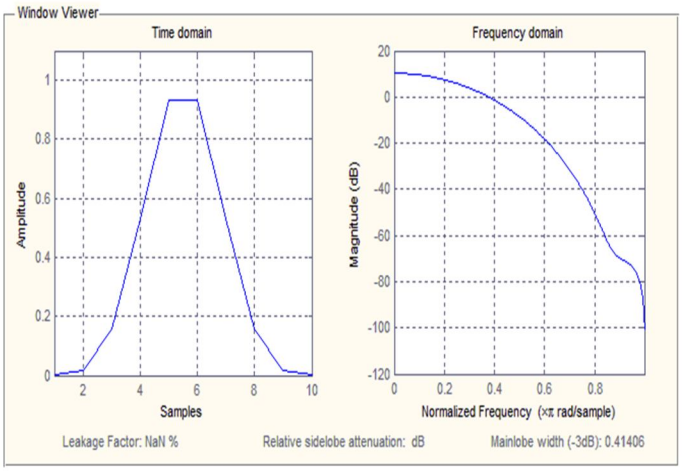

Fig1. Time domain and frequency domain of nuttall window

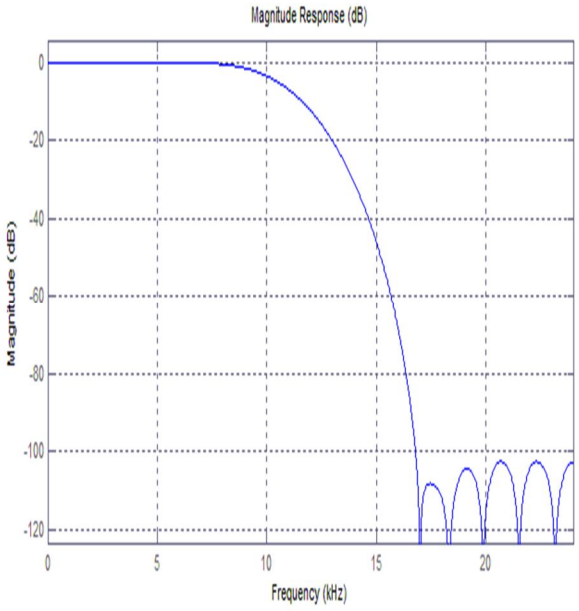

Fig2. Magnitude Response of Nuttall Window Technique

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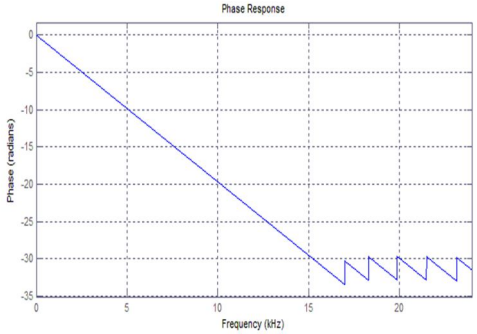

Fig3. Phase Response of Nuttall Window Technique

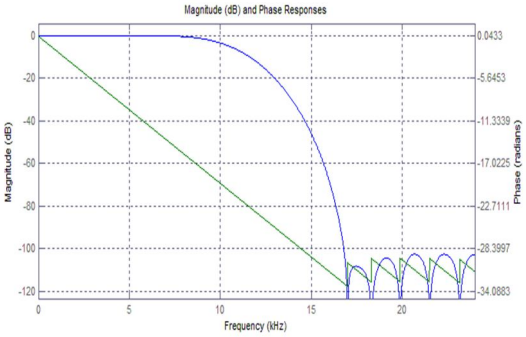

Fig4. Magnitude and Phase of Nuttall Window Technique

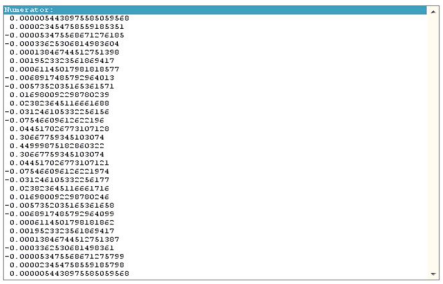

Fig5. Filter coefficient on Nuttall Window Technique

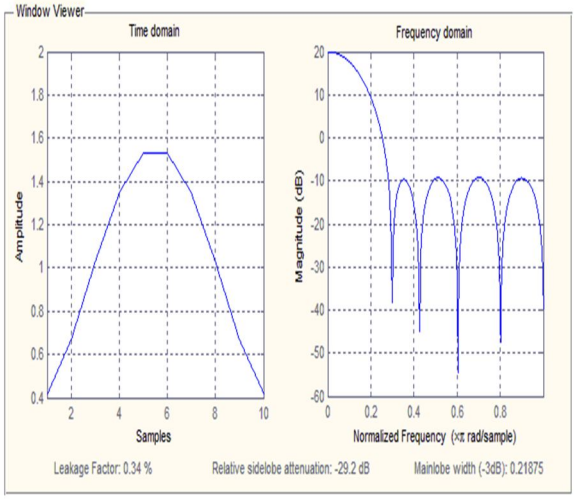

Fig6. Time domain and frequency domain of Taylor window

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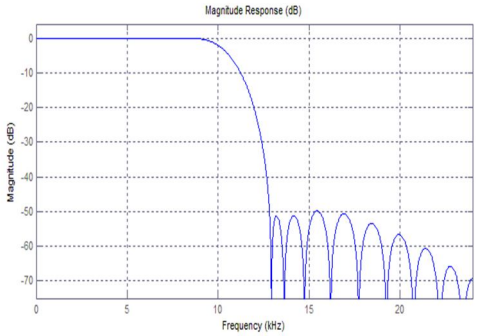

Fig7. Magnitude Response of Taylor Window Technique

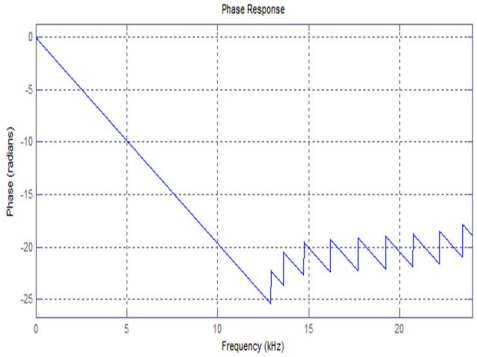

Fig8. Phase Response of Taylor Window Technique

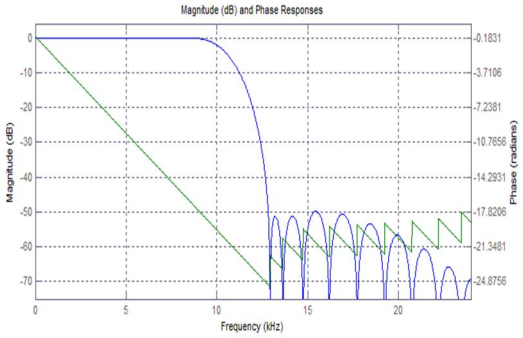

Fig9. Magnitude and Phase of Taylor Window Technique

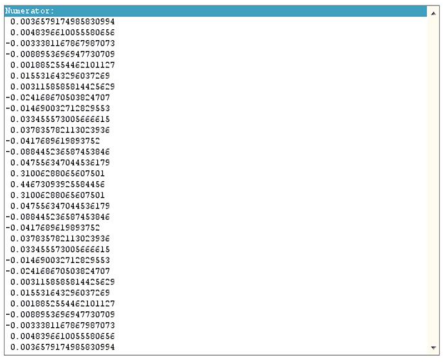

Fig10. Filter coefficient on Taylor Window Technique

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VIII. CONCLUSION

In this research paper, low pass filter has been designed and simulated using Nuttall and Taylor window. By analyzing magnitude and phase response using MATLAB simulation of order 30, it conclude that Nuttall window has better pass band response as compare to Taylor window. So it state that Nuttall window technique is perfect than Taylor window technique.

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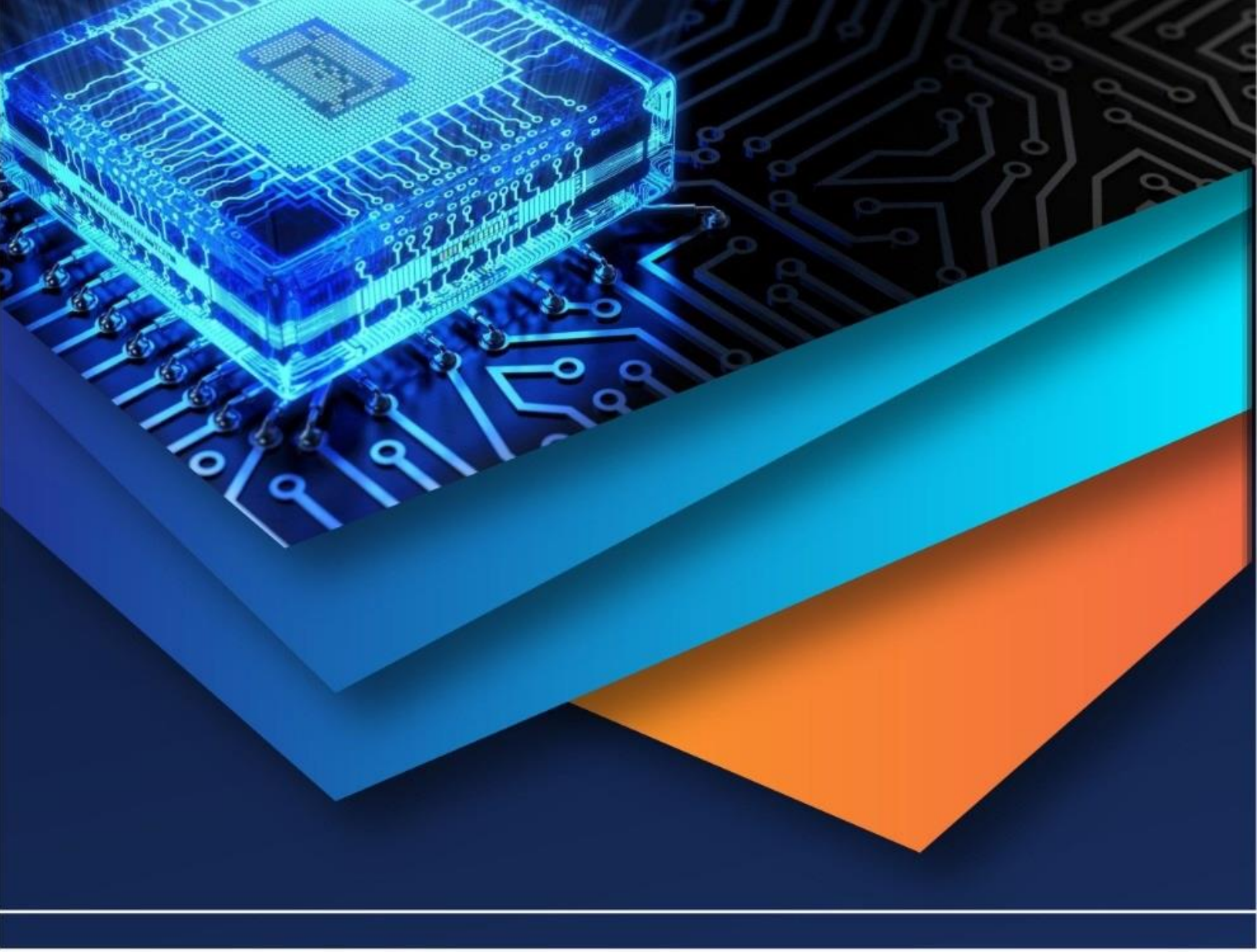

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