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Design of FIR Filter to Improve Signal Using Genetic Algorithm

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Abstract: Over the past few years, hands-free systems are used for safety purposes and in mobile communications but now-a-days they are also used in video-conferencing systems. Today hands-free communication is more preferred by people. The big advantage of hand-set system is that more than one individual in a conversation at the same time is allowed and the other advantage is that the person can moves freely in the room because of hands free system. But because of this advancement there is a significant increase in noise level and the received signal may get distorted. To receive the undistorted signal we must use filters which may minimize the effect of noise and gives the signal equivalent to original signal. However in practice to design an ideal filter is impossible. For the same purpose in our work we have design a FIR filter model which is using genetic algorithm and thencompared with other algorithms. The main objective of the research is that the final results would be free from any noise.
Keywords : DSP, FIR, GA, IIR, AEC, echo etc

I. INTRODUCTION

In twenty-first century, Digital Signal Processing (DSP) is one among the most powerful technologies which are shaping engineering world. DSP is used in different areas like communications, medical, radar, imaging, sonar, music etc. Each of these areas has their own algorithms, mathematics, and techniques. [1] In analog and digital handsets, acoustic echo is generated. This acoustic echo is produced in handsets and hands-free devices due to poor voice coupling. Voice degradation is caused by voice compressing encoding/decoding devices which process the voice paths within the handsets and in the wireless networks. This returns echo signals with highly variable properties. The quality of call is greatly diminished due to compounded inherent digital transmission delays. In hands-free systems, the background noise is generated through the network apart from acoustic. A multipath audio is created and transmitted back to talker when additional sounds are directly or indirectly picked up by the microphone. The distorted speech is caused by surrounding noise when passes through the digital cellular vocoder whether in automobiles or in crowded-public environment. Echo is generated by digital processing delay and speech-compression techniques. Delays are encountered in signals when they are processed through various routes like copper wire, optical fiber, gateway, satellite etc. [2] The digital filters are an essential part of DSP. In fact, the performance of design filters is one of the key reasons that DSP has become so popular in communication. The purpose of the filters is to allow desired frequencies to pass unaltered, while completely blocking noise. [1] To remove unwanted noise from signals, filtering is used in many digital systems. There are mainly two types of filters: finite impulse response (FIR) filters and infinite impulse response (IIR) filters. [3] A FIR digital filter has finite impulse response because there is no feedback in this filter. The main issue is power reduction in wireless systems. Today, DSP is used to resolve the transmitted information in many wireless communication systems. FIR filters are main building blocks in DSP. [4] IIR filters have infinite impulse response because they have feedback. [5]

II. LITERATURE SURVEY

Performance of FIR Filter design has been analyzed by Shamsul and Hasan. [6] The output response curves using Blackman window method, Frequency sampling method and Optimal method are compared with the ideal response curve. The Optimal method produced best results because it minimizes the maximum weighted error between the desired response and the actual response.

Yu and Lim applied genetic algorithm (GA) to optimize the discrete coefficient values of very sharp linear phase FIR digital filters generated by the frequency-response masking (FRM) technique. Advantage of applying GA as compared to linear optimization technique is that the values using GA are very close to that of the continuous solution as compared to rounding the coefficient values of the continuous solutions. [7]

Goyal and Raina identified power dissipation as major issue in wireless communication system and portable devices. Power dissipation is measured by the hamming distance between the number of toggled signal and consecutive coefficient values. [4]

Awad presented merger of filter parameters using adaptive window method of FIR filter design in which adaptive FIR filter is used. Adaptive FIR filter has good performance and it is stable when implement in non-recursive form. [8]

Recently, most optimization techniques were formulated in terms of minimizing and maximizing a single objective. However, there is much attention towards formulating these problems in terms of multi-objectives. The magnitude and group delay is minimized in designing of recursive digital filters by Kaur and Kaur. [9]

The equiripple behavior is shown by optimal response and the Chebyshev approximation is used to count the number of ripples shown by Shayesheh. [10].

Due to the following issues like formulation of problems or implementation problems in algorithms, success is not achieved even after number of attempts. Turgay and Cevdet Ince presented Otto Herrmann method for designing equiripple filters. After solving nonlinear equations, the maximum number of ripples is obtained. Another method (other than optimal Chebyshev approximation) has limitation of designing of low-order filters. [11]

Nurhan and Cetinkaya presented that frequency sampling method is easy to design the FIR filter. This method designs the coefficients of filter over and over until the error is minimized and to determine filter coefficients by using optimal method is difficult. [12]

To detect and remove the echo we use a device named Echo canceller. The three main Components of echo canceller are presented by Bhupender and Dhull. [13]

In the noise cancellation model various are used to remove the noise level from the desired output. Original signal may be any sinusoidal signal is always free from any noise. In the original signal some noise is introduced that is additive white Gaussian noise (AWGN) which always comes into practice when the signal is passing through channel is described by Lu et.al[14]

Enzner, Gerald presented that echo estimator and a subtractor is used for the filter designing. The received path is monitored by the echo estimator. Then the estimated echo is applied to subtractor so that the path is eliminated and the final output may be seen at the receiving end is free from any noise. [15]

III. PROPOSED MODEL

To design a low pass FIR filter with ideal magnitude response, zero phase and very small phase variation, the method is applied through MATLAB. The effect of which would be to nullify the noise level in the signal and the received signal will be echo free. The proposed work is to make a model which is equivalent to an ideal filter that would improve the system performance by reducing the noise level or by attenuating the signal at ideal cut off frequency. The filter is designed using genetic algorithm (GA) in the model to remove the noise. Before using GA, we use acoustic echo cancellation (AEC). It is a process to cancel the echo. It is important in conferences due to presence of full duplex transmission. In AEC, microphone has two signals:

A. The near-end signal

B. The far-end signal

The aim of AEC is to allow the near-end signal for transmission after removing the far-end signal from the microphone. [16]

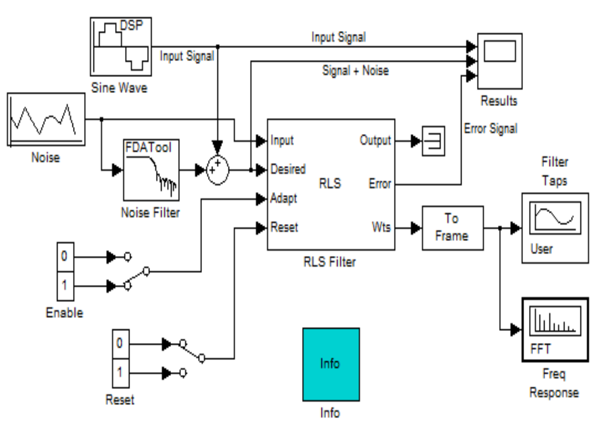

Fig.1.1: Proposed Model

C. Methodology for GA:

The concept of genetic algorithms (GA) was inspired by “Survival of the fittest” that derived from evolutionary theory which describes the mechanism of natural selection. Natural selection favors individuals who survive in the environment i.e. weak and unfit species extinct and the strong ones survive and reproduce.

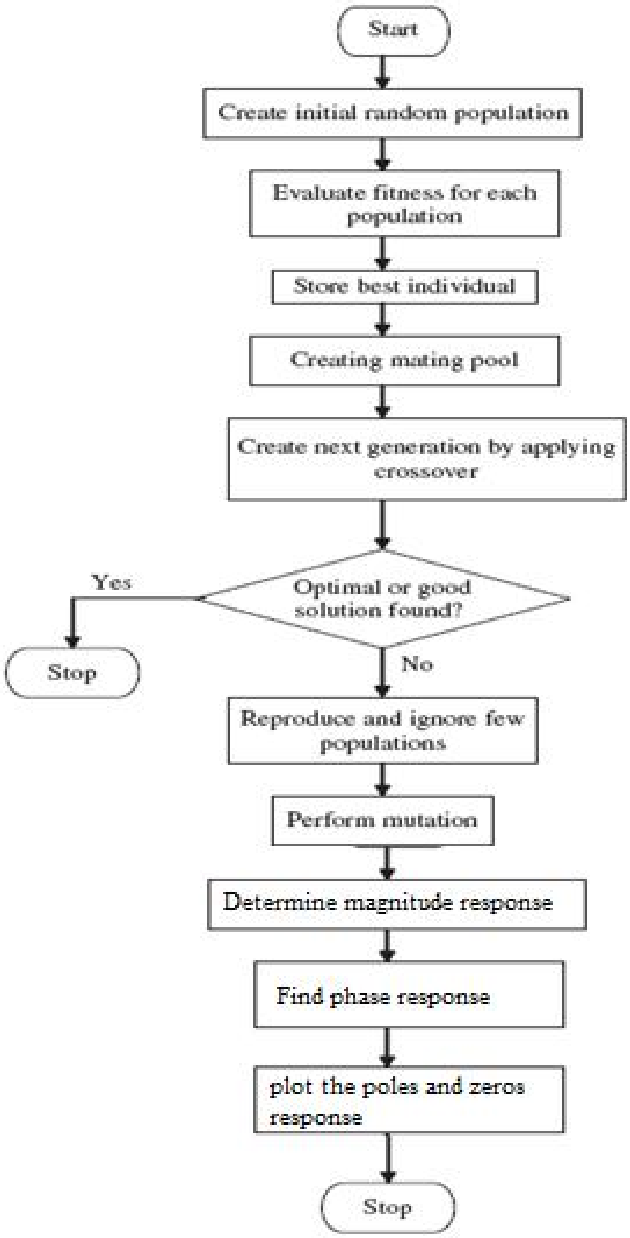

Fig. 1.2: Flow chart of GA

IV. RESULTS

The reults would be seen in the graphical form. First the magnitude response and phase response is shown by fig. 1.3 an 1.4 respectively. Then the original signal shown by figure1.5(b) in the sin waveform. And then figure1.5(c) shows the waveform which is a combination of signal and noise that’s why the waveform is in distorted form. After applying low pass filter (designed by GA) whose waveform is shown in figure 1.5(a) the final output would be shown in figure 1.5(d). The Output signal is however somewhat distorted as no filter is ideal filter so there is some error signal which is the difference between the desired and the received output.

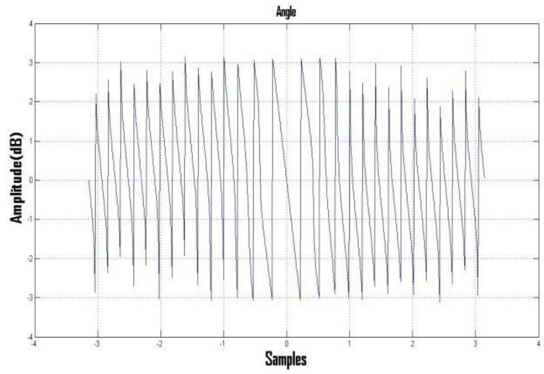

Fig.1.3: Phase response

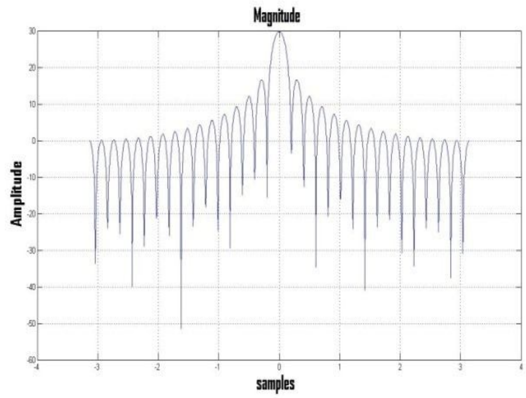

Fig. 1.4: Magnitude Response

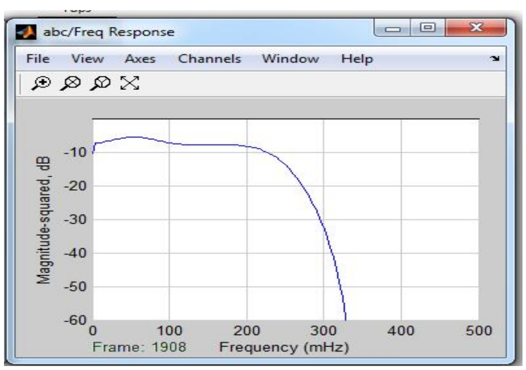

Fig. 1.5 (a): Output of Low pass filter

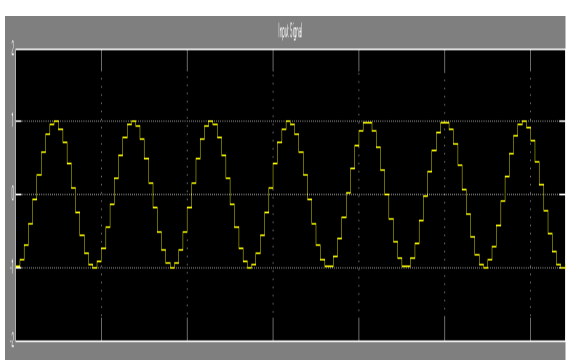

Fig. 1.5 (b): Original Signal

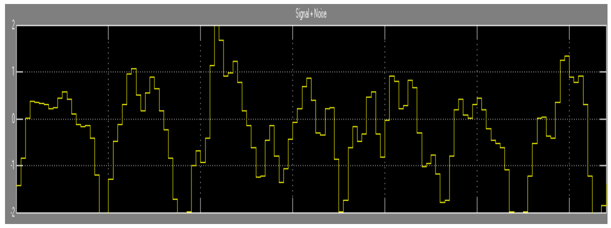

Fig. 1.5(c): Distorted Signal

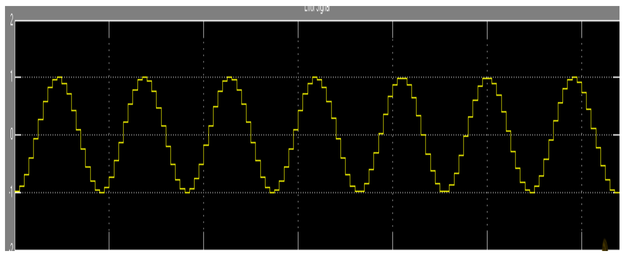

Fig. 1.5 (d): Filtered signal

V. COMPARISON

There should be flat passband, flat stop band and very small transition bandwidth in ideal case of low pass filter. Fig1.6 shows that in Hamming Window the passband is flat but there are large ripples in stopband and the transition bandwidth is also large. In Parks McClellan there are small ripples in passband, very large ripples in stopband and transition bandwidth is very small. Using GA there is small ripples in passband, very small ripples in stopband and transition band width is very small.

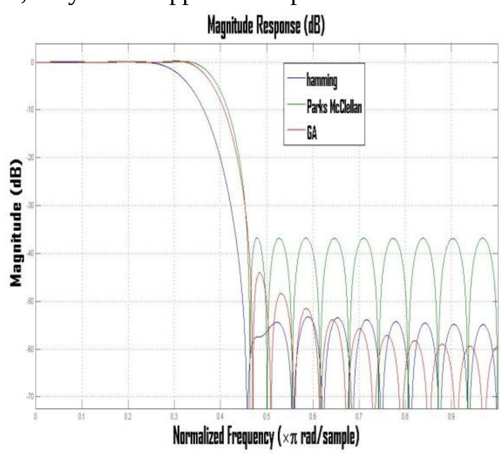

Fig. 1.6: Comparisons between Magnitude Response using different Approaches

VI. CONCLUSION & FUTURE SCOPE

This paper represents the designing of FIR filters using GA to remove noise and comparison with hamming window and Parks McClellan. The magnitude response of GA is relatively better than Hamming Window and Parks McClellan techniques. In this, practical noise cancellation model is used which filter out the echo from the signal and the received signal is distortion free. In future the same algorithm may be used for bandpass filter or some other technique may be used.

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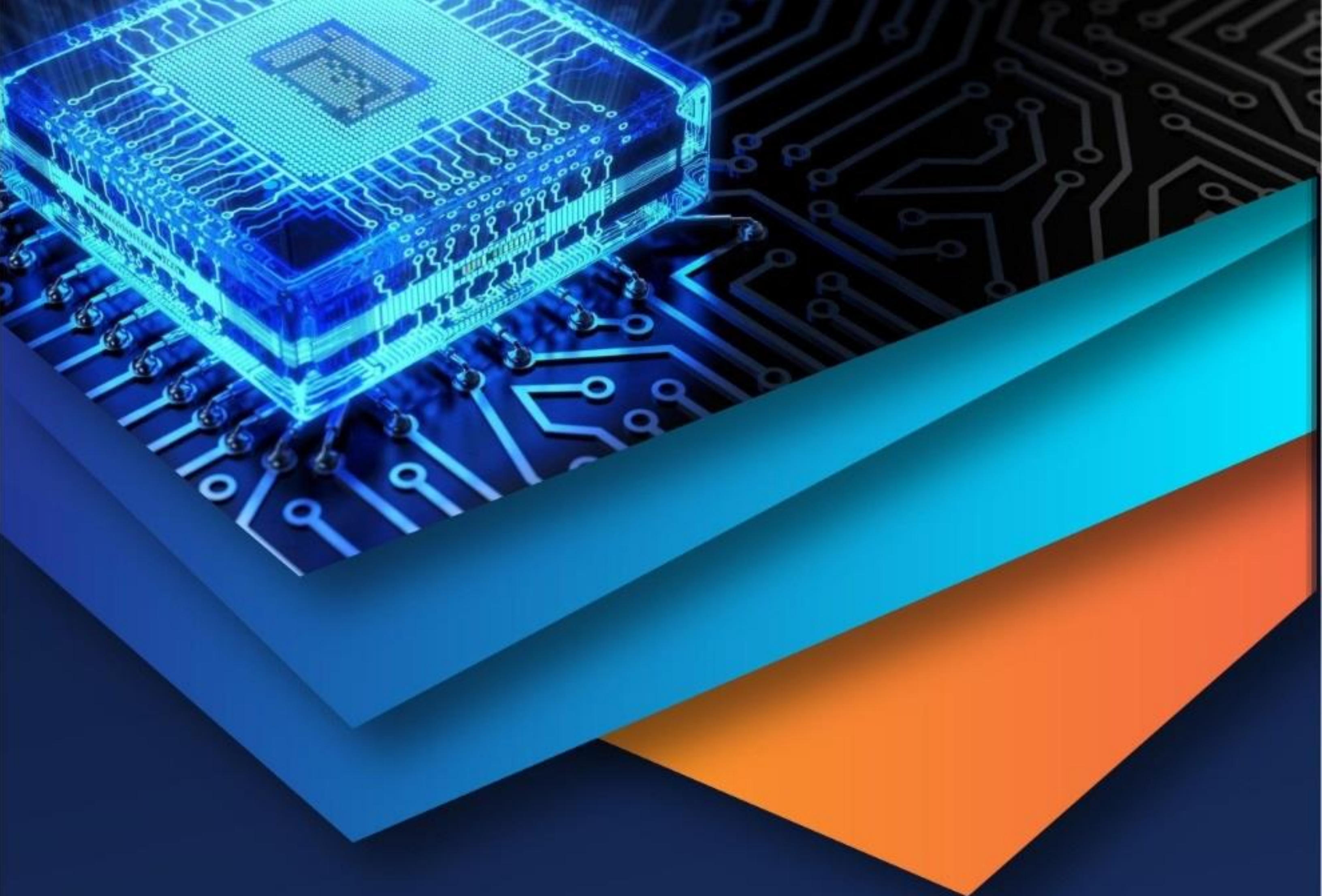

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