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Hardware Implementation of Notch IIR Filter

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***Abstract*— Digital filter is a system, which applies a mathematical operation to discrete time signal x[n] in order to diminish or increase the particular aspect of signal. In this manuscript, digital Notch infinite impulse response (IIR) filter is employed. In filter design, a band stop filter, also known as a band reject filter, is a filter that allows most frequencies unchanged but has a very low level in a particular range. A band-stop filter with a condensed stop-band is a notch filter. This paper carries out the hardware implementation of the digital Notch filter. We have used IIR direct form- II structures for implementation. Time-changing bandwidth notch filters have been implemented using IIR structures. Xilinx ISE Tool is used to implement the suggested design on an FPGA. This Notch filter is also validated using MATLAB for sampling frequency of 1000 samples/second with notch frequency of 300 Hz. Here the input test data is taken with three frequency component of 100, 300 and 700 Hz. The hardware and software (MATLAB) implemented results clearly stops the 300 Hz frequency component with improved timing.**

Keywords*— Hardware implementation, Notch filter, FPGA, IIR filter, Direct form structure.

I. INTRODUCTION

The Notch filter, which is used to eliminate a single frequency or a narrow frequency, has a wide range of applications. When it comes to the audio system, a notch filter can be utilized to eliminate disruptive frequencies like power-line hum [1]. Additionally, it can be used to disable a particular set of interfering frequencies in software-defined radio and radio receivers.

The filtering activity that needs to be carried out on a continuous time signal is implemented by a digital filter using computation. A block diagram of the process used in this method of frequency-selective filter design is displayed in figure 1. The continuous-time signal x(t) is converted into a corresponding sequence of numbers using the "Analog-to-digital (A/D) converter" block [2]. The digital filter transforms the sequence of numbers x[n] into a new sequence of numbers y[n], which is then translated into the corresponding continuous time signal by the digital-to-analog (D/A) converter on a sample-by-sample basis by the digital filter. At the system's output, the reconstruction (low-pass) filter [3] creates a continuous-time signal y(t), which represents the filtered form of the original input signal x(t).

When researching digital filters, it's crucial to keep the following two things in mind: To take advantage of well-understood discrete-time, the fundamental design method is typically based on the usage of analogue or infinite precision models for the sample of the input data and all internal calculations.

The input data and its internal operations are all quantized to a finite precision time, whenever another discrete time filter [4] is built in a digital form for actual usage, as we described in figure (1). Whenever another one is the discrete time filter [4] is implemented in a digital form for practice use, as we mentioned in the figure (1), the input data and the internal manipulation are all quantize to a finite precision time.

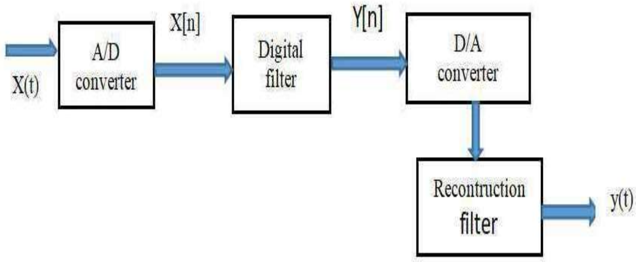

Figure-1: A continuous-time signal filtering system, made for a digital filter

Using either the finite impulse response (FIR) order form or the infinite impulse response (IIR), the digital notch filter can be created. An IIR notch filter is preferred over a FIR notch filter for reducing the computational complexity and signal technique delay. But the IIR notch filter have a transient response and might damage the starting portion of processed signal. Filter order is responsible for transient response duration, so filter designer uses the lower order notch filter [5]. Dr. Joseph H. Piskorowski proposed an answer in an effort to suppress the initial time varying analysis with notch bandwidth [6].

A function that varied in time was used to gradually expand the pole radius to the desired amount, starting with a tiny value for the pole radius. When a result, the initial samples had a broad notch width, and as the transient diminished, the notch width shrank. In [7], an enhanced

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