Hardware Optimization For Reconfigurable Polyphase FFT Design in SDR

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Abstract

Polyphase FFT techniques implemented for channelization algorithm for receiving narrow band signals . In a multistandard wireless communication receiver, channelizer must have the capability of extracting multiple channels of distinct bandwidth corresponding to the different communication standards. Reconfigurability in multistage filtering is required to design a prototype filter bank technique for selecting the distinct polyphase subfilters and taps for different standards. It is proposed that the architecture designed for polyphase channelizer is considered for receiving narrow band signals by reducing the number of coeffecients and the design complexity for the physical implementation**.**

Keywords: *FIR Filter, Multi-standard wireless communication receivers, Channelizer, Reconfigurability, Channelization.*

1. Introduction

Channelization is the extraction of independent communication channels from a wideband signal, performed in the receiver of a communications device. Channelization is achieved by filtering, to isolate the channels of interest, and down-conversion, to prepare the channels for subsequent baseband processing. The non-uniform channelizer needs to reconfigurable in case the allocation and number of nonuniform channels varies within the frequency band. Hence, channel bandwidth flexibility and reconfigurability are two of the most desirable characteristics of a non-uniform channelizer. The functions need to be performed with low complexity and minimum reconfiguration overhead mainly to ensure efficient utilization of the constrained resources. The channel adaptation can be accomplished by using a reconfigurable finite impulse response (FIR) filter

2. Multirate filter bank

A multirate filter is a digital filter that changes the input sampling rate of the input signal into another desired one. These filters are of an essential importance in communications, image processing, digital audio, and multimedia.

2.1 Multistage filtering

Multirate Digital signal Processing is used to filter and shift to baseband all the independent information channels. Multirate signal processing is possibile in the polyphase decomposition of a digital filter .This can be applied to interpolation and decimation filters in order to carry out the convolution operations at the lower sample rate, reducing the number of operations per second.

3. Decimation

It has two process filtering and downsampling . filter employed is a low pass filter which limit the bandwidth of the input signal to avoid the overlapping or anti alaising of the output signal with its shifted replicas Multirate filtering techniques based on polyphase FIR filter partitions

4. Channelization

Channelizer designs are based on frequency transforms such as the FFT. These techniques are extremely efficient at simultaneously channelising a number of channels. Frequency-transform techniques can be highly optimised . Through these optimisations it is possible to develop single-chip channelisers capable of down-converting thousands of channels simultaneously. Reconfigurability in the filter design leads to dynamic frequency response.

4.1 Uniform Channelisation

Frequency transforms, such as the FFT, are special cases of channeliser designs. They divide the input bandwidth into a number of evenly spaced frequency bands, commonly referred to as "bins", in order to allow the frequency content of an input signal to be analysed. In fact, the operation of the FFT is analogous to a stack of evenly spaced band-pass filters, where each of the frequency bins represents the output of a filter. When viewed in this way, an FFT can be considered as a simple channeliser that converts an input signal into N evenly spaced channels, where N is the length of the FFT. Uniform DFT-FB can be used because of low degree of complexity.

5. Polyphase filter bank algorithm

The polyphase DFT has much better adjacent channel rejection in a steady state condition. The windowing function improves the filter side lobes but increase the width of main lobe. These characteristics may be improved by properly designed filter banks. Polyphase filter consists of 2N independent FIR filters Where N is the number of channels in the polyphase FFT. T Tap FIR filter computes T multiplication operation. The polyphase filter bank algorithm is a very efficient way to implement a uniformly distributed multichannel filter bank using a fast Fourier transform. In standard channelizer designs, the bandwidth of the prototype is specified in accord with the end use of the channelizer outputs[8]. when a channelizer is used to separate adjacent communication channels, which are characterized by known center frequencies and known controlled nonoverlapping bandwidths, the channelizer must preserve separation of the channel outputs. Inadequate adjacent channel separation results in adjacent channel interference .The length of any FIR filter is controlled by the ratio of input sample rate to filter transition bandwidth.

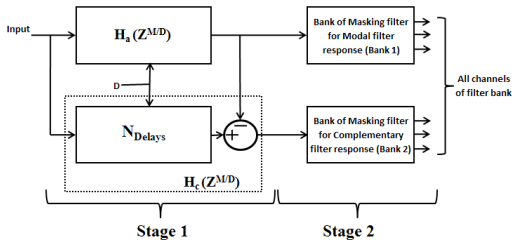

fig. 1 Proposed Filter Bank

6. Proposed system

The reconfigurability of the receiver is accomplished by switching among different Filter banks, each designed for a particular standard. Same hardware platform is reusable for different system parameters configurations without requiring any hardware changes to Software defined radio receiver. To realize a filter bank, which can be reconfigured to accommodate multiple standards with reduced hardware overhead , it is proposed that Frequency response masking based reconfigurable polyphase Filter bank architecture . A polyphase filter that uses different decimated resampling factors for maximally decimated, under decimated, over decimated, and combined up and down sampled is used for reducing the area ,time power optimization efficiency. This technique consists of synthesis filters and analysis filters. Each sub band filter operates on 1/N the of the input samples Input rate has its specifications controlled by its output rate due to Nyquist sampling criterion after spectral folding due to down sample operation. The length of the finite impulse response (FIR) prototype filter s required to satisfy the filter specifications. The filter using the same hardware requires high level of flexibility in DSP. Polyphase filter consists of 2N independent FIR filters , where N is the number of channels in the polyphase FFT. T tap FIR filter computes T multiplication operation x(n-i) input samples , where a_i is the filter coefficients.

$$y(n) = \sum_{i=0}^{L} a_i\, x(n-i) \qquad \text{- [1]}$$

7. Simulation Results:

Factorization specifies the factors for each stage . The product of all the factors in the factorization input must equal the factor input value. Factor specifies the sampling frequency conversion factor of the multirate filter factor. Multistage design requires less computation and storage than a single stage design. If the sampling frequency conversion factor M contains the factors M1,M2 and M3.such that M=M1*M2*M3 andM1>M2>M3>1.

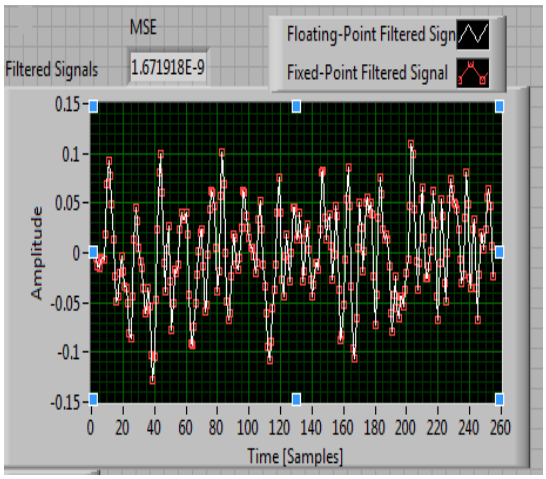

fig. 1 Amplitude vs time graph of Multistage multirate filter.

8. Conclusions

A modal filter and its complementary filter is proposed , then each delay of these filters is replaced by M delays which results in much sharper transition bands .Different filter banks for multi standard software defined radio receivers were discussed. The proposed filter can extract non uniform bandwidths and very narrow bandwidth channels compared to conventional Filter banks. The additional optimization methods may be adopted to reduce the complexity to a minimum. The frequency response masking (FRM) based filter bank and coefficient decimation (CD) based filter bank, which can offer a good trade-off between reconfigure ability and low complexity and satisfy most of the requirements for SDR receivers.

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