Correct and Approximate Algorithms for the channel outline Optimization issue

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Abstract- The filter coefficients are finding by using the filter design optimization (FDO).The filter satisfying the filter constraints and minimum complexity. To implement coefficient multiplications are used adders and subtractors. The complexity is depending on the adders and subtractors here reduce the adders subtractors. The complexity reduced by using the exact algorithm. The exact FDO algorithm is apply only small number of coefficients. Approximate FDO algorithm used to apply for the more number of coefficients.

Keywords- Filter Design Optimization (FDO) , Exact Algoritham and Approximate algorithms, Xilinx.

I. INTRODUCTION

Digital filtering is a Omnipresent operation in computerized signal processing, applications and is acknowledged utilizing finite impulse response (FIR) . The IIR filter always requires less number of coefficients than the FIR filter.

$$\mathrm{Y(n)} = \sum_{i=0}^{N-1} h_i . x(n-i)$$

the above equation is output of an N-tap FIR filter where N is the length of the filter. h_i is the coefficient of the filter,an (n-i) is the previous filter. The given figure shows diverse types of the of N-tap FIR channel. Figure 1(a) shows direct transform and 1(b) shows transposed form.

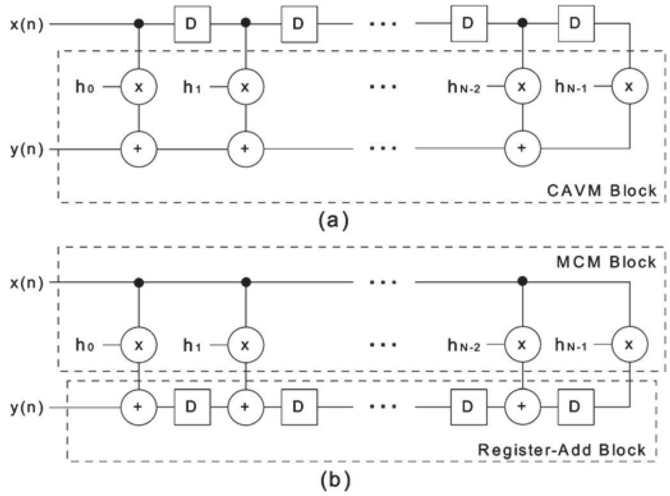


Figure 1. Diverse types of a N-tap FIR channel: (a) direct; (b) transposed.

The many-sided quality of the FIR channel configuration is ruled by the multiplication of channel coefficients when moved renditions of the channel info, i.e., the constant array-vector multiplication (CAVM) hinder in the immediate type of Fig. 1(a) or by the multiplication of channel coefficients by the channel info, i.e., the multiple constant multiplications (MCM) obstruct in the transposed type of Fig. 1(b) . Since channel coefficients are settled and decided previously and the acknowledgment of a multiplier in equipment is costly as far as zone, defer, and power scattering, these CAVM and MCM operations are for the most part actualized under a movement includes engineering utilizing just moves, adders, and subtractors. Many algorithms are used to design MCM block targeting optimization of delay, area, power dissipation***)*** but also reduce the number of operators. To design the CAVM we need less number of operations and to decrease the delay and gate level area of the CAVM design.
The exact FDO algorithm is called SIREN. By using this algorithm find solutions symmetric filters less than 40 coefficients. Approximate algorithm is called NAIAD. The algorithm handle symmetric filters more than 100 coefficients up to 325.

I. Multiplierless design of the CAVM and MCM block

The CAVM block of the transform of the form is

$$y = h_0 x_{0+h1} x_1 + \ldots + h_{N-1} x_{N-1}$$

Here xi for input filter of the time shifted version.

$$0 \leq i \leq N-1$$

The MCM block of the transposed form of the Multiplications in the form of

$$Y_0 = h_0 x y_1 = h_1 x \ldots y_{N-1} = h_{N-1} x, \text{ where}$$

x denotes the input filter. The Digit based recording (DBR) technique [1] defines Number representation. The decomposition of the liner Transform as shown in below. The Linear transform y=21x0+53x1 is as follows:

$$y = 21_{x0} + 53_{x1} = (10101)_{CSD} x0 + (1010101)_{CSD} x1$$
$$= x0{<<}4 + x0{<<}2 + x0 + x1{<<}6 \;\; x1{<<}4 + x1{<<}2 + x1$$

Figure (2a) required 6 operations. Here Constant multiplications are y0=21x and y1=53x in as it follows MCM block.

$$y_0 = 21x = (10101)_{CSD} x = x{<<}4 + x{<<}2 + x$$

$$y1=53x=(1010101)_{CSD}x=x<<6+x<<4+x<<2+x$$

Here figure (2b) required 5 operations as shown in figure.

II. Multiplier less Design of the MCM Operation-

MCM block are designed by the shift-adds Are two types Graph based (GB) [4],[5],[6] techniques and Common sub expression elimination (CSE) Algorithm[2],[3].CSE means number representation. It has possible to choose the Best sub expression. Drawback of the CSE is Number representation .GB methods are not to any number representation. Aim of the GB is to find intermediate sub expression. So GB is the best solution than CSE methods. Figure (2b) is Example of the MCM.

III. Multiplier less Design of the CAVM Operation-

The algorithm also known as ECHO .It consists of two types In its initial segment, the movement includes acknowledge of constants in the CAVM operation are discovered utilizing a MCM algorithm. In its second part, the constants in the straight change are supplanted with their genuine izations in the MCM arrangement and the common sub expressions are removed iteratively utilizing an arrangement of changes.

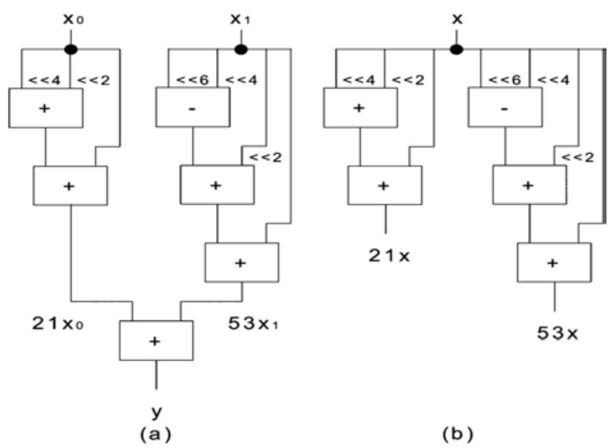


Figure 2. Multiplier less realization of constant multiplications using the DBR Technique [35]:(a.)21xo+53x1 ;(b)21x and 53x.

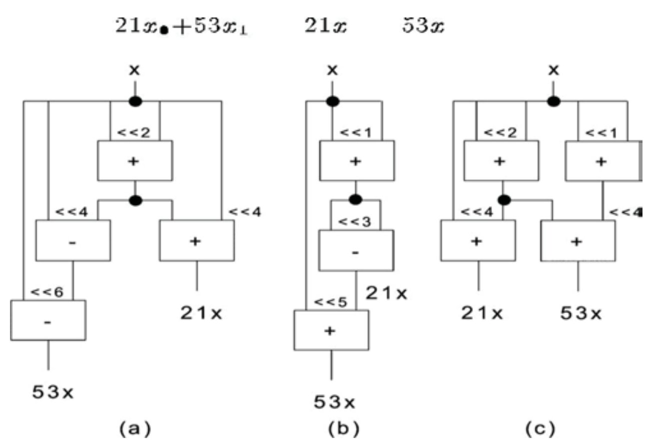


Figure. 3. Multiplier less realization of 21x and 53x : (a) exact CSE algorithm [7]; (b)the exact GB algorithm [9]; (c) Approximate GB algorithm [9] .

IV. Filter Design Optimization

$$G(w)=\sum_{i=0}^{[M]} di \text{ hi } \cos(w(M-i))$$

The above equation is zero-phase frequency response of a symmetric FIR filter. Where di = 2-ki, M with ki, M is the kromecker delta and M= (N-1)/2, hi € R with -1 ≤ hi ≤1, and w € R is the angular frequency.

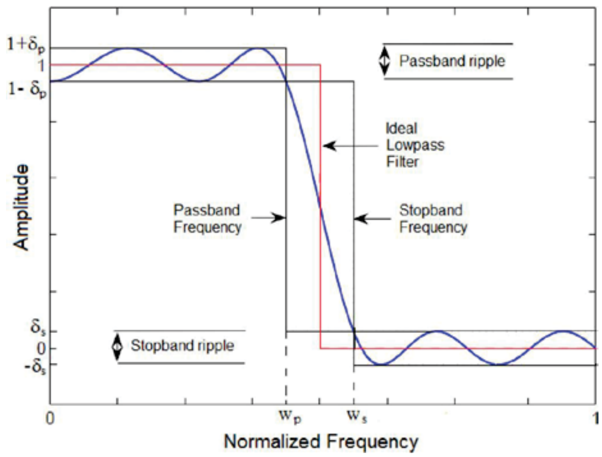


Figure. 4. Zero-phase frequency response of a low-pass FIR filter

A low pass filter is shown in above Fig.5 and assuming that the stop band gain and desired pass band are equal to 0 and 1 respectively .The filter satisfy the given below equations.

$$1-\delta_p \leq G(w) \leq 1+\delta_p, \quad w \in [0, w_p]$$
$$-\delta_s \leq G(w) \leq \delta_s, \quad w \in [w_s, \pi]$$

There is no relation between Pass band gain and DSP applications. Scaling factor (s.) can be added into the constraints of the filter as follows shown in below

s $s(1-\delta_p) \leq G(w) \leq s(1+\delta_p), \quad w \in [0, w_p]$

Where s_l and s_u is upper bounds of s. s_l is lower bands of s .

A straightforward filter design technique (SFDT) having 2 steps i)FIR filter is realized by using the minimum number of sub tractors /adders .ii)The filter coefficients ,that respect the filter constrains, are found by using the filter design.

II. PROPOSED ALGORITHM

A. Exact and Approximate FDO

It is mainly 2 sub-sections. They are NAIAD and SIREN by using this 2 sub-sections filter constrains given for a symmetric filter. NAIAD is required to target constraints of the filter, optimization of the number of operations and FIR filter of the direct form. SIREN is the FIR filter of the transposed form optimization of the number of operations without a delay constraint.

B. SIREN: An Exact FDO algorithm

SIREN was produced to find an arrangement of channel coefficients yielding a base number of adders / subtractors in the channel outline and fulfilling the channel requirements. Its pseudo-code is given in Algorithm 1. It takes the five-tuple fspec indicating the channel particulars as information and returns an arrangement of fixed-point coefficients sol. In Algorithm 1, remains for the quantization esteem used to change over skimming direct numbers toward whole numbers.

ALGORITHM-1

SIREN(fspec)
Q=0, sol={ }
h^l, h^u, s^l, s^u=ComputeBounds(fspec)
O=OrderCoefs((h^l, h^u))
repeat
Q=Q+1,H^l=[($h^l . 2^Q$)],$H^u = [(h^u . 2^Q)]$
If Check Validity((H^l, H^u)then
Sol=DFS(fspec,O,Q,h^l, h^u, s^l, s^u)
until sol ≠ Φ
return sol

C. NAIAD: An approximate FDO algorithm

NAIAD was developed based on two groups.
i) given channel details, finding an arrangement of floating-point coefficients, that satisfy s the channel requirements, takes a polynomial time[4],[6]; ii) given an arrangement of coefficients, finding a multiplier less configuration of coefficient increases including various adders /subtractors near the base should be possible in a sensible time. NAIAD it mainly two parts **i**) investigating sets of coefficients that fulfill the channel imperatives and finding the ones with the smallest EWL value; ii) investigating the inquiry zone in the area of every arrangement got in the initial segment and finding the one that prompts the base configuration unpredictability.
1) Exploring Coefficients Satisfying Filter Constraints- To investigate conceivable arrangements of coefficients, which fulfill the filter con-strains, methodically, the variable is incorporated into the left and right sides of channel imperatives of (4). To discover its lower bound, , the accompanying LP issue is fathomed:

$$\begin{aligned}
&minimize : f = \epsilon \\
&subject\ to : s(1-\delta_p)-\epsilon \le G(w) \le s(1+\delta_p)+\epsilon, \quad w \in [0, w_p] \\
&\qquad s(-\delta_s)-\epsilon \le G(w) \le s(\delta_s)+\epsilon, \quad w \in [w_s, \pi] \\
&\qquad h^l \le h \le h^u \\
&\qquad s^l \le s \le s^u
\end{aligned}$$

Where s is the scale factor, h is the filter coefficients, € is the continuous variable.

Algorithm 2-

```
LSM(fspec,ISP,cost,Q)
bc=cost,bs=ISP
loop
repeat
    w2repeat=0
    O=GenerateAnOrdering([M])
    for i=1to[M]+1do
```

$h^u o(i)$:
$(h^i o(i)\,)$)) =
findLUB(0(i),fspec,ISP,Q)

for c=$[h^i o(i)]\,to[h^u o(i)]\,do$

```
if c≠ISPo(i) then
            NSP=ISP,NSPo(i)=c
            impcost=ComputeImpCost(NISP)
            ifimpcost < bc then
               W2repeat=1
               ISPo(i)=c,bs=ISP,bc=impcost
until w2repeat=0
if Terminating conditions are not met then
    NSP=ChargeCoefs(fspec,ISP,Q)
    if NSP≠ISP
            ISP=NSP
            impcost=ComputerImpCost(ISP)
            if impcost ≤ bc then
                bs=ISP,bc=impcost
    else
            return bs,bc
    else
            return bs,bc
```

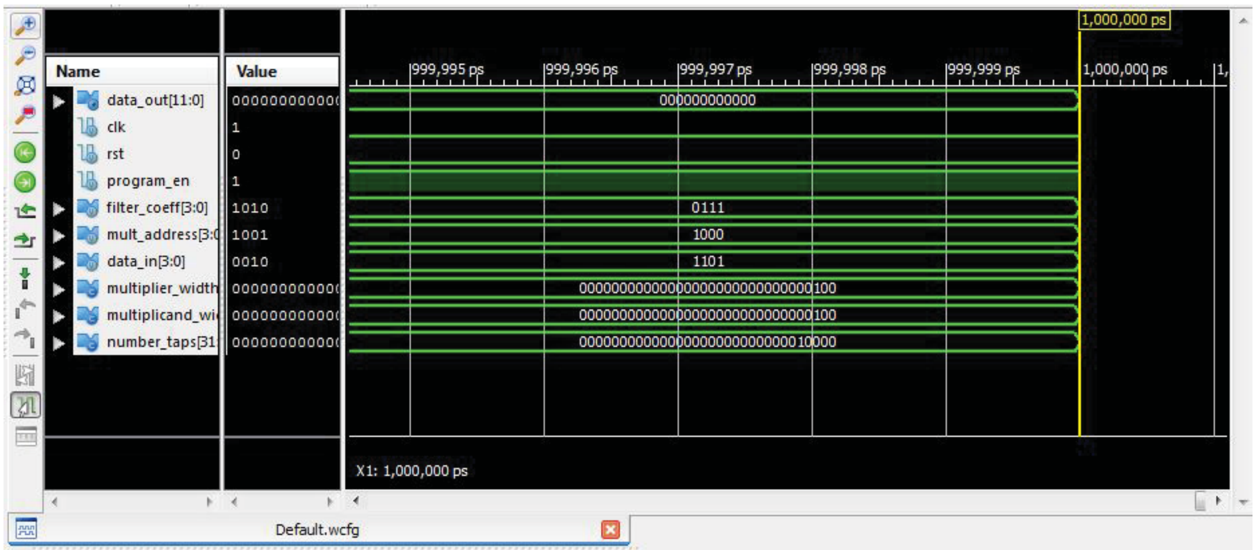
D. Exploring sets area around coefficients-

A local search method (LSM) is connected to every component of (an arrangement of coefficients indicated as ISP with its execution taken a toll esteem expense and quantization esteem Q). Its pseudo-code is given in Algorithm 1, where bc and bs are separately the best cost esteem as far as TA and the best arrangement counting the arrangement of coefficients with bc. The bc and bs are at first set to cost and ISP, individually. The LSM capacity intends to investigate the search range around ISP and to diminish the execution expense of the channel outline. To do that this work iteratively takes a coefficient, changes its worth between its lower and upper limits, finds the usage expense of the new channel outline unfailingly, and keeps the one with the base expense.

COMPARISION TABLE

TECHNIQUE	AREA COMPARISION	DELAY COMPARISION
FIR WITH DBR	542	11.773 ns
FIR WITH EXACT GB	542	11.773 ns
FIR WITH ECHO-A	346	11.698 ns

III. SIMULATION RESULT



IV. CONCLUSION

An exact and approximate FDO algorithm, with an efficient methods to locate the least operations in the shift-add design of the coefficient duplications. Then the common sub expression, graph based, digit based recording algorithms was implemented with low complexity architectures. Device utilization and delay values are compared. Hence the conclusion compares the area and delay to find the filter coefficients using common sub expression, graph based, digit based recording algorithms .Future enhancement of this is to design FIR filter using filter coefficients and taking another coefficients pair using digit bit size and implement fir filter ..

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