CHAPTER 54

TECHNOLOGY
ELECTRONICS & COMMUNICATION
ENGINEERING

Doctoral Theses

01. AGGARWAL (Apoorva)
Design of Optimal Filters.
Supervisor : Dr. Tarun Kumar Rawat
Th 24210

Abstract
(Verified)

Filters characterize most of the signal processing devices significantly. Digital filters have grabbed attention of many researchers from last few decades due to their enormous applications in engineering fields such as signal processing, control engineering, biomedical signal processing, image processing, telecommunication, etc. The problem of filter design can be viewed as a constraint minimization problem, to meet all requirements with acceptable degree of accuracy for an optimal design. To find a more efficient techniques and application based optimal solution is still an active field of research. There are different gradient based techniques that exist for the design of FIR filter such as least squares, windowing, minimax, maximally flat, the L_1-method, etc. These classical methods are complex and require loads of computations. In recent years, researchers have analyzed that optimization algorithms, designed by modelling the natural procedures are advantageous in solving numerical optimization problem of filter design. This thesis applied evolutionary algorithms for the optimal design of digital filters band differentiators that compute the optimal filter coefficients in frequency domain with great accuracy, based on a novel fitness function using the L_1-norm. The 1-D FIR filters are optimized using the L_1-method, real-coded genetic algorithm (RCGA), particle swarm optimization (PSO) and cuckoo-search algorithm (CSA). Further, in this thesis, the design of 2-D FIR filters is presented designed using the 2-D L_1-method, RCGA, PSO, GSA and hybrid PSO-GSA methods. The results affirm that the proposed 2-D FIR filter designs are efficient when compared with the existing designed filters. This thesis also focused on the design of 1-D FIR and IIR, and 2-D FIR digital differentiator (DD) using the L_1-method and L_1-norm based RCGA, PSO, bat algorithm and CSA. The designed DD are compared with existing designs and are found to be more appropriate in terms of magnitude error.

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02. BARSAINYA (Richa)
Some Investigations into Wave Digital Filter Theory and Design.
Supervisor : Dr. Tarun Kumar Rawat
Th 24203

Abstract
(Verified)

In this thesis, novel wave digital equivalents of analog passive elements and new class of second order digital filters are developed. A new GIC digital structure is developed using the concept of wave characterization of wave theory and two s-to-z transformation techniques such as fractional bilinear transform, Al-Alaoui transform are employed for the discretization procedure. The new GIC structure developed using fractional bilinear transform is named as the fractional GIC structure whereas structure procured using Al-Aloaui transform is called new GIC structure. The resultant GIC structure is used to realize biquadratic digital filter sections from an analog reference configuration, comprising GICs and resistors. These second-order digital filter sections are used as building blocks in cascade synthesis. The noise performance of the resultant 6th order filter is compared with that of conventional GIC digital filter. The statistical analysis of power spectral density is carried out to show the comparison with the conventional design of filter. Lattice wave digital filter is utilized for differentiator design as it is known for explicit properties and advantages. LWDF is considered as the target filter for the novel design of differentiator which requires minimum number of multiplier for its structural realization. The differentiator design problem is formulated as an optimization problem using transfer function of the lattice wave digital filter. Three optimization algorithms, namely, genetic algorithm, particle swarm optimization and cuckoo search algorithm are applied to determine the optimal LWDF coefficients by minimizing the error function. The optimized coefficients of lattice wave digital filter leads to the design of optimal differentiators. The realization of differentiator using LWD structure increases the design accuracy, as only N number of coefficients are to be optimized for Nth order LWDF based differentiators. Two design examples of 3rd and 5th order lattice wave digital differentiators are demonstrated to justify the design accuracy.

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