



# Optimization algorithms, an effective tool for the design of digital filters; a review

Renjith V. Ravi<sup>1</sup> · Kamalraj Subramaniam<sup>2</sup> · T. V. Roshini<sup>3</sup> · Sundar Prakash Balaji Muthusamy<sup>4</sup> · G. K. D. Prasanna Venkatesan<sup>5</sup>

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## Abstract

Nowadays, optimal and intelligent design approaches are vital in almost all areas of engineering. Scientists and engineers are attempting to make frameworks and models more proficient and intelligent. This paper deals with a detailed investigation on design of various digital filters using optimization algorithms. Generally digital filters are classified into two types which are FIR and IIR filters and are again classified into one dimensional, two dimensional and three dimensional filters for signal, image and video respectively. The design of a digital filter that satisfies all the required conditions perfectly is a challenging factor. So, apart from the conventional mathematical methods, optimization algorithms can be used to design optimal digital filters. IIR Filters are infinite impulse response filter; they have impulse response of infinite duration. FIR Filters are finite impulse response filters; they have impulse response of finite duration. In this paper we have discussed the design of various optimal digital filters based on various optimization algorithms, for processing of signal, image and video. The design of digital filters based on Evolutionary algorithms and swarm intelligence algorithms like Genetic Algorithm, Particle Swarm Optimization, Artificial Bee Colony Optimization, Cuckoo Search Algorithm, Differential Evolution, Gravitational Search, Harmony Search, Spiral Optimization, teaching–learning based optimization, wind driven optimization, hybridization of optimization algorithm are presented.

**Keywords** Optimized filter design · Evolved filter design · Filter design using metaheuristic optimization · Nature inspired filter design · Filter design using optimization · Bio inspired filter design · Filter design using heuristic search · Hybrid optimization algorithms

## 1 Introduction

Digital Filters are basically used to reduce or obtain certain aspects of the given signal. It is based on mathematical operations which are applied on the sample discrete time signal. Digital filters (Proakis and Manolakis 2007) are classified into types which are finite impulse response filter (FIR) and infinite impulse response filter (IIR). Based on the dimension of input signal these filters are further classified into two, which are one dimensional (1D) filters and two dimensional (2D) filters for signal and image processing respectively. Since FIR digital filters are inalienably stable and can have linear phase, they are commonly favoured over

IIR filters. These FIR filters have numerous essential applications in digital signal and image processing.

The design of digital filter involves, determination of a set of filter coefficients which are satisfying the features, and are affecting its performance such as width of pass-band and stop band, attenuation of stop band, overall gain, cut-off frequencies and tolerable ripples in the pass band and stop-band. There are many conventional methods such as windowing functions as Butterworth, Chebyshev, Kaiser etc., transformation technique like bilinear transformation for filter design. Remez exchange algorithm proposed by Parks and McClellan and Steepest-descent method for optimization of digital filter development by selection of filter coefficients, but they are not suitable for FIR filter optimization because of the several reasons (Singh 2014).

An optimisation algorithm is fundamentally a strategy to locate the best feasible solution to a problem out of the different accessible solutions, there could be no single method

✉ Renjith V. Ravi  
renjithravi.research@gmail.com

Extended author information available on the last page of the article