Optimizing Filter Parameters using Particle Swarm Optimization

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ABSTRACT

Filters of some sort are essential to the operation of most electronic circuits. It is therefore in the interest of anyone involved in electronic circuit design to have the ability to develop filter circuits capable of meeting a given set of specifications. Unfortunately, many in the electronics field are uncomfortable with the subject, whether due to a lack of familiarity with it, or a reluctance to grapple with the mathematics involved in a complex filter design. Filter designers often have to calculate the best parameters to suit the filter specifications.

Software is typically used to help estimate those values, but sometimes the parameter combination cannot yield perfect results. Calculating the filter parameters using transfer functions would be more challenging with filters that have high orders. This project presents an application of a Particle Swarm Optimization algorithm (PSO) for designing high order filter. The proposed algorithm was successfully applied on a six-order elliptic filter, and has been shown to work well. It is applied by calculating the mean-squared error between the ideal response and the actual response of the signal. Results have showed that the PSO have able to find all parameters with the least amount of mean-squared error.

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CHAPTER 1

INTRODUCTION

1.1 PROBLEM STATEMENT

Multistage filters usually require significant time and are tedious to design them due to its complexity of its circuit. Typical filter designs use mathematics to solve complex transfer functions of the filters. During the process, errors, estimations and rounding make the result unsatisfactory.

There are several softwares that help the designer to design filters, such as FilterPro from Texas Instruments. This software works when the designer insert several needed parameters into the software and it will automatically gives out the RLC value. Several specifications need to be entered, and the software will automatically find the parameter values. Even so, we might expect that the software too is using some estimation to arrive at the solution. This is because the software is using TINA simulation software, where the set of predefined values are already been defined and only needs several parameters to complete the calculations. The software also only can calculate filter parameters up to only 10 stages.

In this project, a modified Particle Swarm Optimization (PSO) [1] algorithm was used for the filter parameters optimization. PSO was chosen because of its good convergence properties and speed when applied to various optimization problems [2]. PSO has a successful track record in solving many optimization problems [3-7]. The algorithm is simple, computationally inexpensive, fast and efficient [1, 8-10]. The PSO algorithm was used to find all parameters of the chosen filter design by automatically plotting the signal response on a logarithmic scale and compare it to an ideal signal response. Then its mean squared error (MSE) is calculated and returned back into PSO to do next optimization.