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Designing of FIR Filter Using Genetic Algorithm

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Abstract :- **F**iltering involves manipulation of signal by passing or blocking certain part of signal. Filters are used to separate or combine different frequencies. There are various applications of Digital filters. An efficient design algorithm for FIR filter design has been presented using genetic algorithm. This algorithm provides the flexibility in control of various parameters such as population size, number of generations, crossover probability and so on.

Keywords: - *FIR (finite impulse response), IIR(infinite impulse response), GA(genetic algorithm).*

I. INTRODUCTION

Finite impulse response (FIR) filters have many applications within a wide range of digital signal processing. Some of these applications require the filter to operate at very high data rates, which gives rise to the need for dedicated high speed application specific integrated circuits. FIR filters are usually thought of as comprised of a sum of time shifted inputs, each multiplied by the appropriate coefficient. Filters are the heart of many design problems. They are used to separate or combine different frequencies, as in frequency converters or multipliers, or in multiplex communications. Nowadays digital filters can be used to perform many filtering tasks and replacing traditional role of analog filters. digital implementation allow to achieve certain characteristics not possible with analog implementation. The electromagnetic spectrum has to be shared, filters are used to confine the radiation from high-power transmitters within assigned spectral limit, conversely, other filters are used to protect receivers from interference outside their operating range. Digital filter is very important tool in digital signal processing field. This is used for the separation of signals that have been combined and the restoration of signals that have been distorted by some way. [2].Genetic algorithm can be successfully employed for cost function minimizing or maximizing. The implementation of digital filters using infinite-precision coefficients introduces quantization errors. major concern in FIR design with restricted coefficients is that the cost function of the filter is generally multi-modal with respect to the filter coefficients. The design of quantized digital FIR filters, being an optimization problem over a discrete coefficient space. Genetic algorithm optimization methods have emerged as a powerful approach to solving the more difficult optimization problems[1]. As a stochastic algorithm, GA can be used to solve complicated problem with a huge search space, the discrete search space is partitioned into smaller ones. Each of the small space is constructed surrounding an optimum continuous solution with a floating passband gain. This algorithm tend to require a large amount of computation, it also offers certain unique features with respect to classical gradient-based algorithms. FIR filters are often used in many phase-sensitive applications because they can always be designed to have linear phase. They are inherently stable due to its poles which lie at the origin .This increases the chances for the GA to find feasible solutions, but not scarifying the coverage of the search space.[3].

II. GENETIC ALGORITHM

A Genetic Algorothm mimics the process of natural evolution. By using such evolutions, the solution gradually evolves to the optimum solution. Basically, in GA, potential solutions of the unknowns are encoded to chromosomes and three genetic operations including selection, crossover and mutation are applied to these chromosomes. after initializing the first generation population of the chromosome , some individuals in the existing population will be selected according to a certain selection mechanism. Those selected individuals are called "parents" and they will produce "children" by crossover and mutation operators. The generation process containing selection, crossover and mutation will be repeated until certain termination criteria has been reached.at the first, a set of coefficient chromosomes is randomly selected. After that these chromosomes are encoded as binary strings called genotypes. Genetic operators such as crossover and mutation are applied on each individual genotype chromosome to produce new generation of offspring chromosomes. Corresponding to each genotype, there is a decimal equivalent,which is called phenotype, used to evaluate cost function. According to the problem under consideration, each individual in the population is assigned, by means of a cost function, which is a measure of its goodness. Best fitted chromosomes, called elite chromosomes are transmitted as it is to the next generation. With each generation, better solutions are obtained. The genetic algorithmn comprises three genetic operations reproduction, crossover and mutation. These three operations are applied again and again, starting from an initial population of individuals. Only good individuals remain in the population and reproduce, while the bad individuals are eliminated from the population Finally, the population will consist only of the best individuals fulfilling the design specification. With the use of natural selection and genetic operators, mutation and recombination, chromosomes with better fitness are found. Genetic algorithm offer a generational improvement in the fitness of the chromosomes. According to Darwin's theory of evolution the best ones should survive and create new offspring. There are many methods for the selection of the best chromosomes, for example-roulette wheel -selection, Boltzman selection, tournament selection, rank selection, and steady state selection. There are four types of crossover Operation : single point crossover, two-point crossover, uniform crossover and arithmetic crossover There are many ways to encode the chromosome such as binary encoding, permutation encoding, and value encoding. In binary encoding every chromosome is a string of bits, 0 or 1. In permutation encoding, every chromosome is a string of numbers, which represents number in a sequence. Permutation encoding is used only for ordering problems. In the case of value encoding, every chromosome is a string of some values. Values can be anything connected to problem, from integer numbers, real numbers or characters [5].

Basic steps of genetic algorithm are-

1)POPULATION

At the first each bit is encoded as a gene and a string of genes are called as chromosome and a set of chromosomes is called population. First step to start with is to initialize the population is called as initial population. Typically, the initial population of m solutions is selected completely at random, with each bit of each solution have a 50% chance of taking the value 0[4].

2)EVALUATION

In the second step each chromosome has to be assessed and to assign a value called fitness value, larger the fitness value, the probability will be more to select it for reproduction. Fitness is the measure of goodness of a chromosome[4].

3)SELECTION

In this step the individual chromosomes which have best fitness values are selected and proceeded for next step called reproduction where blending of the both parents would be carried to process new offspring[5]. Two regularly utilized methods are „roulette wheel‟ & „tournament‟ selection Over roulette wheel, every individual will be allocated a sector size proportional to their fitness evaluated The wheel is then spun and the individual inverse to the marker turns into a standout amongst those as parents[3].

4)REPRODUCTION

In this step two chromosomes which are selected based on their fitness value from the population undergo a process called reproduction to produce offsprings. Parents who have better fitness values have superior possibilities to be selected for production of fine offsprings[4].

5)CROSSOVER

Crossover refers to replacing some of the genes of one parent with that of the other parent. Crossover fraction decides the amount of genes replaced. crossover is important random operator. By Choosing a random point which is called crossover point and Splitting the parents at this crossover point and Creating children by trading their tails is called crossover process. function of the crossover operator is to generate new 'child' chromosomes from two 'parent' chromosomes by combining the information extracted from these parents. the probability for crossover ranges typically from 0.6 to 0.95.

6)MUTATION

Mutation is the random changes done to a chromosome in order to get a good fitness value. Mutation reintroduces the genetic diversity into the population. Mutation includes choosing a subset of genes randomly.

III. FIGURE

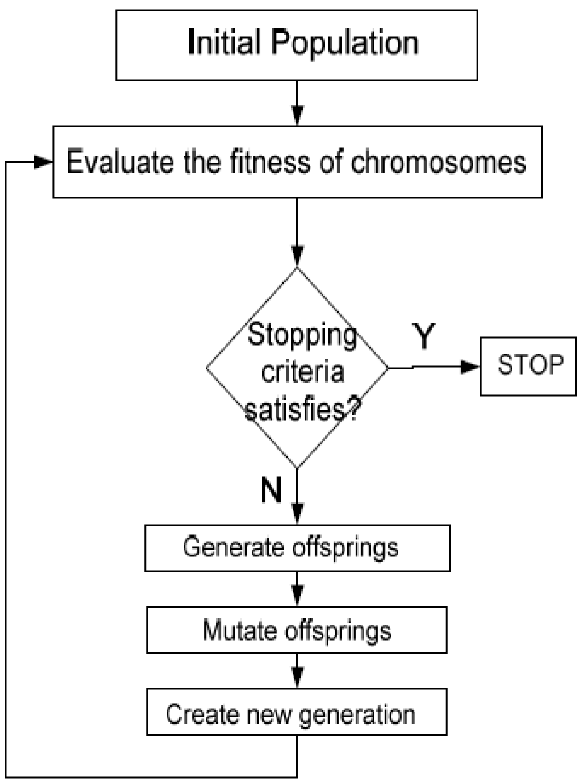

Fig.1 Typical flow of a genetic algorithm

Step 1:

Initial population has been set which is set of chromosomes and the chromosomes are the string of genes.

Step 2:

Fitness of chromosomes is evaluated each chromosome has to be assigned a fitness value which is the measure of goodness of a chromosome.

Step 3:

Check whether the desired fitness value has been achieved or not. If the desired value of fitness function has not been achieved then the process is stopped.

Step 4:

Crossover process is applied to generate new offspring using the two parents. Splitting of parents has been done at the crossover point. A new child chromosome is created using two parent chromosome.

Step 5:
Mutation is applied to the offspring, in this process of mutation random changes has been done in a chromosome in order to get better fitness value.

Step 6:
New generation has been created based on the new fitness value.

IV. CONCLUSION

When genetic algorithm designing new filters, it directly optimizes the coefficients by considering the quantization effect. On the other hand, when the genetic algorithm mapping predesigned filter coefficients to integer arithmetic, since hand quantization does not results in optimal results, it can quickly find a satisfactory result. The proposed technique achieves the optimum number of coefficients required to get the desired frequency response. . This genetic algorithm can modify and reshaped as the specific needs and characteristics of the applications

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